Chapter

Antioxidant Properties of Alpine Plant

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Abstract

Alpines are the exceptional regions of the world's biomes. They have unique climatic and topographic conditions; they are the habitat of some of the highly specialized flora and fauna. The harsh environmental conditions and extreme fluctuations in them on a seasonal and diurnal basis created extremely stressful situations for the alpine plants. Such stress causes damage to biochemical structures and compounds of the plant cells leads to the production of free radicals, *i.e.* reactive oxygen species (ROS), which can further damage the plant cells or tissues. Alpine plants protect themselves from those ROS efficiently by their highly competent enzymatic and non-enzymatic antioxidant system. In general, this protection increases in alpine plants with altitudes; however, some exceptions are also reported. Antioxidant compounds *viz.* ascorbic acid, tocopherol, glutathione, carotenoids found in alpine flora in higher concentrations as compared to low land plants. Phenolic compounds protected the alpine plants from UV induced ROS by screening the UV radiations and blocking their entries in the cell's mesophyll. This higher antioxidant potential of the alpine plants is highly beneficial for the human being as most alpine plants are the sources of some life-saving drugs.

Keywords: enzymes, non-enzymatic compounds, UV radiation, medicinal plants, freeze–thaw cycles, flavonoids

1. Introduction

Alpine biomes of the world are characterized by their unique features and usually lie between an altitude of about 10,000 feet (3,000 meters) and where the snow line of a mountain begins. The Alpine and Arctic biomes cover 16% of the earth's surface area. Testolin *et al*. [1], based on regional tree line models, estimated their extent to 3.56 Mkm^2, corresponding to 2.64% of the total land area outside Antarctica. Asia hosts almost three-fourths of the global alpine area with 2.59 Mkm^2, followed by South America (15%; 0.55 Mkm^2), North America (9%; 0.32 Mkm^2), and Europe (2%; 0.08 Mkm^2), while Oceania and Africa together contribute to only 1% of the global alpine area. The climate of the alpine regions is dynamic and changes as you move above the lower to higher elevations. The most prominent environmental factor, *i.e.* the temperature normally drops by about 10 °C for every 1000 meters as we go up a mountain. The alpine regions experience a long and cold winter season that lasts about nine months in some alpine areas of the world from around October to May. Temperatures in summer normally ranges from 40 to 60 °F and may last from June to September. Temperature shows very high fluctuations and can normally drop from warm to freezing within a day. The alpine biome is usually dry, with an average precipitation of 12 inches (30 cm) each year. Topographical specialization such as physical gradients, rough terrain, and relative isolation, mountains created attitudinally segregated life zones, and harsh climatic factors of the regions make them very special and unique habitats of some wonderful floras around the world. However, to grow in such a harsh environment, they must have to cope up with the related constraints, including reduced O_2 and CO_2, strong winds, high solar irradiance, shallow rocky soils, low temperatures, and low water and nutrient contents, UV radiation, large temperature variations, *etc.* [2]. Combinations of high-altitude environmental stress lead to increased reactive oxygen species (ROS) production, which increases the risk of oxidative damages in the alpine floras. For performing the vital life functions, alpine flora must quench those ROS. Thus, the alpine flora showed specific adaptations such as accumulation of the secondary metabolites (SMs). Several enzymes such as ascorbate peroxidase, catalase, superoxide dismutase, and glutathione reductase, *etc*., and other specific molecules such as carotenoids, xanthophylls, *etc.*, play an important role in the protection of alpine flora from the ROS. In this chapter, we will adress the challenges related to ROS production and protection from them in alpine plants.

2. Challenges of alpine habitats that leads to ROS production

Reduced or lower partial pressures of physiological gases (Atmospheric pressure is reduced from sea level values of c. 1000 h Pa (1 bar) by c. 10% for every 1000 m in elevation.), and other associated factors, for example, lower temperatures, correspondingly more precipitation falling as snow, and less atmospheric attenuation of radiation affected the life processes of the alpine plants. Temperature directly affects the plant metabolism by affecting them at the molecular *viz.* DNA, proteins or supramolecular *viz.* membranes, chromosomal structures [3]. The chilling temperature causes decreased activities of several enzymes, including the kinases, carboxylases, *etc.* involved in respiration and photosynthetic processes. Further lowering of the temperature beyond the freezing point leads to the cessation of the vascular functions. Other cytosolic damages involve the complications like the formation of embolisms or cavitation in the xylem and injury to cell membranes.

Along with this alpine region experiences unusually higher diurnal temperature fluctuations, the temperature may range from 0–18 °C from dawn to dusk, on these conditions, leaf temperatures might increase up to 35 °C and lower up to −7 °C to 28 °C. The freeze–thaw cycles operated in plants due to fluctuating diurnal and seasonal temperature may inactivate the PS II and catalase [4] and can enhance the ROS formation in the alpine flora. Radiations affect the alpine environments positively and negatively; for example, positive longwave radiation balance warms leaves in the cool alpine, but the more common negative longwave balance cools minimum temperatures in an already cool environment. Visible shortwave (solar) radiation drives photosynthesis and warms leaves but can also cause photochemical problems [5]. The most destructive radiations in the alpine region are ultraviolet radiation that may cause photochemical damage and other somatic and molecular damages in the alpine flora. High irradiation coupled with low temperature and other stresses leads to the photosynthesis machinery's photoinhibition and halts in synthesis, transport, and storage of the resources. Desiccation is also a profound problem in the alpine plants that are experienced by the plants either in winters due to the freezing lead complications in the plants *viz.* root damage, loss of xylem conductivity, ice formation inside the plants, and in the summer when warmer temperatures can intensify the leaf-to-air vapor deficit and further stimulated the desiccation stress [6]. All the above factors lead to the formation of the ROS that may lead to damage to the general cellular structure and loss of function and block of basic metabolism and repair processes [7], and control of ROS formation and ROS detoxification might be of key importance for the survival of alpine plants.

3. ROS protection in alpine plants

Plants operated several mechanisms to quench the ROS based on the enzymes and several other compounds, including several primary and secondary metabolites. Antioxidative enzymes enhanced their activities, and other lipid and water-soluble compounds, which serve as antioxidants, increase the tolerance in plants to several stresses responsible for ROS productions [8, 9]. Alpine plants also adopted numerous biochemical strategies to quench the ROS that may damage the lipid membrane generated during the physiological process. These strategies included oxidation of superoxide by cascades of enzymatic reactions and accumulation of the compounds like carotenoids, a-tocopherol, ascorbic acid, glutathione, flavonoids, *etc.* [10, 11, 12]. Mostly high altitudinal ecotypes consisted of higher antioxidants than their lower altitudinal counterparts mainly due to combined effect and higher light intensities and lower temperature as compared to lower elevations [13, 14].

3.1 Enzymatic antioxidant protection in alpine plants

The enzymatic antioxidative defense system is the cascade of the many enzymes; some of them catalyzes the ROS degradation [superoxide dismutase (SOD, EC 1.15.1.1), catalase (CAT, EC 1.11.1.6), guaiacol peroxidase (POX, EC 1.11.1.7), glutathione peroxidase (GPX, EC 1.11.1.9), *etc.*] and other's regenerated the soluble antioxidants [ascorbate peroxidase (APX, EC 1.1.11.1), monodehydro ascorbate reductase (MDAR, EC 1.6.5.4), dehydroascorbate reductase (DHAR, EC 1.8.5.1), and glutathione reductase (GR, EC 1.8.1.7)] [15]. Alpine flora showed an increase in many of these enzymes, such as CAT, SOD, APX, DHAR, GR [16, 17] but some plants also showed a contradictory pattern. For example, the SOD, GR, and CAT activities were higher in the leaves of *Soldanella alpina* but lower in leaves of *Ranunculus glacialis* [18]. Other plants also showed the range of the variations in antioxidant enzyme activities; for example, extremely higher antioxidant enzyme activities were found in high altitudinal ecotypes of *Soldanella pusilla* moderate in *Poa laxa*, *Carex curvula* and lower in *Taraxacum alpinum, Dryas octopetala,* and some other species [6, 18, 19]. For example, *Polygonum viviparum* showed increased antioxidant enzyme's activities as the altitude increases in the Tianshsan Mountain [20]. During the winter acclimation and spring rewarming, the role of the antioxidant enzymes becomes more prominent, especially in the perennial plants where roots also efficiently takes part in ROS quenching as found in roots of perennial grasses *Poa sphyondylodes, Bromus inermis, Bromus sinensis, Elymus nutans* [21]. In alpine plants, antioxidant enzymes are also involved in the freezing resistance [22] and protected the plants from the ROS produced due to the freeze–thaw cycles of the alpine habitats.

3.2 Non-enzymatic antioxidant

Non-enzymatic antioxidant comprises the major cellular redox buffers which interact with various cellular constituents includes the compounds like ascorbic acid (AA), glutathione (γ-glutamyl-cysteinyl-glycine, GSH), tocopherol, carotenoids, and phenolic compounds. These commands also served as the cofactors of the various enzymes involved in ROS quenching [23]; along with this, these compounds also participate in UV protection.

3.2.1 Ascorbic acid

L-ascorbic acid (L-AA or vitamin C) is the most important antioxidant found in the plants that also takes part in various physiological and developmental processes in the plants protected critical macromolecules from the ROS. Alpine plants are very specific about the L-AA, and some contain extremely high L-AA content. For example in the young leaves of *Soldanella alpina* [12] and *Polygonum viviparum* [20] reported a very high L-AA range. In few alpine species, ascorbate/L-AA is the major C metabolite after sucrose; for example, in the leaves of *S. alpina* [12] in such plant species majority of L-AA found outside the chloroplasts [18]. Although in some alpine flora relatively lower level of L-AA was reported, such as in *Ranuculus glacialis* and *Homogyne alpina,* and most of their L-AA content was reported to present in the chloroplasts. The importance of ascorbic acid in antioxidant protection was determined by Wildi and Lutz [19]. They found an increasing level of antioxidant content in some alpine plant species as the altitude increases. The role of the ascorbic acid is most prominent in this increase where they correlated this increase to increase in light intensity as altitude increases. The concentration of L-AA within an alpine plant species also reflected the diurnal variations. The rhythm of L-AA concentration was reported to go along with light intensity; hence the lowest L-AA was observed at the time of lowest light intensities and lowest temperature in some alpine plants [19].

3.2.2 Glutathione

Glutathione is a tripeptide (γ-glutamyl-cysteinyl-glycine; γ-Glu-Cys-Gly) with long hydrophilic groups and a key low molecular weight non-protein thiol compound known to play a crucial role as an antioxidant [24]. Glutathione also helps in the regeneration of other antioxidants, ascorbic acid and tocopherol, it is the substrate of dehydroascorbate reductase that catalyzes the regeneration of reduced ascorbate, which is the substrate for ascorbate peroxidase regenerated α-tocopherol while detoxifying of H_2O_2 and arresting lipid peroxidation reactions [25, 26]. Potentially higher glutathione synthesis was observed in many plant species in stress conditions, especially in high light intensities, chilling, or freezing temperatures, as reviewed by Tausz [27] and Hasanuzzaman *et al*. [28]. Alpine plants did not show uniformity in the presence of glutathione concentrations; for example, it was higher in *Taraxacum alpinum* and *Soldanella alpina* and comparatively lower in the *Homogyne alpina* and *Ranunculus glacialis*. In general, the alpine plant showed an increase in glutathione concentrations with increasing altitudinal gradients [19], as found in *S. alpina* and *R. glacialis* [26]. Diurnal variations were also observed in studied alpine flora where with increased glutathione concentrations during the morning and maximum during the mid-day and the concentration decline continuously in the afternoon and reached a minimum in the night [19]. Wildi and Lutz [19] also reported the diurnal fluctuations in the glutathione concentration in the alpine plant-like *T. alpinum* and *H. alpina,* which depend on the light intensities and the temperature differences. Glutathione plays an important role in the chilling and freezing protection along with other antioxidants from low temperature in the non-acclimatized plants as well as the acclimatized [29, 30]. Glutathione also plays an important role in increasing the alternative antioxidative scavenging by ascorbate and enzymes like catalase [26], and the glutathione status also acts as a signal or modulator for stress response in the plants [25, 31].

3.2.3 Tocopherols and tocotrienols

Tocopherols and tocotrienols, collectively termed tocochromanols are lipid-soluble molecules with a polar chromanol ring and a hydrophobic polyprenyl side chain [32]. They are synthesized in the shikimate and 1-deoxy-D-xylulose 5-phosphate (DOXP) pathways. The tocopherols are the tocochromanols having a fully saturated side chain. In contrast, tocotrienols are with an unsaturated side chain, and the naturally occurring form of tocopherols *viz.* α, β, γ, and δ is determined by the number of methyl groups in the chromanol ring. Tocochromanols participate in the quenching of peroxyl radicals and other ROS [33] and an important thylakoid-bound radical scavenger. The levels of tocopherols are generally high in some alpine and arctic plants; however, some exceptions are also present, for example, leaves of *Ranunculus glacialis* in which it is extremely low [19]. However, range of the variations was also observed in the tocopherols in the alpine plants [12, 18, 19] for example, Sickel *et al*. [34] showed the range of concentrations of the tocopherols in the dominants fodder species of the alpine pastures of the Norwegian alpine region from 2 to 664 μg g^{-1} DW as the lowest level in *Avenella flexuosa* and tocopherol pool in all studied species was dominated by α-tocopherol. However, *Vaccinium myrtillus* showed relatively higher γ-tocopherol [34]. Tocopherol concentration also showed the diurnal rhythm in alpine plants. That was light and temperature-dependent in the study of the Wildi and Leutz [19], in which midday was represented by higher tocopherol concentrations and lower during the night. The fluctuations in the a-tocopherol content may be due to the rapid turnover of this compound. The plants react with rapid changes in the level of tocopherols to the slight differences in the environment (e.g., shading and chilling) [19, 35]. Light conditions affected the levels of tocopherols in the plants, and plants are grown in higher light exposer generally have higher tocopherol levels than plants from shady habitats. Concentrations of tocopherols increase typically with increasing altitudes in alpine plants as found in *Soldanella alpina* leaves in which a-tocopherol content showed a 2-fold increase at 2000 m as compared to 1000 m [19]. Tocopherol plays an important role in cold hardening, chilling, and freezing resistance in the various plants, including the alpine flora, as reported in Scots pine, where cold acclimatized older needles contain higher a-tocopherol levels than younger ones [36]. γ-tocopherol may also play an important role as an antioxidant in tissue that exhibits desiccation stress and an indicator of senescence and senescence-related changes.

3.2.4 Carotenoids

Carotenoids are lipophilic pigment and antioxidants which can quench the ROS like toxic oxygen and hydroxyl radicals [37] and broadly classified as hydrocarbon carotenes (included α-carotene, β-carotene, γ-carotene, lycopene, phytoene, and phytofluene) and oxygenated xanthophyll (lutein, zeaxanthin, β-cryptoxanthin, astaxanthin, and fucoxanthin) [38, 39]. Carotenoids are the parts of the light-harvesting complexes (LHC) and play a prominent role as photo-protectant by harvesting light efficiently along with chlorophyll [40] and quench the ROS before these species initiate the oxidative damage. The carotenoids quench the excess light energy and subsequently the ROS production via active non-photochemical quenching (NPQ) or by the dissipation of heat [40, 41]. Singlet oxygen formation at the PSII may damage the D1 protein of the PSII during photo-inhibition and initiate the lipid peroxidation in the chloroplast and carotenoids along with tocopherol protect chloroplast from this peroxidation [41, 42] and among all the carotenoids zeaxanthin reported to have the higher antioxidant capacity [43]. Singlet oxygen produced due to the low temperature-induced photoinhibition is reported either efficiently scavenged or its formation is avoided, which have a high implication on the alpine plants due to their low-temperature habitat. Under high light intensities, ROS production increases at PSI, including hydrogen peroxide (H_2O_2) and singlet oxygen at the PSII in the chloroplast [41]. Alpine plants are exposed to very high light intensities in their habitats. In that scenario role of carotenoids became most prominent from ROS protection in such high light intensities and, along with other antioxidants, carotenoids such as zeaxanthin, neoxanthin, and lutein [43] efficiently quenching ROS in alpine plants. That's why sun-exposed plants of higher altitude are characterized by the higher ratio of Chl a/b and b-carotene/xanthophyll accompanied and a lower ratio of Chl/Car, which results mainly from higher contents of xanthophylls and is interpreted as a higher capacity for non-radiative dissipation of excitation energy and antioxidative protection by carotenoids [6]. ROS are highly reactive and therefore accelerate photoinhibition through direct oxidative damage to PS II. However, the highly variable carotenoid content, especially the zeaxanthin contents reported in alpine plants, for example, a study by Streb *et al*. [18], reported a very high level of carotenoids and xanthophyll cycle pigments in leaves of *Soldanella alpine* and *Homogyne alpina* as compared to *Ranunculus glacialis* leaves. Oncel *et al* [44], in their study also reported the presence of the high b-carotene and xanthophyll in the alpine plants, and among the various alpine plant forms the higher b-carotene content was reported in tree and brush as compared to the herbaceous plants. The diurnal variations observed in the pigment content and carotenoids in alpine plants represented a light-dependent control study by Wildi and Leutz [19], showed all carotenoids except lutein and neoxanthin were showed diurnal rhythm in selected high alpine plant species. An increase in carotenoid content, especially the xanthophyll cycle pigments, also reported in the alpine plants as reported by Wildi and Leutz [19]. However, no effect of altitude in *R. glacialis*, and even decrease in some species such as in *Dryas octopelata* was reported. Seasonal variations also observed in the carotenoid content as reported by Gonzalez *et al*. [45] in *Polylepis tarapacana* where carotenoids content increase with altitude and exhibited seasonal variations, and the highest value recorded in winter. Hence increased carotenoids content in alpine and high altitudinal plants as a safety valve venting the excessive PAR energy before it can damage the photosynthetic system [46] against the large amounts of solar energy coupled with a low temperature in the alpine habitats [43, 47] along with their role in photosynthesis.

3.2.5 Phenolic compounds

Phenolics or polyphenols are the compounds found in plants that belong to secondary metabolites of the plants. Plant phenolics mainly belong to aromatic metabolites with one or more acidic phenolic hydroxyl groups. Their structure ranges from simple phenols such as salicylic acid to complex polymers such as suberin and lignin. Phenolics in plants included hydroxycinnamic acids (HCAs), flavonoids, anthocyanins, and tannins that are widely distributed in the plant kingdom to the classes that are limited taxonomic distribution such as isoflavones, stilbenes, coumarins, furanocoumarins, and styrylpyrones [48]. Phenolics have several functions in plants; they are an integral part of some structural components of the plants, component of plant–animal interactions, plant–plant interactions, act as signaling molecules, screening of highly visible and UV light, pathogens defenses, and general protection against oxidative stress [49, 50]. The role of phenolic compounds in the alpine became most important, especially for protecting against the harmful UV- radiations that are abundant in alpine regions and increase with elevation [51]. Mostly higher content of phenolic compounds was reported in alpine plants than the plants of the lower altitudes, and the reason for this was sighted there need to adapt to the harsh changing environment [52]. The phenolic compounds may also compensate for the lowering of the radical scavenging activity when temperatures become very low in alpine habitats [53]. Phenolic compounds showed great diversity in the interspecies and intra-species level; such variations were reported by Lefebvre *et al*. [54] on three alpine species *Dryas octopetala, Rhododendron ferrugineum,* and *Vaccinium myrtillus*, where flavonoid content and its diversity is very high in *Rhododendron ferrugineum*. *In vitro* evaluation of the phenolic content in extracts of several alpine plants represented their high antioxidant protection, such as in *Potentilla fulgens* [55]. A study in *Gaultheria trichophylla* an alpine Himalayan plant showed a positive correlation between the altitude with total phenolics, tannins, flavonoids, and flavonols, and a direct relationship with the antioxidant potential of the extract prepared from the species [56]. Seasonal variation in total phenolics in *Acorus calamus* and antioxidant activity was reported by Bahukhandi *et al.* [57]. This high phenolic content and diversity may be responsible for medicinal properties of some of the high valued plants of alpine areas such as *Nardostachys jatamansi*, *Aconetum, Picroriza Kurroa, Rheum* sp., *Hippophae* sp., etc. [58]

4. Freeze and thaw cycle, ROS production and antioxidant protection in alpine plants

Alpine plants have to cope with the phase shifts that are frequent events in the alpine regions, mainly the freeze–thaw cycles that can happen daily during the late winter to early spring. The freezing–thawing cycle (FTC) is a phenomenon in which the soil undergoes repeated freezing and melting due to seasonal or diurnal temperature change [59]. Alpine habitats are represented by the various growth forms such as small prostrate woody shrubs, grasses, sedges, tussocks, herbaceous perennials and annuals, cushion plants, etc. Some of them experienced the diurnal freeze–thaw cycles, and some escaped the seasonal cycle, mainly the herbaceous annuals. Still, almost all of them faced the diurnal freeze–thaw as well as freeze–thawing cycles in spring or autumn [52]. In the alpine regions the most important environmental phenomenon that enflunces the vegetation growth and survival is the freeze–thaw cycle. This cycling causes major complications in plants, such as injuries due to the leakage of cellular solutes [physico-molecular perturbations in cell membranes, and oxidative injury to macromolecules due to cellular accumulation of reactive oxygen species (ROS; e.g., superoxide, singlet oxygen, etc.)] [60]. In the alpine areas, plants mostly experienced two kinds of freeze–thaw moments. One is due to extreme day-night temperature variation, mainly during September–October. The other occurs from November to April, where the temperature is freezing in November and increasing in April [21]. Zhou *et al.* [21] analyzed four grass species from the alpine region for seasonal fluctuation in ROS and antioxidant protection. They found that this freeze–thaw cycle in the autumn destroyed the aerial part of those grasses due to the membrane damage, loss of membrane integrity, and higher electrolyte and lipid peroxidation [21]. This lipid peroxidation resulted due to the decrease in the antioxidant enzyme activities assayed in their work and leads to senescing process. Although roots of those perennial grasses resistant to such freeze–thaw cycle induced ROS with the help of their highly efficient antioxidant enzyme system. Most of the alpine herbaceous perennial plants survived winter with rhizomes, stolons, or other underground storage organs. Those organs may have high antioxidant enzyme activities; besides this, they are rich in secondary metabolites, which also ensures antioxidant protection to them. Complications of the freeze–thaw cycles are more challenging for the alpine woody shrubs, where roots and evergreen leaves have to experience and overcome these freeze–thaw cycles. The diurnal freeze–thaw cycle can also affect the reproductive shoots of several woody and herbaceous plants [61]. Somehow, natural antioxidant protection, either enzymatic or non-enzymatic, is genetically or environmentally induced in the alpine plants to protect them from diurnal and seasonal freeze–thaw cycles. However, the climate changing scenario disturbing this protection, such as unusual late spring frosts, early fall frosts events, a warmer- fall than normal, leaves the alpine plants in the vulnerable stages and subjected them to recurrent freeze–thaw conditions leads to more damage to plants due to more ROS production and little antioxidant protection.

5. Ultraviolet radiations ROS production and antioxidants in alpine plants

High ultraviolet radiations are the characteristic feature of the alpine regions [62]. That can be quite stressful to the alpine lives because of shade-devoid environments and high albedo due to the snow. Increasing UV doses affected the vital processes in plants such as productivity, carbon assimilation, stomatal function, etc. [63] that becomes more relevant when the ozone layer is depleting continuously. Exposure to higher UV radiations leads to the production of free radicals or ROS and other chemically active harmful molecules in the cells that can bring damage to the membrane lipids, nucleic acids proteins including enzymes, etc. [47, 64]. However, alpine plants are protected naturally from the UV radiation's harmful impact with its enzymatic and non-enzymatic equipment. Accumulation of the phenolic compounds such as flavonoids and derivatives of the phenylpropanoid, induction of photo-repair system either prevent the UV from penetrating the cells or help to cells to overcome all the UV driven difficulties. An increase in UV-B absorbing compounds such as pigments like carotenoids, chlorophylls, flavonoids contents was observed in alpine plants with increasing altitude as well as in different seasons [65]. Chanishvili [65] screened various alpine plants, for example, *Tripholium pratense, Plantago major Taraxacum officinale, Achillea millefolium, Polygonum aviculare* for antioxidant compounds content for different altitudes with different level of UV radiations and concluded that the numbers of stress factors in the alpine interacted with UV radiation stress with these plants and the mechanisms of these plant to adapt in such conditions are species-specific [65]. An antioxidant like glutathione, ascorbic acid, phenolic compounds efficiently protect these plants from UV induced ROS, but the protection mechanism or level was species-specific. In the comparison of the herbaceous species, other alpine or subalpine life forms generally have a higher screening capacity of UV radiations [66] leads to more ROS formation in herbaceous plants due to increased penetration of the UV radiations in the underlying mesophyll [67]. In an artificial UV simulation experiment, it was observed that in some alpine plants such as *Carex firma, Dryas octopetala, Ranunculus alpestris, Salix retusa* several striking changes were observed, such as the reduction in glutathione content in most of the studied species. In contrast, other antioxidants such as ascorbic acids, tocopherols, flavonoids seemed to remain unaffected, which means alpine plants are genetically fixed to cope up with such conditions [68].

6. Alpine plants antioxidant and medicinal importance

The alpine plants are packed with antioxidants, and enzymatic as well as non-enzymatic antioxidant makes them quench the ROS produced due to the stressful conditions. Human utilizes this potential of these unique floras for their purposes like food and medicines. The popularity of antioxidants as food and nutraceuticals is increasing globally, and there is a continuous spike in the research on plant-based antioxidants and their medicinal potentials. Several alpine plants were used in various traditional and modern health care systems for their antioxidant activities, which comprises their other properties such as anti-cancerous, immune-modulatory, anti-stress, etc. A range of studies are available on the alpine plants' antioxidant potential [56, 57, 58, 69] and revived by Bhatt *et al*. [70]. Alpine plants from the Himalayan region are most remarkable for their medicinal properties plants like *Picrorhiza kurrooa* [71, 72] *Aconitum* sp. [72, 73], *Polygonum bistorta* [73, 74] *Nardostachys jatamansi* [75], etc.

7. Conclusion

Unique features of the alpine habitats make them home to some of the extraordinary flora and fauna in the world. In their habitats, alpine plants experience extremely stressful conditions, which causes the production of the free radicals or ROS species in them. However, these plant species genetically or phenotypically adapted to scavenge those ROS. Enzymatic as well non-enzymatic antioxidant system efficiently protecting the alpine floras, although this protection is species-specific, as a generalized feature the antioxidant potential in alpine plants increase with altitudes. Alpine vegetation showed a range of variation in the antioxidant protection plants like *Ranunculus glacialis* has very low antioxidant protection despite this, the plant species can survive in some of the highest altitudes of the world. On the other hand, species like *Soldanella alpina* showed very high antioxidant potential with high ascorbic acid, glutathione, phenolic, and other antioxidants. Alpine plants adapted to diurnal as well as seasonal fluctuations to ROS production due to the fluctuating environmental conditions of their habitats, especially during the daily freeze–thaw cycle of the early spring and late winter as well as the seasonal cycle. However, the changing climate is interfering with this seasonal acclimation. For example, a heatwave during the winter can deacclimatized the dormant buds of woody alpine trees, and a cold wave during summer may destroy the reproductive shoots. All these disturbances interrupt the ROS-antioxidant protection dynamics in those alpine plants. Most of the alpine floras are currently facing extinction due to climate change scenarios and anthropogenic activities, and we need to protect those unique habitats and related flora and fauna.

Conflict of interest

The authors declare no conflict of interest.

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Dynamics of Socio-Economic Development

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Preface

India is one of the fastest growing economies of the world with the majority of its population, approximately 68.84%, still living either in villages or in small towns. The country has achieved success in taming many macroeconomic variables like GDP, inflation, fiscal deficit, poverty, micro-financing, forex reserves, BoP etc. and have done well in the field of space, health, energy, food security after independence. Many economists criticize the growth story of the country and consider it far from being inclusive. They are of the opinion that the major growth centres of the country are still located in big cities, and the country is unable to exploit the potential of rural areas and rural population fully. This book has been designed to give an insight into various ever-changing aspects in the arena of socio-economic development. The critical analysis presented in the book covers critical dimensions of growth and development including tourism, PDS, skill development, MSME, banking, micro-financing, telecom, entrepreneurship etc. The areas covered will be beneficial for the scholars, faculty and society at large in guiding them about various hindrances to the inclusive growth of the country as well as simultaneously providing strategies to overcome them. Addressing the challenges and surpassing the impediments will promote not only economic growth, employment generation and better standards of living in the urban areas, but also stimulate economic activities and innovations in the rural areas.

Developing a comprehensive and holistic book is an integral part of the conference for which we have worked really hard. We are highly indebted to Professor R.D Sharma, Vice Chancellor, University of Jammu, without whose blessings and support the project would not have been possible. We are also grateful to Professor G M Bhat. It is only due to his out of the box thinking and continuous encouragement that has stimulated us to undertake this endeavour. We sincerely acknowledge the consistent support

and guidance of Professor Alka Sharma, Director of The Business School from the very beginning. This conference is a result of untiring efforts and timely advice of Professor Sameer Gupta and Professor Vinay Chauhan, who have continuously acted as torchbearers throughout this journey. We are thankful to all authors for their precious time, valuable research and the confidence they have shown in us. Nothing can happen without finances; we are grateful to the Indian Council for Social Sciences Research for providing us sufficient and timely financial support this venture. We are thankful to Bharti Publications for bringing the book out in time. At last, we convey our thanks to each and everyone who has contributed to this endeavour. We hope that this book will prove useful to our readers.

Editors

Contents

About the Editors

Dr. Dharam C. Attri is presently a Research Associate at G.B. Pant National Institute of Himalayan Environment has been actively engaged in working on Plant Physiology, Ecology and Ethnobotany, especially the propagation of high Altitude Medicinal and Aromatic Plants (MAPs) through advanced technological interventions from last 8 years. He has done his MPhil (Environmental Plant Biology) and PhD (Plant Physiology) Degree from High Altitude Plant Physiology Research Centre (HAPPRC), HNBGU Srinagar Garhwal. After the PhD, he has joined as a Technical Expert (TE) on UNDP based MAP project. He has published many research papers in reputed International and National Journals. He has participated in number of National and International conferences, seminars and workshops and has delivered several talks on the promotion of MAPs cultivation. He is a recipient of Young Scientist Award (CSIR, IIP 2017). He is a member of American Association of Plant Biologists (AAPB).

Sushma Devi is presently a Ph.D scholar in University of Jammu and is working on Leukaemia. She has qualified CSIR-NET, SLET as well as GATE in life sciences. She has done M. Phil in the field of limnology and M.Sc. in Zoology from the department of Zoology, University of Jammu. Her area of interest includes molecular biology, limnology and biodiversity conservation. She has published many research papers and has attended various national and international conferences. She is a life member of Indian Science Congress Association (ISCA).

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4

CLIMATE CHANGE : IMPACT & SOLUTION

Dr. S.K. Singh[1], Dr. Krishan Pal[2], Dr. Hari Om Sharma[3], Dr. Jai Pal[4] and Dr. Babita Patni[5]

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Chapter Content

Introduction

Now a days the whole world is discussing about the climate & global warming and its effects on plants, animals and microbes which are essential to maintain the balance of ecosystem. Climate can be defined as " the average weather over a long time period in region". " Climate refers to natural variation in climate that occurs over months to decades". "It is the aggregated pattern of weather, meaning average, extreme, timing, special distribution of hot & cold, cloud & clear, humid & dry, drizzles &downpour, snowfall & snow melt etc". We can say that climate is the average weather pattern of the particular region including temperature, humidity, rainfall, precipitation wind etc.

In this chapter we will discuss about climate change and its influences on plants and animals. Climate change means altered pattern. Global average temperature is just are measure of the state of the global climate as expressed in these pattern. Climate change is a statistically significant variation in either the mean statistics of the climate variable or in its variability that persists over a prolonged duration.(Vijay Venkata Raman,2012)

Climate change is very big issue not related to any particular country ,but it is a global issue.

UN charter 2015 set up 17 sustainable development goals(SDGs) to cover social and economic development issues including poverty, hunger, health, education, climate change, gender equality, water, sanitation, energy, urbanization, environment and social justice to transform our world by 2030.

Climate change caused by increased concentration of green house gases in the atmosphere has emerged as the most prominent global environment problem. As per prediction of scientists, it has been concluded that there is a possibility of loss of 4.5 million tones in wheat production with every rise of 1 degree centigrade temperature of the atmosphere.

To sustain the food and nutrition security of the country, it is imperative that Indian agriculture is made more resilient to climate variability and change.

Reasons of Climate Change

Climate change is caused by a change in the earth's energy balance- how much of the energy from the sun that enters the earth is released back in to space.

- Industrial Revolution-This is directly related to human activities that produced huge amount of green house gases in the atmosphere.
- Too high concentration of green house gases than too much heat trapped and earth's temperature rises outside the range of natural variability.
- There are some natural and human causes of climate change as solar activity, earth movement, volcanic activity, surface reflectivity, concentration of aerosol and green house gases.
- Urbanization is one of the main reasons of climate change.

Earth's Atmospheric Gases

The 99 percent gases are non-green house gases that is nitrogen and oxygen.

Only 1 percent are green house gases that is carbon dioxide, methane. Green house gases in the

Chapter - 8

Herbal Preparations for Boosting Immunity

Soban Prakash, Malini Bhattacharyya and Babita Patni

A detailed illustration about the therapeutic potentialities of natural herbs for boosting immunity

Abstract

Ayurveda is the science of life that spreads the gifts of nature for maintaining healthier, and delightful lives. Ayurveda's vast knowledge is based on the preventive attentions derived through the principles of "Dinacharya" - daily regimes and "Ritucharya" - seasonal regimes to healthy lives. Everyone can achieve immunity by maintaining and uplifting resistance that was demonstrated across the user-friendly ancient Ayurveda manuscripts. The immune system is one of the important systems which protects human body from pathogenic stress but when compromised it could produce loads of persistent illnesses. Nowadays, the modulatory effect of immunity is examined in various ways. The various stimulants, which may be immunosuppressants, are either cytotoxic or even trigger fatalities. Alternatively, plant-based medicines being medicated by the people to treat different diseases due to their less harmful activities in biological systems, like, lower poisoning and also the availability in low price and sustainability. Many plants and their formulations are often used in traditional medicine to treat a variety of chronic diseases and also responsible for boosting the immune system. This article illustrated the usefulness of the plant-based preparations for upsurging human immunity.

Keyword: Ayurveda, resistance, Ashwagandha, Guduci, Tulsi

Introduction

Charaka defined Ayus (life) as a mix of the human body, mind, Soul and organs [1]. In another term, Ayurveda gave emphasis to live healthy and joyful long lives. Principles about health and conditions tend to be discussed with information in many classical texts of Ayurveda. These concepts include knowledge of medical science, aetiology, symptomatology, various measures to maintain a healthy condition and the causes of falling ill [2]. Many

Chapter – 8

Herbal Preparations for Boosting Immunity

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16

Nitrogen: A Key Nutrient for Rice Production

Babita Patni[1], Machiavelli Singh[2], S.K. Singh[3], Ashwani Kumar[4] and Vijay Kant Purohit[1]

Abstract

Agricultural sector operates within an interwoven and complex system of ecological, social and economic factors. Therefore, each issue of agricultural development is mired in these complexities. This chapter is a modest attempt to understand the role of nitrogen in rice production because nitrogen is an essential plant nutrient being a important component of amino acids, nucleic acids, nucleotides, chlorophyll, enzymes, and hormones required for rapid plant growth and improves grain yield and grain quality through higher tillering, leaf area development, grain formation, grain filling, and protein synthesis.

Key Words: *Agriculture, Nitrogen, interwoven, complex system, development, nitrogen rice production.*

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26. Role of Endophytes in Development, Nutrient Acquisition, and Tolerance to Abiotic Stress in Host Plant

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Abstract

Endophytes are microorganisms that are bacteria or fungi or actinomycetes present in the plant tissues with symbiotic association. They are ubiquitously associated with almost all plants. An endosymbiotic community of microorganisms colonizes in plants and can be easily isolated on the medium for plant production. These bacteria may be found to colonize the roots or aerial parts. These microorganisms are called obligate, facultative, or passive endophytes on the basis of different mechanisms used internally to colonize a plant. The endophytic bacteria belongs to a broader community of microorganisms that have their life cycle partly or entirely within the plant and are found in intracellular and intercellular spaces or in the vascular tissue. The population of endophytes are affected by climatic changes and the location where the host plant grows. They contain a wide variety of compounds that are useful for growing plants, preserving the environment and maintaining the host. They act as biocontrol agents by producing toxic alkaloids to prevent grazing that protect plants from herbivorous animals. Endophytes also produce large number of bioactive compounds of economic importance to humans as antibiotics, drugs or medicines and food processing. Above all they themselves produce various hormones or induce plant to synthesize same to improve growth and productivity of crop plants under various stressful conditions.

Keywords: Endophytes, Epiphytes, Plant-growth promoting bacteria (PGPB), Plant-microbe interactions, Rhizosphere, Phytohormone

1. INTRODUCTION

All plant species maintain interactions with endophytic microbial communities that is called as plant-endophyte (Santos *et al.*, 2018). An

Article

Role of Survey Research for the Assessment of Medicinal usage of Four Economically Important Plants in the Garhwal Himalaya, Uttarakhand

Malini Bhattacharyya[1], Nirjhar Bhattacharyya[1], Krishnendu Debnath[3], Ambika Kandpal[4], Abhishek Jamloki[5], AR Nautiyal[6], Babita Patni[7]

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A B S T R A C T

Indian Himalaya is rich in flora and fauna. Plants growing in Himalayan region are greatly valued by local village dwellers for curing diseases. This survey has been conducted in five villages (Khirsu, Gwad, Mangshu, Mandi, Madhi) of Pauri and Tehri Garhwal district of Uttarakhand to evaluate the medicinal value of four economically important plants; Malus domestica Borkh. (Apple, local name Seb/ syo), Ricinus communis L (Castor, local name Arandi), Prunus persica L (Peach, Local name Aroo), Carica papaya L (Papaya, local name Papita) in rural life. The aim of the survey was to know the disease treated using the above mentioned plants. These data were collected from randomly chosen individuals of different age groups having different types of knowledge sources regarding medicinal plants. This survey research strategy was the multimode type containing close ended questions in the form of questionnaire. Questions were asked verbally and via telephone to less educated people in the form of interview and distributed for filling up to others. Survey revealed demographic and personal characteristics of rural people. This was done in the month of Oct-Dec 2020 (during unlock 5 and 6.0) and the survey explored that, rural people significantly use the above-mentioned plants for recovery from gastrointestinal disorders, Pain/ Arthritis, fever and aches, for removing weakness, anemia and Dengue. For validation, data were collected from Ayurveda doctors using the same questionnaire with the help of face-to-face, Computer Assisted Telephonic Interview (CATI) and telephonic interviews. In this paper, based on survey results and data analysis, it is concluded that, these four plants are not only economically useful, they have medicinal properties also. People with increased age and female farmers use these plants in the above-mentioned diseases and the knowledge of using these plants in the above-mentioned diseases came from their parents as well as from spiritual manuscripts.

Keywords: Disease Recovery, Medicinal Plants, Rural People, Villages

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Introduction

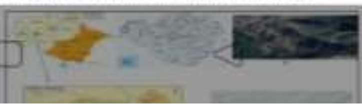
Indian Himalaya is rich in biodiversity. It has more than 64 species of gymnosperms, 17,000 species of angiosperms, 2,850 types of bryophytes, 1,200 pteridophytes and 2,021 lichens (Joshi and Pant, 2012). In India, 7,500 species have been reported by scientists to have several medicinal properties (Shiva, 1996). Indian Himalaya has a wide range including tropical, sub-tropical, temperate and alpine areas. Uttarakhand is a state of India which is situated in the lap of Himalaya. Rural dwellers of Uttarakhand are still dependent on medicinal plants for curing diseases. As per World Health Organization (WHO) mentioned that about 25% of modern medicines are developed from medicinal plants. (Malla et al., 2015, WHO, 2002). Local people get knowledge of the medicinal properties of plants through their need, observation and the knowledge acquired from ancestors as well as books like spiritual manuscripts. Most diseases cured by Ayurveda doctors are like aches and pains, respiratory diseases, musculoskeletal ailments and wounds. Doctors also suggest medicinal plants to the village people to cure diseases (Singh et al., 2017). Knowledge of using medicinal plant parts may be passed from generation to generation via mouth (Jansen 1981) or with the help of

Primary alcohols, Quercetin, Hyperoside , Quercetin 3-O-β-Rutinoside, Quercetin-3-O-β-D-glucopyranoside, Quercetin 3-O-β-D-xylopyranoside, Ricinine, β-Sitosterol, Stigmasterol, Stearic acid, Tartaric acid, Tannins (Singh and Gitanjali, 2015) and Carica papaya L. leaves have phenolic acids, as well as trace amounts of chlorogenic acid, compared to flavonoids and coumarin compounds(Vyas et al., 2014).

Material and Method

Study Area

The study was carried out in five villages of Pauri and Tehri Garhwal districts of Uttarakhand, India, which is situated near the bank of Alaknanda river. The district Pauri is located between 29°20'-29°75' N latitude and 78°10'-78°80' E longitude. Tehri Garhwal is located at 30°3'00" to 30°53'00" N latitude and 77°56'00" to 79°04'00" E longitude on the ranges of the Central Himalaya (Figure 1) (Table 1).



Seaweed as alternative organic fertilizer for crop nutrition: mode of an agri-entrepreneurship

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Seaweeds are important marine renewable resources. Use of sea weeds is not new technology to mankind. But until now the contribution of sea weeds in agriculture as source of organic fertilizer is rarely significant. Use of seaweeds as fertilizers may be a great alternative of conventional synthetic fertilizers. However, it is having a great potential due to the presence of large quantities of nutrients in it. In agricultural system, sea weeds can be used as soil conditioners, fertilizers, and green manures due to the presence of high amount of potassium salts, micronutrients and growth promoting hormones and regulators. Chemical analysis of sea weeds and their extracts have shown the presence of a wide variety of plant growth regulators such as auxins and cytokinins in varying amounts. Besides this, seaweed extract can also be used as liquid fertilizers (SLF) for foliar spray on plants as the nutrients would be readily available to plants through natural openings of plants such as lenticels, hydathodes and stomata. Seaweed extract, as a foliar spray, have been used in horticulture for several decades, and due to being organic and biodegradable in nature, it is important in sustainable agriculture. The seaweed concentrates are effective bio stimulants in many crops including vegetables, trees, flowering plants and grain crops. To test it we did an experiment at Crop Research Centre of Rajendra Agricultural University, Pusa, Samastipur, Bihar. Performance of two seaweed liquid fertilizers extracted from 'Kappaphycus (K sap)" and "Gracilaria (G sap)" was evaluated on Autumn Maize. The experiment was carried out in Randomized block design with 10 treatments. The treatments consisted of RDF (Recommended Dose of Fertilizer for Maize Crop) N: P: K: 120: 75: 50 and Zn @ 5 Kg/ha along with 3 sprays of K sap, G sap and use of water as control. Spraying of saps was done at knee high, tasseling and silking stage on Maize cultivar '900 M gold'. We found positive response on yield due to seaweed sap spray. For other crops it was also reported as biostumulant by many researchers. In this way we can say that collection of seaweeds and extraction of liquid seaweed sap can be a great agri-entrepreneurship for the people residing near seashores.

Key Words: Seaweeds, organic fertilizer, crop nutrition, K sap and G sap.

India is Primarily an agricultural country. Most of the population of rural area engaged in agriculture, are making the backbone of our economy. For fulfilling the stomach of the booming population, scientific agriculture should be practiced, so that stagnated yield of crops and soil health can be improved. Our current food production is nearly 250 MT and it must be doubled by 2040 to feed the booming population. We Indian are finding many emerging challenges in the field of agriculture related to crop nutrition, viz. soil organic matter depletion, imbalance fertilizer use practices, declining nutrient use efficiency, negative soil nutrient balance, emerging multi-nutrient deficiencies in many parts of the country, particularly of secondary and micronutrients etc. Indiscriminate and imbalance use of chemical fertilizers have resulted in poor soil health and the sustainability of the agricultural production system. Emergence of multi

Microenvironments, Microhabitats, Microreserves: Rooms of Hope for Conservation in Climate Change Persiste....

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PREFACE

In the current scenario, many of the earth's resources are influenced by human interference and has become vulnerable due to the pressure of overconsumption, population growth and technological intervention, causing environmental degradation as well as extinction of many spices across the globe. From the last two decades, there is debate among researchers and environmentalists for environment conservation which also involves the issues of biological diversity and ways to preserve it. Conservation of environment simply indicates the sustainable use as well as management of natural resources which include wildlife, water, air and earth deposits etc. Its main focus is upon maintaining the health of the natural world and the conservation policies to protect it. Environmentalists have the vision that development is essential for a better future, but only when the changes occur in ways that are sustainable in the long run and are not wasteful. Biological data demonstrates that wildlife species are vanishing faster than ever before in Earth's history, while the average global temperature is dangerously rising. The glaciers are melting, extreme weather events are becoming more common and if necessary measures are not taken immediately to protect the environment, humans and other species on earth are at high risk due to an unprecedented climate change which may threaten the very existence of life.

The scientific developments have empowered human beings to harness natural resources for their wellbeing but humans have exploited natural resources to such an extent that causes increased pollution and other environment-related problems. As a result of this, multiple agreements have been signed by many countries to prevent damage or manage the impacts of human activities on natural resources. Some of the well-known international agreements include the Kyoto Protocol and the Paris Agreement. The Indian government has always taken it very seriously and has incorporated several provisions in the constitution demarcating the responsibility of the Central and State governments towards environmental protection. It shall be the duty of every citizen of India to protect and improve the natural environment including forests, lakes, rivers, wildlife and to have compassion for living creatures.

The main question is how to conserve the environment for a sustainable future. Presently about one-half of the forests that once covered the earth's surface has been destroyed due to deforestation. It is advised that humans should not cut trees, use it in smaller quantity and stop the burning of poly bags, because it produces a lot of smoke and carbon dioxide. The communities living near the vicinity of forest areas must be careful towards forest fires. One of the best ways to conserve the environment is the use of Hydro-power and solar power. Many products come from the trees like papers, cups, cardboard and envelopes and by recycling these products, We can reduce the number of trees cut down every year. Fossil fuels will not last forever therefore, We must make efforts to conserve and rationalise their use.

Here, we have used a holistic approach to environment conservation. In this book, attempts have been made to address the issues and challenges which exists in the protection and management of the natural environment. The authors have contributed their best efforts in the preparation of this book to present the various issues concerning the environment in a very lucid manner. We are sure that, this book will provide useful insight and a wonderful experience to our readers.

Editors

CONTENTS

5

Microenvironments, Microhabitats, Microreserves: Rooms of Hope for Conservation in Climate Change Persistence

V. L. Trivedi[1], Dharam C. Attri[1,2] and M. C. Nautiyal[1]

Abstract

Environmental and topographic factors varies greatly along with the distribution range of a species; such local micro-environmental microhabitats provide various comforts to the inhabitants. Such micro-environments mainly varies from average environmental circumstances experienced by other individuals of the same species within a broad geographical area. In the present scenario where the problems like changing climate and anthropogenic disturbances continuously pushing flora and fauna in the path of extinction, these microrefugia may become saver of the many species facing the extinction risk either in the local and global picture. The conservation approaches focused on these micro-environments may play a significant role in the conservation strategies of an individual species. These local micro-environments influence the phenotypic plasticity, patterns of genetic variation, physiology, reproductive behavior, population persistence of the species due to the disparity in topography, nutrient levels, water availability, light regimes, etc. Variations in the micro-environment could protect the local population of a plant species from the adverse impact of climate change by modifying the physiology and biotic interaction among the species, including the community dynamics. In this chapter, we assessed the role of those micro-spaces on the conservation of plant species in the special context of climate change.

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Keywords: *Plant Conservation; Monitoring; Phenotypic Plasticity; Adaptations; Species Invasion; Global Warming.*

Introduction

From the past few decades climate change has become a topic of hot discussions; every person from a student to a farmer is now familiar with the issue. Global warming, increasing CO_2 in the atmosphere, increasing desiccation, changing precipitation patterns and all other components of climate change have made their way from the scientific arena to daily lives. These variables continuously affect the environment; however, the impact may differ along the gradients of a particular geographical area. Within a mountain range, the effect of increasing temperature may be different in northern and southern slopes, along the bank of a stream, in small caves, or tree canopies and exposed rocks. Many times the species which are thought to be extinct were rediscovered from the specific small restricted areas; for example, *Hibiscadelphus woodii,* which supposed to be extinct, had been rediscovered from an isolated mountain cliff (Lee, 2019), rediscovery of a plant species known as *Globbaander sonii* from the Sikkim Himalayas in India near the Teesta river valley region after a gap of nearly 136 years (Banerjee, 2020). There are many more examples where extinct taxa came to life, and that all the charm of those micro spaces that protected them from the neighborhood disturbances. When we talk about the conservation strategies and assessment of taxa, the geographic scope became the main component, and a geographic component depends upon the range of the distribution of the particular species. The distribution of a species could range from small microhabitats such as rock cervices, or it may extend across relatively larger geographical areas, such as the entire mountain range. In the current scenario where millions of species are moving towards extinction and millions more becoming rare, endangered, or threatened and climate-changing factors further increasing this pace. In this context, the importance of micro-spaces is very crucial in the conservation of flora, fauna, and even microbes. These small spaces form the "island" of a suitable habitat surrounded by an unfavorable limiting environment (Cartwright, 2019). Various international associations such as the Convention on Biological Diversity (CBD), World Wildlife Fund (WWF), and the International Union for Conservation of Nature (IUCN) indicated the importance of micro-spaces in their conservation strategies.

Materials and Methods

Literature Web of Knowledge, SCOPUS, Google were used to search the literature for a combination of terms: “small”, “protected areas”, “micro reserves”, “conservation”, “microenvironment”, “microhabitat”, monitoring, “climate change” etc. After scanning the paper title and abstract, we read the paper and extract the information that is relevant to our chapter’s objective.

Results and Discussion

Microenvironment and Microhabitats

Microenvironment can be defined as the immediate small-scale environment of an organism, especially as a distinct part of a larger environment (Denny et al., 2020). The microhabitat is a habitat which is of small or limited extent and which differs in character from some surrounding more extensive habitat. The microenvironment generated due to the interaction between the various biotic and abiotic factors, and any change may lead to drastic consequences (Behera, et al., 2012). Abiotic and biotic conditions may differ in a microhabitat from average conditions experienced by other individuals within the same population along a geographical region. For example, the microhabitat factors affect the distribution of the exotic species across forest edges in temperate deciduous forests of southern Illinois, USA (Honu & Gibson, 2006). These microhabitats also differ in community dynamics and traits to its large neighboring area. Microenvironment associated difference in the distributional patterns is observed in many plants. For example, two species of the *Draba,* in Venezuelan paramo, prefer different types of habitat. *D. chionophila,* which is a rosette species present extensively in frost-heave soil areas with very low plant cover and species richness. While the shrub species *D. arbuscula* prefer the rocky outcrops, with higher plant cover and species richness (Pfitsch, 1988). These microenvironmental heterogeneities can impact the species association hence could affect the current community structure and community dynamics in the coming futures. Not only the microenvironment influences the plants, but individual plants also influence its microenvironment, thus facilitating or impeding it’s for other species within the same microenvironment. These microenvironments also influence the functional traits of a species, Blonder et al. (1988), demonstrated that microenvironment controls species distribution at the fine-scale and are strongly associated with species mean functional trait values. Regionally rare microenvironments sometime produce unusual landscapes that uphold unique flora and fauna, and from the conservation point of view, these ecological islands are very important (Anderson & Ferree 2010; Comer et al., 2015). Along with the annual variations from the coexisted ecosystem, these microenvironments also comprise seasonally wet or dry spaces so that microenvironment not only supports local annual vegetation but also to the aquatic or arid endemic plants with their specialized adaptations (Shure, 1999; Cartwright, 2019). According to Cartwright (2019) "microenvironments serve as "stepping stones" to facilitate movement between larger islands" and hence the key concrete material for conservation strategies.

Variability in an ecosystem at a small spatial scale has significant physiological consequences (Helmuth & Hoffman 2001; Miller et al., 2015), and the ability of an organism to move among those microhabitats added more significant, especially in the case of environmental change (Monaco et al., 2015; Otero et al., 2015). These microhabitats act as the buffer in the extreme neighboring ecological conditions that may kill other organisms by providing the rescue sites (Hannah et al., 2015). Microhabitats also play a crucial role in recruiting new members of species such as seeds and other vegetative propagules, and this role became more important if these microhabitats are serving as the refugia. A study by Hilton and Boyd (1996) showed that the Microhabitat variables such as soil depth, maximum water depth, soil texture, soil nutrient status influence the capsule production, seed production, and dispersal in *Amphianthus pusillus* on a granite outcrop near Franklin, Heard County, Georgia. Gómez-Aparicio (2012) also stated that in *Acer opalus* ssp. *granatense* spatial pattern of seedling establishment affected by the conditions of microhabitats in Sierra Nevada National Park and in Sierra de Baza Natural Park, in southern Spain.

Characteristic Regimes of Microhabitats or Microenvironment

Heterogeneity of the microenvironments within an ecosystem forms various zones of abiotic factors composition in an ecosystem. Factors like water availability, temperature (air and soil), and light availability and edaphic factors like soil composition, nutrient availability, and concentration highly impact the distribution and the survival of a species. For example, in desert run areas and drainage lines have more water availability then the surrounding habits; hence have high primary productivity, thus form specialized niche forming an ephemeral riverbed along a well-drained slope (Free et al., 2013). In the same way, the variation in water availability along the elevational gradients affected growing season timing, and duration also varies dramatically. They are associated with differences in growth rate, flowering time, and water use efficiency (Kooyers et al., 2015, 2019). The most critical factors of microhabitats are temperature, which is represented by the variety of fine-scaled features. Air temperature, as well as soil temperature, highly influenced by the canopy, covers in the woodland ecosystem, greater canopy cover, making that environment more temperature moderate (Keppal et al., 2017). The same goes for mountain slopes where north-and south-facing slopes experienced severe differences in soil and air temperature (Scherrer & Korner 2010). Light availability is can also available in various level in microhabitats; for example a grassland ecosystem comprises habitats ranging from fully sun exposed sites with a low density of neighbors to sites with closed canopies that are compactly populated by neighboring grasses and herbs (Hegewr, 2016). Edaphic factors such as soil composition, nutrient level in microhabitats affected survival and distribution of the species within an ecosystem. Rolo et al. (2012) showed the close relationship between species composition and nutritional value in different microhabitats of Mediterranean open woodlands.

In each microenvironment, an organism experienced different abiotic and biotic conditions than the rest of the broader environment, which itself are sometimes stressors. Variability in the factors experienced by a plant these microhabitats influence their morphology, physiology, phenology, and other traits (Biswas et al., 2019). Hence within a broad geographical space, experienced and the response of the plant to the abiotic stresses such as drought or excessive waterlogging, thermal extremes and soil salinity, *etc.* may vary. Simultaneously, a plant is coping with stress in that geographical area, other neighboring plants that occupying a different micro-environment may experience more gentle circumstances. So the influence of microhabitats on the physiology of the plants is the most important factor to comprehend for foreseeing the impact of global climate change on an ecological and evolutionary perspective. It is also important to evaluate the microhabitat's potential to conserve the declining biodiversity and protect those from the adverse effects of this changing climate and their potential to act as refugia or microrefugia.

Microhabitat and Climate Change

Although climate change is a natural phenomenon, anthropogenic activities were changing the climate at an alarming rate by influencing the abiotic factors as well as ecological communities worldwide. Increasing global temperature, change precipitation pattern, extreme weather events all consequences of the climate changes vary across the regions (Borghi et al., 2019) which act on broad scales; however, their effects on plants will depend on how they influence the local environment that individuals experience (Siepielski et al., 2017). The drivers of climate change in a local environment of a plant influence physiological, phenological, and morphological traits (Pereira, 2016). Change in temperature has a considerable change in precipitation patterns leads to change in soil moisture regimes and water availability of the soil. A plant must deal with low water availability or waterlogging conditions in the coming environment scenario, especially on the regional scales. Site-specific heterogeneity influences the response of the plant to the conditions like drought and waterlogging. For example, *Populus* species (Salicaceae) grown in a semi-arid environment showed substantial variation in stomatal size and density, attributed to small-scale climatic conditions in localized microenvironments (Pearce, 2006). Due to changes in temperature patterns, the episodes of excessive heat waves or unexpected chilling periods increase globally. Still, at the microclimatic level,the temperature is highly influenced by the wind, light intensity, day length, and water level. Temperature not only impacts the biochemical pathways in plants, but it also controls plant growth, development, phenology, and reproduction (Denney et al., 2020). Coulson et al. (1993) stated that the different temperatures in microhabitats affected shoot temperatures, root temperatures, and the resulting efficiency of nutrient/water uptake. Elevated CO_2 in most of the studies known to enhance photosynthesis in plants, but along with other factors such as decreased water availability, increased temperature, it tends to develop heat stress in plants. Change in the drivers of climate change can be more understandable by modeling fine-grained environmental variation that leads to a more insightful understanding of the dynamics that shape physiological plasticity and influence the genetic structure of populations across landscapes (Thuiller et al., 2008). These factors also modify the biotic interactions among species, including competition, pollination, herbivory, and host-pathogen dynamics within a community. This modification may be different in various microhabitats, either qualitatively or quantitatively. Microrefugia served as the protective shelter for many species in past climate change events and may also be playing such a role in the ongoing climate scenario. Such micro-refugia could help the plants to adapt to the novel climatic composition arises by persisting the populations, especially those are lacking genetic variation (Olson et al., 2012). Such type of refugia can occur within small distances from the current distributions; hence seeds and pollen movement will be easy (Hylander et al., 2015), and many of the habitats in a broad geographic area of some species are restricted to some local sites (Hylander et al., 2015), and that signifies the potential role of microrefugia in the future climate change context. Micro-refugia can nurture the declining biodiversity so that the conservationist should include the concept of microhabitat and microenvironment in their conservation planning and strategies.

Microhabitat and Invasive Species

The impact and establishment of invasive plant species in the region are environment-dependent due to its competitive ability governed by environmental factors (Amarasekare, 2003). Amarasekare (2003) and Bieberich et al. (2020) stated the importance of microhabitats on establishing *Impatiens glandulifera* an invasive species in Germany. Amarasekare (2003) noted that the competitive environment between an invasive and native species in a heterogeneous habitat changes from patch to patch, thus determine the dominating species of that particular patch and facilitate spatial co-existence. Another possibility for species co-existence is temporal niche partitioning, which is microhabitat dependent. Invasive species modified its microenvironment, such as soil nutrients, water availability, and even causes shading effects that negatively affect the establishment and regeneration of native species (Nuzzo, 2000; Stinson et al., 2006). Underlying drivers of the interactive relationship between invasive plants and native plant community are competition, facilitation, and avoidance of competition, and their regulation by environmental factors (Trinder et al., 2013). Micro-habitat specific interactions between native species and an invader can also be due to micro-habitat specific performance of the plant species (Bieberich et al., 2020). A study in the alpine system by Anthelme et al. (2014) reviewed how the interaction in alpine flora became facilitative or competitive in response to climate change in their micro-environmental context and the potential of nurse plants to buffer changes in microhabitats. Topography, environment, and spatial distance of rock cress influenced the invasion of a species and its interaction with other individuals. For example, Naithani et al. (2014) found in *Boecherastricta* that the performance of this species in a meadow community was mainly influenced by intraspecific competition and insect herbivory, which is controlled by microhabitat and its spatial distribution in the meadow community are limited by dispersal and microhabitat preference.

Invasive plants modified their microhabitat, especially the rhizosphere, by releasing the allelochemicals for avoiding the competition. An invasive plant species can modify native plant's ability to occupy space influences its ability to access resources such as light, water, and nutrients by changing its environment. Carter et al. (2019) showed microenvironment modification by *Cytisus scoparius,* globally important nitrogen (N)-fixing invasive plant species that can alter soil water dynamics, soil chemistry, and plant communities. Invaders tend to modify the nutrient pools of soil (Dassonwille et al., 2008) and altered the water utilization patterns of soil, thus change baseline microenvironment conditions.

Micro Reserves

Micro reserves are comparatively recent concepts and still debated for their conservation role, but these small isolated regions are quite helpful for studies of endemic species. Micro reserves are established primarily on the outside of the protected areas but can also be set within a protected area. Micro reserves are the isolated sites that play an important role in protecting the endemic endangered and threatened species of that area (Thanos, 2007). Spain is the country, which pioneers the concept of micro reserves around 1991 concerning the factors like diverse geography as well as abiotic factors of the region that having conservation importance (Laguna, 2001). Approaching this concept, first plant micro reserves (PMRs) were constructed by the Regional Wildlife Service of the Generalitat Valenciana, the autonomous government of the Valencia region (East Spain) in 1994 (Anon, 1994). PMRs are the regions that have uttermost value in terms of plant richness, endemism, or rarity; generally, these are small land plots up to 20 ha. These areas are constructed, focusing on the long term monitoring and conservation of plant species and vegetation types of the region. PMRs allow those traditional values and actions that are compatible with the plant conservation practices; PMRs maintain the legal frame that advises them a permanent status while providing solid protection to plants and their substrate. PMRs became very useful in the conservation and protection of those plants whose in situ conservation poses complications, including the scatter of the taxa of concern in a geographical region, the small population size of the taxa, the ecological characteristics of endemic flora, the extremely localized occurrence and small size of some populations. There are several advantages of PMRs over the large protected areas; firstly, the PMRs allow nearby monitoring of target species by skilled staff and the development of conservation actions tailored to their needs in the whole territory, whereas large protected areas are only able to cover a fraction. Secondly, PMRs are highly proclaimed for the monitoring and conservation of a single target species. Hence, PMRs lead to a small scale and flexible approach to plant conservation; according to Laguna et al. (2016), sometime PMRs have species richness higher than the total species richness of the region and able to protect the endemic, threatened, and rare plant species.

With increasing developmental practices and resulted fragmentation of the landscape, the role of the small reserves is becoming more realistic alternatives to preserving biodiversity. The formation of the large protected areas limited by the increasing anthropogenic activities, especially by the developmental projects such as roads, dams, etc. that posing a serious threat to the ecosystem such as habitat fragmentation (Volenec & Dobson, 2020). Although these small reserves can contain high-quality habitat (Schwartz & van Mantgem, 1997) and highly diverse species assemblages (Semlitsch & Bodie, 1998) they have some shortcomings, particularly the ecosystem services and species that occupy the larger spaces are affected. These shortcomings include extinction debt and ecological traps. At the same time, a major share of the regional flora and fauna can harbor by the small reserves, but these regions may be unable to provide habitat for specialized species. However, the combination of a complementary set of large and small reserves within a network can provide the habitat for specialized species (Semlitsch and Bodie 1998; Brooks, 1999; Laurance & Vasconcelos, 2009) services in the surrounding landscape are also an important part of these small reserves, especially in the area where large distant reserves cannot be able to deliver essential in-situ ecosystem services and in the landscapes that are having high developmental activities (Krauss et al., 2010). Thus networks of the small effective reserves will help meet the conservation aims both large and small reserves. These small reserves have special significance in the urban environments, where the original species and communities may not be available. However, still, these small reserves or fragments may provide new opportunities for diverse and novel assemblages (Decocq et al., 2016). In urban settings, these small reserves or fragments can be able to provide habitat for those species which are suffering habitat loss due to the anthropogenically induced range narrowing (Ceballos et al., 2017).

Conclusion

Small spaces have a bigger impact on plant diversity and distribution, community assemblages, phenotypic diversity, and adaptations to the diverse environmental conditions. These micro spaces became more significant in today's scenario when the world is suffering from a catastrophic problem like global climate change, loss of genetic diversity, species extinction, etc. In such consequences, these micro spaces may act as refugia for the flora as well as fauna in the present as well as future climatic situations.

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The Impact of Talent Management Practices on Financial Performance: An Empirical Study in Banking Sector

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ABSTRACT

In the modern business scenario, talent management (TM) act as a major driver for organisational excellence such as financial performance. A financial indicator reflects the fulfillment of the economic goals of the firm. In this context, present paper has explored the impact of talent management practices on the financial performance of the organisation. The data has been collected from the managers working in five prime banks (according to market shares) of Jammu city. The scale has been purified and validated with the help of exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) respectively. SEM has been used for hypotheses testing. Further, theoretical and managerial implications and scope for future research have also been discussed.

Keywords: *talent Identification, Succession Planning, Talent Development, Talent Retention, Financial Performance, Banking Sector*

Introduction

In the present business set up, organisation's struggle to attain sustainable competitive advantage and HRs are the only assets in the organisation that are capable of generating sustainable competitive advantage. In this context, talent management (TM) is one of paramount importance due to its qualitative focus on

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attracting, identifying, selecting, succession planning, developing, engaging, retaining and deploying talented workforce/employees (Valverde et al., 2013; Kamjula, 2012; Woollard, 2010; Bhatnagar, 2007). In the period of globalisation, expansion and diversification of activities, changing demography and inadequate development of skills, TM has emerged as a critical element and multidisciplinary field of strategic HRM (Jyoti and Rani, 2014; Tarique and Schuler, 2010).

Despite, the increasing attention towards TM, literature review has revealed that there are few empirical studies on talent management especially with modern practices (Jyoti and Rani, 2014; Agrawal, 2010; Kontoghiorghes and Frangou, 2009; Piansoongnern et al., 2011; Janardhanam et al., 2011; Grobler and Diedericks, 2009). Further, the impact of talent management practices on financial performance has not been evaluated at length in the literature. For testing the relationship, this study has conceptualised that talent management is a multidimensional construct that comprising talent identification, succession planning, talent development and talent retention practices. Further, the main purpose is to investigate the impact of talent management practices on the financial performance of an organisation.

OBJECTIVES OF THE STUDY

- To study the impact of talent management practices on financial performance.
- To recommend key implications for HR managers, branch managers and future research.

CONCEPTUAL FRAMEWORK

Figure 1 shows proposed model, which illustrate the relationship between talent management practices and financial performance.

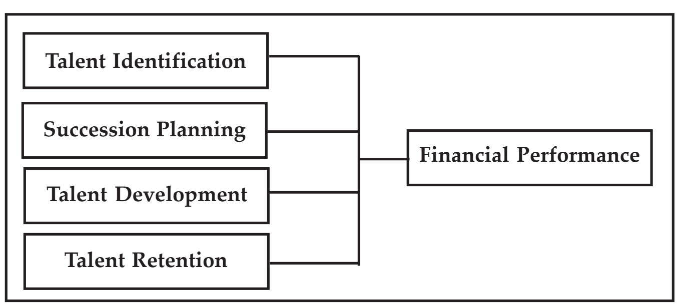

Figure 1: Proposed Research Model

HYPOTHESES DEVELOPMENT

Impact of Talent Management Practices on Financial Performance

Talent management practices help not only to overcome a talent shortage, but also deliver financial results that will win the approval of all stakeholders (Janardhanam et al., 2011). It increases productivity and capability; develops better linkage between individuals' efforts and business goals. Moreover, Jyoti and Rani (2014) conceptually revealed that organisations that apply talent management practices will achieve significant higher financial outcomes in terms of sales revenue and productivity (Kontoghiorghes & Frangou, 2009), net profit margin and earnings before interest, depreciation, and amortisation (DiRomualdo et al., 2009), return on assets and return on equity (Joyce & Slocum, 2012), or return on shareholders' value and market value (Huselid & Becker, 1998). The identification of talent has a significant impact on the competitive advantage of the firm. They contribute towards the materialisation of strategy and organisation's economic objectives and cutting the cost of fluctuation. Talent management reduces the extra cost of recruitment process for vacant positions because management chooses the best candidate from the selected talent pool (Horvathova & Durdova, 2010). By attracting and developing a satisfied, highly skilled talent pool and organisations enjoys improved customer service, increased sales, improved stock prices, individual contributions, and organisational growth (Connors et al., 2008; Puvitayaphan, 2008; Heinen & O'Neill, 2004; Handfield-Jones et al., 2001). Managing talent results in better financial outcomes such as company profit, market value, and greater shareholders' value, return on assets and return on equity. Furthermore, succession planning and talent development have statistically significant positive consequence in financial terms such as on profit, market value, and overall talent productivity (Bethke-Langenegger et al., 2010; Heinen & O'Neill, 2004). Moreover, talent management leads to cost savings through long-term proactive internal succession planning and higher retention rates (Sebald et al., 2005; Steinweg, 2009; Tansley et al., 2007). Though, Batt (2002) researched that high standard human resources practice i.e., talent retention contributes to the firm's profitability and market value. But, Bethke-Langenegger et al. (2010) founded that no effect of talent retention on financial outcomes at the company level. The above literatures lead to formulation of following hypotheses:-

H_1: Implementation of talent identification leads to better financial performance.

H_2: Implementation of succession planning leads to better financial performance.

H_3: Implementation of talent development leads to better financial performance.

H_4: Implementation of talent retention leads to better financial performance.

RESEARCH DESIGN AND METHODOLOGY

Generation of Scale Items

The concepts in the review of related literature have been used for designing the talent management practices and financial performance constructs. The Human Resource Management experts and one branch manager of each bank have also been consulted while framing the items. A five-point Likert scale has used in order to achieve uniformity ranging from 5-strongly agree to 1-strongly disagree.

Twelve items for measuring talent identification have generated after review the following literature: Edwards and Bartlett (1983); Horvathova and Durdova (2010); Yarnall (2011); Piansoongnern et al. (2011); Hartmann et al. (2010).

Twelve items for measuring succession planning have generated from research papers of Farashah et al. (2011); Krishnakumar (2011); Hartmann et al. (2010); Bano et al. (2010); Piansoongnern et al. (2011).

Twelve items for talent development have generated from research papers of White (2009); Collings and Mellahi (2009); Heinen and O'Neill (2004); Yarnall (2011); Bano et al. (2010).

Twelve items for talent retention have adopted from Kontoghiorghes and Frangou (2009); Hausknecht et al. (2009); Bhatnagar (2007); Priyadarshi (2011); Piansoongnern et al. (2011).

Seven items for financial performance have adopted from Fuentes et al. (2006); Venkatraman & Ramanujam (1986).

DATA COLLECTION

For selecting the sector, a pilot survey on 20 bank managers (conveniently selected) has been done to know the extent of talent management practices being practiced. The result of pilot survey revealed that TM practices are being implemented in banking sector, so final survey has also been conducted in this sector. The data have collected from two public banks (SBI and PNB) and three private banks (HDFC, ICICI and J&K bank) in Jammu city. Total 110 managers have contacted (convenient sampling method) out of which 103 responded properly.

DATA ANALYSIS

The data have been analysed with the help of two softwares i.e. SPSS and AMOS. Before data analysis, it has duly purified with the help of exploratory factor analysis and validated through confirmatory factor analysis (CFA). The detailed result of exploratory and confirmatory factor analysis is as under:

Scale Purification- Exploratory Factor Analysis (EFA)

In this study, majority of scales are self generated. Thus, this study has conducted multivariate data reduction technique of factor analysis for examining the inter-relationship among variables and reduction of a large number of variables into few manageable and meaningful sets. It has carried with Principal Component Analysis along with the orthogonal rotation procedure of Varimax for summarising the original information with minimum factors and optimal coverage. In this study, the statements with communalities and factor loading less than 0.5 and Eigenvalue less than 1.0 have ignored in the subsequent analysis (Sharma and Jyoti, 2006). EFA has been conducted on each practice of TM separately. The detailed outcomes of EFA are explained as under:-

The twelve items of talent identification have reduced to 7 after EFA. The high KMO value (0.659) and Bartlett's test of sphericity (chi square =716.723, sig<.001) indicate required sample adequacy for factor analysis. The loading of all items have greater than 0.50. The total variance explained by this factor has arrived at 72%.

The 12 items of succession planning got reduced to eight with 73 percent variance explained. The high KMO value (0.713) and Bartlett's test of sphericity (chi square =282.925, sig<.001) provided required sample adequacy for factor analysis. Again, the loading of all items is greater than 0.60.

Talent development construct initially consisted of 12 items that got reduced to 9 under one factor. It is explaining 78 percent of total variance. Further, high KMO value (.880) and Bartlett's test of sphericity (chi-square= 1550.239 sig<.001) revealed the sample adequacy for factor analysis. The factor loading of all items is greater than .50.

Further, Talent retention construct got reduced from 12 to 8 items and explained 68 percent of total variance. Further, high KMO value (.882) and Bartlett's test of sphericity (chi-square= 1254.373 sig<.001) revealed the sample adequacy for factor analysis. The factor loading of all items is greater than .60.

Financial performance construct contained seven items with high factor loading (<.70). Further, high KMO value (.816) and Bartlett's test of sphericity (chi-square= 1541.496, sig<.001) revealed the sample adequacy for factor analysis. The total variance explained by this construct arrived at 79%.

RESULTS

Henseler et al. (2009) and Anderson and Gerbing (1988) suggested two phase procedure for testing the theoretical model: 1) the measurement model and 2) the structural model. For assessing the composite reliability, convergent validity and discriminant validity, the measurement model i.e. Confirmatory Factor Analysis has been tested first. Hence, the items that emerged after EFA under the individual factor have validated through CFA and items with standardised regression weights (SRW) less than 0.50 have deleted (Hair et al., 2007). Fitness of the model has been assessed with various global fit indices like goodness of fit index (GFI), adjusted goodness of fit index, comparative fit index (CFI), normed fit index (NFI), Root mean squared error (RMR) and root mean square error of approximation (RMSEA). Goodness of fit of all the measurement models are within threshold limits (GFI, AGFI, CFI, NFI > 0.9; RMR <0.05; RMSEA <0.08) (see Table 1).

Table 1: Goodness of Fit Indices of Various Easurement odels (CFA)

Scales	Ç2/df	RMR	GFI	AGFI	NFI	CFI	RMSEA
Talent Identification	1.05	0.28	0.97	0.929	0.96	0.998	0.023
Succession Planning	1.635	0.26	0.976	0.911	0.968	0.987	0.08
Talent Development	1.643	0.029	0.956	0.885	0.965	0.986	0.081
Talent Retention	1.471	0.039	0.958	0.902	0.943	0.981	0.069
Financial Performance	1.569	0.021	0.953	0.89	0.976	0.991	0.076

Further, CFA has also been used to assess convergent validity (Bagozzi et al., 1991). The convergent validity has been checked through factor loadings and the AVE of all constructs. High standardised estimates (SRW>0.05) and AVE (>0.05) proved the convergent validity (Table 2).

Table 2: Reliability and Validity Analysis

Scales	AVE	Cronbach's alpha	Composite Reliability
Talent Identification	.895	.839	.970
Succession Planning	.896	.891	.983
Talent Development	.903	.933	.986
Talent Retention	.851	.934	.990
Financial Performance	.969	.956	.971

Apart from the validity, reliability of the constructs has been checked through internal consistency in the application of Cronbach's alpha (Cronbach, 1951) as well as by extracting the composite reliability with the help of variance extracted. Alpha values equal to or greater than 0.70 indicate high construct reliability (Nunually, 1970), which is proved in this study. Composite reliability is calculated as the squared sum of the individual item loadings divided by the squared sum of loadings plus the sum of error variances for the measures.This measure of internal consistency is similar to Cronbach's alpha except Cronbach's alpha assumes a priori that each measure of a construct contributes equally to construct (Cronbach, 1951). Bagozzi and Yi (1988) suggested that composite reliabilities of 0.6 or greater are desirable and that the individual item reliabilities will be usually lower than composites. The Cronbach's alpha and composite reliability values are presented in Table 3 prove that the constructs are quite reliable. Fornell and Larcker (1981) highlighted the importance of evaluating the discriminant validity of the constructs used. A successful evaluation of discriminant validity shows that a test of a concept is not highly correlated with other tests designed to measure theoretically different concepts. It has been proved by comparing the variance extracted with squared correlations between two constructs. The variance extracted for the constructs is higher than the squared correlation thereby proving discriminant validity (Table 3).

Table 3: Discriminant Validity and Correlation Analysis

	Talent Identif-ication	Succession Planning	Talent Develo-pment	Talent Reten-tion	Financial Perfor-mance
Talent Identification	.895				
Succession Planning	.283 (.532**)	**.896**			
Talent Development	.374 (.612**)	.494 (.703**)	**.903**		
Talent Retention	.421 (.649**)	.413 (.643**)	.633 (.796**)	**.851**	
Financial Performance	.158 (.398**)	.391 (.626**)	.488 (.699**)	.279 (.529**)	**.969**

Note: ** Significance level=0.01Values the diagonal axis represent Average Variance Extracted and below diagonal axis are squared correlations and values within the parenthesis are coefficient of correlation

Assessing the Impact of Talent Management Practices on Financial Performance: A Structural Equation Modeling

As suggested by Anderson and Gerbing (1988) in the second phase, the structural model has used to test all the hypotheses simultaneously. In the present study, the relationship between talent identification, succession planning, talent development, talent retention and financial performance have been assessed. Figure 2 reported the results of the study. Hypothesis 1 states that implementation of talent identification leads to better financial performance. But, structural model shows that there is an insignificant relationship between talent identification and financial performance (â = 0.06, p>.05). Hence, this hypothesis is not supported. The reason may be that talent identification is a planning process, which focuses only on identification of best, average and low performers in the organisation at every level.

Further, hypothesis 2 states that implementation of succession planning leads to better financial performance. The standardised regression weight (SRW) of this relationship (â = 0.54, p < 0.001) is significant, which supports the second hypothesis (Figure 2).

It has been further hypothesised (H3) that implementation of talent development leads to better financial performance. The result (â =

0.30, p<0.001) revealed that talent development has strong impact on financial performance of an organisation (Figure 2). So, this hypothesis has also stands accepted.

Further, Hypothesis 4 states that implementation of talent retention leads to better financial performance. The result (â = 0.25, p<0.05) revealed that talent retention also significantly affects financial performance of an organisation (Figure 2). So, this hypothesis also stands accepted.

Though out of 4 hypothesised relations 3 stand accepted but, the goodness of model fit is poor (÷2/df=2.363, RMR= 0.239, GFI= 0.639, AGFI= 0.574, NFI= 0.660, CFI= 0.767, RMSEA= 0.117). So, in order to achieve the goodness model fit, the insignificant relationship between talent identification and financial performance has been removed (as suggested by Arbuckle and Wothke, 2004), still the goodness of model fit are not appropriate. So, the modification indices have been inspected, which suggested regression paths from Talent identification ® Succession planning and Talent identification ® talent development. The introduction of these paths improved the goodness of model fit significantly, which yield model 2 has better fit (÷2/df=1.974, RMR=0.059, GFI=0.907, AGFI=0.870, NFI=0.809, CFI=0.903, RMSEA=0.080). Further, model comparison also revealed differences in the two models (“÷^{2}>3.84, p<0.01).

DISCUSSION

Talent management practices play a prime role in the banking sector for enhancing their financial performance. The result of this study revealed that succession planning, talent development and talent retention significantly and positively affect the financial performance of banks. Under succession planning, organisations assign a successor/talented employee to a given pivotal position in the organisation for future work. Talented employees use their high potential, skills, competence and knowledge for achieving the organisational goals, which in turn increases the financial performance of the organisation. Further, organisations develop their talent (employees) through training, long-term development programs and high targeted assignments. By these exercises, employees are able to enhance their knowledge, skills, and efficiency, which are further used for the organisational benefits especially financially. But, only development of employees is not enough for the organisation. Organisations have to retain these talented employees within the organisation for a long period of time for superior financial outcomes as compared to their competitors. Moreover, this study also revealed the insignificant impact of talent identification on financial performance. The reason may be that the talent identification is the first stage of the talent management process, where managers or experts merely identify talented employees for future purposes. So, only the identification of talent pool may not contribute towards the financial outcomes such as an increase in market share, increase in profit and so on. Talent identification may affect financial performance indirectly through succession planning and talent development. Further, Alternate model results also indicated that talent identification has significant impact on succession planning (SRW=.48, $p<0.01$) and talent development (SRW= .66, $p<.01$).

THEORETICAL IMPLICATIONS

This study has validated the scale of talent identification, succession planning, talent development and talent retention. Further, this study also explored that three practices of talent management affect directly financial performance i.e., succession planning, talent development and talent retention, whereas talent identification affects financial performance indirectly through succession planning and talent development.

MANAGERIAL IMPLICATIONS

This study derives noteworthy implications for the branch and HR managers, which can help them in formulating and implementing talent management practices more effective in the banking sector. Further, these implications will also be beneficial for branch manager by enhancing their role in TM process. The first implication is that branch as well as HR managers should have to devote sufficient time and attention towards the formulation, implementation and evaluation of all talent management practices.

Further, managers should adopt a formal process for identification of talented employees such as nomination and segmentation process and should also maintain a proper database of each talent (employee) and review it at the time of identifying and retaining them. Further, it can be used for succession planning also. Managers should survey all the levels within banks for identifying their talented employees. If identification of talent is correct, then other practices can be easily established and yield positive results. Further, bank managers should also offer need based benefits plans for the development of employees such as enroll them in a long-term leadership development programs and succession planning procedure. HR managers should also stress on the participation of branch managers in succession planning of employees, which will enhance their decision making power, boost their confidence level and motivate them to achieve organisational goals. Mentoring plays vital role in talent management practices, which is missing in this sector. So, top management (HR managers) should have to develop formal mentoring programs to guide, coach and counsel employees regarding their career as well life related issues, which in turn yield positive outcomes for employees (career development, role efficacy, job satisfaction, work-life-balance) as well as for the organisation too (financial performance).

LIMITATION AND FUTURE RESEARCH

The study has been conducted with all possible precautions to maintain objectivity, reliability and validity, yet there are some limitations in this study. First, this study is on the basis of the manager's perspective, which may be guided by their likes and dislikes. So, in future, multi respondents such as HR managers and employees survey should be conducted for removing the problem of common bias. Next, this study is cross-sectional in nature. In future, a longitudinal study can be conducted to draw better inferences. Further, other outcomes of talent management practices such as employee performance, job satisfaction and organisational commitment need to be explored in future.

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2

Does Microfinance have Equal Distribution Across the Different Regions of the Country?

*Vinay Kumar**

INTRODUCTION

The significant population of the world is poor and are earning their lives by different means. More than 500 million poor people of the world are economically active and are earning their bread by working in small organisation or businesses employing just four to five people or working at their own (self-employed) with available resources like retailing, making mud pans, selling vegetables on the streets etc. These poor people often fail to manage their finances as they don't have access to the financial services. They can't get the funds to finance their businesses and even don't find place to keep their savings. So absence of financial services to these poor households makes it very difficult for them to survive and then they approach private lenders such as friends, families, relatives etc. for financing their small businesses. This lag between the financial requirements and available financing options to the poor households led to the emergence of concept of micro financing. The concept of microfinance deals with the catering of the needs of the unprivileged section of the society. Microfinance actually refers to the provision of financial services like loans, savings and insurance facilities to the poor entrepreneurs and business owners who otherwise don't qualify for such services from the banks. In other words, microfinance refers to small-scale financial services

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for both credits and deposits, that are provided to people who do small household activites such as farming, fishing or operate small or micro-enterrises where goods are produced, recycled, repaired, or traded; provide services; work for wages, or commissions; gain income from renting out small amounts of land, vehicles, draft animals or machinery and tools; and to other individuals and local groups in developing countries in both rural and urban areas.", Robinson(2001).

This concept of microfinance was actually started by Non-Government Organisations and banks such as Grameen Bank of Bangladesh, Bank Rakyat Indonesia, Kenyan Rural enterprise, Kenya and others. The much used expression of Micro-financing has its roots in 1970s when the Grameen Bank of Bangladesh along with pioneer of Micro-finance Mohammed Younus, who got the Noble Peace Prize in 2006 for his continues efforts towards the achievement of the objective of transforming the traditional micro financing system. They did experiment with the old system of 1970s used for lending and found that rural people who were generally excluded from the financial services offered by the financial institutes, were repaying the loans on time. They extended the loan to them with slighter different method that of lending without collateral with loans repayable in regular instalments. Hence the results were quite amazing and encouraging. The borrowers were repaying their loan to the financial institutions at time. In India the National Bank for Agriculture & rural Development was the first institution that started the concept of micro-financing. The NABARD took the initiative to start the concept of creation of Self Help Groups and then the linkage of Self Help Groups with the formal banking system. Under this scheme the banks were allowed to open up the accounts of the Self Help Groups either registered or unregistered. These SHGs are actually the group of 15-20 members belonging to the very poor families. The banks use to lend money to these groups on the market rate against certain deposits made by them with the bank. The lending of funds under NABARD takes place through two modes: through Self help Group Linkage Programme (SHG-BLP) which is the main lending model and financing through Micro-financing Institutions.

As per the latest data of Microfinance Industry in India as on 31st March, 2017, microfinance Industry has total loan portfolio of Rs 106916 cr. This represents the growth of 26% over the last year. AS per the data of financial year 2016-17, the Non Banking Financing

Corporations along with Micro financing Institutions represent 42% of the microfinance lending followed by banks at 38% and SFBs.

Thus it is very important to understand and use the concept of micro-financing and to overcome the social & economic problems like unemployment. It is the only micro-financing that can help an economy to remove the problem of unemployment & poverty. Dr. C.K. Prahalad has very rightly said "If we stop thinking of the poor as victims or as a burden and start recognizing them as resilient and creative entrepreneurs and value conscious consumers, a whole new world of opportunity will open up'. So we need to focus on the needs and problems of the poor and then should find the ways to help them out by providing technical as well as financing aid.

REVIEW OF LITERATURE

Yaron (1994) suggested a model based on dual concept of outreach & sustainability of micro-financing institutions. The outreach & sustainability has become the one of the most popular criteria for the assessment of performance e of Micro-financing Institutions. The outreach represents the number of accounts serviced and the quality of the products provided. Sustainability represents the ability of the institutions to generate enough income to sustain the institution atleast.

Burgess, R., & Pande, R. (2004). in their study on **"**Do Rural Banks Matter? Evidence from the Indian Social Banking Experiment" concluded that Indian central bank in its rural branch expansion programme authorised the commercial banks to open up the branches in rural areas between the period 1977 to 1990. The period witnessed the relatively more expansion in the number of branches in rural areas of the India and this expansion significantly decreased the level of rural poverty and increased the non agricultural output. **Sinha (2007)** in his study on SHGs in India revealed that India is now over-flooded with the number of Self help groups and even number of self help groups are increasing at a faster rate than the targeted but the social & empowerment facts are not as widespread as they were hoped to be. The study recommended that these SHGs need to be mentored more effectively & strategic guidance should be imparted for more period of time for getting the expected results from these Self Help Groups. **Kumar, V., Sharma, R. K., & Sharma, H. R. (2008)**. in their study on Impact of Microfinancing on Employment, Income and Empowerment-Micro Evidence from Himachal Pradesh revealed that microfinancing alone cannot help the rural household to move from first round impact (Survival) to second round Impact (Income, employment & poverty eradication) but some special efforts need to be taken for the effectiveness of the micro financing. Some parameters that are acting as the structural constraints such as lack of skills, absence of training & development are coming up as emerging constraints and are need to be addressed on priority for making the micro financing as an effective tool for eradication of unemployment and poverty. **Bhat, K. A., & Maurya, R. S. (2013).** A Study on Role of Micro Finance Provided by the Jammu and Kashmir Bank. In their study they have concluded that J&K bank is the leading Financial institution J&K which is providing the Micro Financial services to the customers. He also concluded that about 55% of the total respondents under study were not aware of the financial services provided by these banks and have used another way for financing their businesses. The customers always prefer hassle free sanctioning of loans and there were branches of the J&K bank that were not taking care of the needs of the customers. Therefore the study can be made that whether the customers are not aware of the Govt. Schemes or lacuna is with the promotion policy of the J&K Bank. **Rajmane, M. S. B. (2015)** in his study on impact of SHGs on women empowerment says that women often face the problem dependence on men, completely or partially, therefore women can become independent by the way of making Self Help groups. The study has shown that women participation in SHGs have created tremendous effect on their life style and they have not only become the self dependent but re also supporting their families too. Therefore the Govt. should take more in initiatives to promote the women participation through creation of self help groups. **Dhar, Parijit (2016**) in his study on the Penetration of Microfinance in India: A state wise Analysis has calculated the Penetration index of microfinance for various states if India and have found that there is a wide disparity in the penetration of Microfinance in India in its various states & mostly it has dominated the southern state of India where it has reached the saturation point where as northern as well as north-eastern states are still lagging behind with respect to the availability formal source of finances. Therefore there is a need for the development of the micro financing models to reach out the hitherto unreached and excluded sections of the society in order to lessen the poverty and to reduce the regional imbalance. **Satya Ranjan Doley (2017)** conducted a comparative study of MFI-Bank Linkage & SHG-Bank Linkage programme in India and concluded that the loan disbursement through MFI-Bank Linkage is high (almost double) as compared to SHG-Bank Linkage but the testing of the hypothesis has supported the assumption that there is no significant difference in the growth rate of loan disbursement between the two linkages and both are equally important for the achievement of financial Inclusion.

OBJECTIVE OF THE STUDY

- To Study the regional distribution of the Microfinance in India.

Research Methodology: The current study is based on the secondary data and the data has been collected from various published reports of the NABARD, MFIN, RBI and few other published materials by Govt. and Non Governmental organisations. The data collected has been analysed through tables and graphs.

Data Analysis: The Micro-financing Institutions in India operates in 29 states, 4 Union Territories & 588 districts in India. The data in the table below shows the number of micro-financing institutions in India state wise. Twenty five micro financing institutions in India are having their presence in more than five states. Among these five MFIs are having operations in sixteen states and 62 MFIs are having their outreach in two to four states. Seventy Nine MFIs are there which are having their presence limited to only Single state. There are only four micro-financing institutions which are having their operations available in eleven to fifteen states. Out of the total of 166 MFIs present in India, only five have their outreach to the customers of the more than fifteen states. So the data clearly shows that there are few no. of MFIs available in India moreover, their operations are confined to very limited number of states.

No. of States/UTs	No. of MFI
1	79
2 to 5	62
6 to 10	16
11 to 15	4
> 15	5
Total	166

Sa-dhan Report-2016, Micrometer-MFIN-2017

The micro financing institutions in India: As per the data given in the table below the Maharashtra is having the maximum number of micro-financing institutions (35) followed by Madhya Pradesh, Chandigarh, Karnataka, Bihar, Uttar Pradesh. So we can see from the table and others data available that maximum numbers of Micro-financing institutions are operating in Southern states or few of them in central & Eastern India. The Northern part of the India is still lagging behind in the number of Micro-financing institutions in India. The reason can be

State/Union	Outstanding loan portfolio (in Cr.)	No. of Micro financing Institutions	Population Density
Jammu and Kashmir	4	1	25,178
Manipur3	134	1	5,120
Nagaland	4	1	1,939
Arunachal Pradesh	49	2	2,909
Mizoram	170	2	2,159
Sikkim	34	2	932
Andhra Pradesh	1,286	3	1,24,482
Chhattisgarh	1,136	3	50,070
Goa	23	4	1,966
Himachal Pradesh	23	5	10,602
Tripura	70	5	5,977
Meghalaya	29	6	6,475
Punjab	1,116	7	43,932
Delhi	559	8	31,743
Kerala	2,372	9	40,306
Puducherry	201	9	2,718
Assam	1,013	10	53,659
Uttarakhand	577	13	18,303
Haryana	1,186	14	46,792
Odisha	3,339	14	66,895
West Bengal	3,406	14	1,45,314

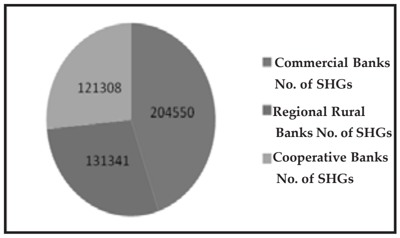
Gujarat	2,193	15	1,09,682
Tamil Nadu	9,039	15	1,19,980
Rajasthan	1,368	16	1,31,009
Jharkhand	977	17	64,308
Uttar Pradesh	6,671	19	3,70,416
Bihar	3,526	20	2,15,014
Karnataka	12,645	20	1,01,783
Chandigarh	25	21	1,822
Madhya Pradesh	4,088	25	1,35,286
Maharashtra	6,589	31	1,88,741
Andaman and Nicobar I slands	1	**	489
Dadra and Nagar Haveli	**	**	1,155
Daman and Diu	**	**	796
Lakshadweep	**	**	81
ALL INDIA	**63,853**	**332**	**21,18,633**

Source: Sa-dhan Report-2016, Micrometer-MFIN-2017

As per the data for from 2014-15 to 2016-17, in 2014-15 the Southern Region is at the top position with maximum number of SHGs (10,05,227) followed by Eastern region with 3,51,800 SHGs, where as the Northern region has just, 43, 848 SHGs. Similar trend was there for the 2015-16 and in the year ending March, 2016-17 the Southern state is again holding the same top position with 11,36,692 number of SHGs and Northern region still lagging behind the Southern region with just 46, 567 number of SHGs. This wider difference between the Southern & Northern regions is creating the need of further research for finding the reasons for less growth of microfinance in Nortern region.

Further if we look into the data of Microfinance growth in Northern region itself as per the Status of Micro-finance in India 2016-17 published by NABARD, Jammu & Kashmir with population of 1,25,48,926 (census-2011) is having 12248 number of SHGs as compared to the Himachal Pradesh with a population of 68,56,509 is having 16913. So there is a wider disparity in the number of SHGs financed through Commercial Banks, Regional Rural Banks & Co-operative Banks and respective populations in these two states.

Himachal Pradesh in spite of having less population than J&K is having more number of SHGs.



The pie-chart in the table is clearly showing the number of self-help groups operated by these three types of banks. Commercial banks are at the top position with respect the number of Self Help groups.

	Commercial Banks		**Regional Rural Banks**		**Cooperative Banks**		**Total**	
State	**No. of SHGs**	**Savings Amount**	**No. of SHGs**	**Savings Amount**	**No. of SHGs**	**Savings Amount**	**No. of SHGs**	**Savings Amount**
Chandigarh	1255	100.11	0	0	37	4.4	1292	104.51
Haryana	19930	1830	17187.36	1334	3498.93	265	40615.71	3431
Himachal Pradesh.	16913	1635.18	9941	1600	18881	1826.39	45735	5061.57
Jammu & Kashmir	12248	428.98	3609	1726.19	1005	29.39	16862	2184.56
New Delhi	4131	1043.4	0	0	349	75.66	4480	1119.06
Punjab	15745	1579.89	9051	731.1	6690	824.35	31486	3135.34
Himachal Pardesh	134328	17197.52	91553	12116.4	90848	5326.34	316729	34640.24
Total	**204550**	**23815.6**	**131341**	**17508.24**	**121308**	**8352.28**	**457199**	**49676.44**

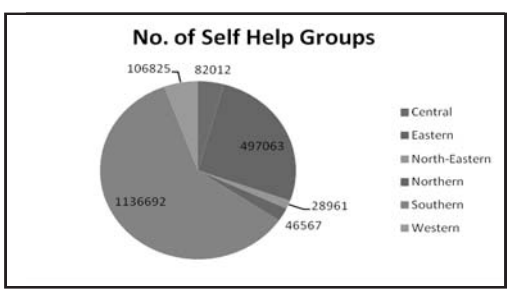
Table-2, Source: NABARD, Status of microfinance in India 2016-17
(Amount in Lakhs)

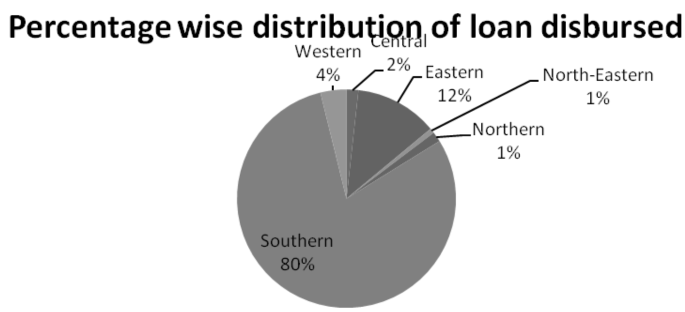
Number of Self-Help Groups & Loans disbursed region wise: The data in the table below shows the number of Self-Help Groups & Loan disbursed to the clients across the various regions of the country. The data clearly shows that maximum numbers of self help groups are concentrated in Southern region of the country followed by Eastern region and then by western region. The least number of self help groups are present in North-Eastern region & Northern region of the country.

Even if we look at the data for loan disbursed to the clients in the various regions of the country, the southern region dominates with 80% loans disbursed, followed by Eastern region with 12% of the loans disbursed. The rest of the regions are just sharing the one or two percent of the total loan disbursed. Therefore there is regional disparity in the presence of micro financing in India and steps should be taken by Govt. of India and these micro financing agencies to increase the share of microfinancig in the other regions of the country.

Region	No. of Self Help Groups	Loan Amount Disbursed (Amount in Lacs)	Loans outstanding amount(Lacs)	%age
Central	82012	67958.46	221368.59	**3.59**
Eastern	497063	473171.99	888561.61	**14.43**
North-Eastern	28961	28420.67	83160.29	**1.35**
Northern	46567	57414.19	91167.07	**1.48**
Southern	1136692	3102331.73	4664964.98	**75.75**
Western	106825	148818.6	208907.82	**3.39**
Total	1898120	3878115.64		100.00

Source: Status of Micro-finance In India 2016-17 by NABARD





Conclusion

The micro financing has shown the good growth rate over the years reaching the poor's for proving them financial services and it has become n important tool for the development of the country. The data for number of self-Help groups, micro financing institutions, Gross loan portfolio, loans disbursed and outstanding amount of the clients shows that the micro-finance in India is growing at the good pace but it has its concentration only in the southern region of the country. Therefore the regional disparity is hampering the true essence of the Micro-financing in India. The Govt. should take certain measures for the achievement of the regional parity in the distribution of microfinance across the various regions of the country.

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3

Microfinance in India: Role, Status and Challenges

Irfana Unjum* Javaid Ahmad Mir**

ABSTRACT

Microfinance is the process or act by which credit and other financial services are made available to those sections of the society who are deprived of high standards. It helps these vulnerable sections to overcome their difficulties related to consumption and other economic needs. Microfinance is dynamic in nature and works in an integrated matter with various stakeholders like clients, Self-help groups etc. keeping in mind its importance in the poverty alleviation, economic development and its outreach to the vulnerable sections of the society, the study is aimed to discuss the role, status, issues and challenges of micro finance in India. After the examination of various aspects of microfinance in India, policy suggestions have been put forth.
Keywords: *Microfinance, Self-help Groups, Grameen Model, India*

INTRODUCTION

Micro finance is the act of making available the thrift, credit and other financial services and products of very small amount to the poor in rural, semi -urban and urban areas so that they can be able to raise their income levels and improve their standard of living. It is emerging as a powerful tool for poverty alleviation in India. It

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has been recognized that micro finance helps the poor people meet their needs for small credit and other financial services. Microfinance as practiced as an informal and flexible services to low-income borrowers for meeting their modest consumption and livelihood needs have not only made it grow at a rapid pace across the world, but in turn has also impacted the lives of millions of poor positively. The poor need micro-finance to undertake economic activity, smoothen consumption, and mitigate vulnerability to income shocks (in times of illness and natural disasters), and increase savings and support self- empowerment. Micro credit is the most common product offering (Nasir, 2013). Micro-finance in India is synonymous with micro credit; because savings, thrift and micro-insurance constitute a very small part of the micro finance space. The loans offered through micro finance in India are mostly in the range of Rs.5, 000 to Rs.20, 000 as the Development and Regulation Bill, 2007, defines loans with amounts not exceeding Rs.50, 000 in aggregate per individual/ small enterprise as microfinance. CRISIL (Credit Rating Information Services of India Limited) estimates that around 120 million households in India continue to face financial exclusion. This translates into a credit demand of around Rs.1.2 trillion. MFIs are the main players in the microfinance space in India; their primary product is micro credit. Other players that extend micro finance services, in addition to their core business, include banks and insurance companies, agricultural and diary co-operatives, corporate organizations such as fertilizer companies and handloom houses and the postal network. Additionally there are specialized lenders, called apex MFIs that provide both loans and capacity building support to MFIs (Mahapatra and Patra, 2010).

ROLE AND STATUS OF MICROFINANCE IN INDIA

Microfinance is dynamic and works in an integrated system with many stakeholders having definite role to play. Client stands as its core. At the second level called micro level, MFIs, NGOs, SHGs and Grameen work to provide financial support to individual client. Apex institutions like NABARD, SIDBI and other nationalized Banks operate in Meso-Level to provide infrastructure, information and technical support to micro level players (Mahanta et al., 2012). Microfinance reaches the poor through delivery models each delivery model has its share of problems and success. In India, various delivery models have been adopted by microfinance institutions and they can be categorized into following broad categories.

Self Help Groups

The Self Help Groups (SHGs) being the dominant microfinance mode In which members pool their small savings regularly at a prefixed amount on daily or weekly basis provide loan to members for a period fixed. SHGs are essentially formal and voluntary association of 15 to 20 people formed to attain common objectives. People from homogenous groups and common social back ground and occupation voluntarily form the group and pool their savings for the benefit of all of members of the groups. These are augmented through financial assistance by MFIs or banks. Saving precede borrowing by the members. NABARD has facilitated and extensively supported a program which entails commercial banks lending directly to SHGs rather than via bulk loan to MFIs. If SHGs are observed to be successful for at least a period of six months, the bank gives credit usually amounting 4 times more than their savings (Mahanta et al., 2012)

GRAMEEN Model

The Grameen Bank model has been a case of exceptional success in Bangladesh. It turns out that many organizations in India have adopted the Grameen Bank model with little variations and good success. Some of the notable examples are SHARE Microfinance Limited, Activists for Social Alternatives (ASA) and CASHPOR Financial and Technical Services Limited. Some of the significant features of Grameen bank model are low transaction costs, no collateral (peer pressure is sufficient), repayment of loans in small and short interval and quick loan sanctions with no formalities. Repayment of loan in small chunk is one of the reasons of high loan recovery (Nasir, 2013).

ROLE OF MICROFINANCE IN FINANCIAL INCLUSION

Micro finance plays important role in helping the poor in meeting their financial needs. It there by helps them in increasing their economic as well as social standards which in turn plays a major role in the economic development of the country. The organization also is helping the right person rather the neglected group (who were neglected by the banks and also government to some extent) by rendering service at the right time at the right place and at the right price that is at reasonable rate of interest(Kolli and Vinutha, 2014).

As we know that formal credit institutions do not meet the credit requirements of the poor rarely lend to the poor so special institutional arrangements become necessary to extend credit to those who have no collateral to offer. Microfinance institutions through their channels provide small loans and savings facilities to those who have been excluded from commercial financial services and thus have been promoted as a key strategy for reducing poverty in all its forms by agencies all over the world. Microcredit has been defined as “programs that provide credit for self-employment and other financial and business services (including savings and technical assistance) to very poor persons”. Nowadays, microfinance represents something more than microcredit - it also refers to savings, insurance, pawns and remittances, in sum to a much wider range of financial services. In most cases, microcredit programs offer a combination of services and resources to their clients in addition to usual credit for self-employment. Also, this is an effort to provide a bridge between formal financial markets and the informal groups in the formal microfinance initiatives.

The basic idea underlying microfinance is that if poor people are given access to economic inputs, they would come out poverty. The need for informality in credit delivery and easy access is demonstrated by the fact that Self Help Groups (SHGs) and Microfinance Institutions (MFIs) constitute the fastest growing segment in recent years in reaching out to small borrowers. Micro-finance is a new development in which Indian institutions have acquired considerable expertise and where up-scaling holds great promise both to expand the nature of financial services offered to micro enterprises and to make these the spring board for entrepreneurial development (Planning Commission, 2006)

The SHG movement is bringing about a profound transformation in rural areas of India. MFIs play a significant role in facilitating inclusion, as they are uniquely positioned in reaching out to the rural poor. Many of them operate in a limited geographical area, have a greater understanding of the issues specific to the rural poor, enjoy greater acceptability amongst the rural poor and have flexibility in operations providing a level of comfort to their clientele. It is roughly estimated that there are about 1,000 NGO-MFIs and more than 20 Company facilitating the activities in all over India. There are today over 22 lakh such groups linked with banks. The objective of the country is to enroll at least 50% of all rural women in India as members of SHGs over the next five years and link these SHGs to banks (Christabell and Raj, 2012).

STATUS

The main operations of microfinance are carried out through specialized institutions called micro finance institutions. In India a large number of organizations with varied size and legal forms offer microfinance service which lend through the concept of Joint Liability Group (JLG). A JLG is an informal group comprising of 5 to 10 individual members who come together for the purpose of availing bank loans either individually or collectively through the group against a mutual guarantee. There are various reasons for the existence of MFIs as specialized institutions performing the functions of microfinance like high transaction cost – generally micro credits fall below the break-even point of providing loans by banks, absence of collaterals – the poor usually are not in a state to offer collaterals to secure the credit, Loans are generally taken for very short duration periods, Higher frequency of repayment of installments and higher rate of Default. Non-Banking Financial Companies (NBFCs), Co-operative societies, Section-25 companies, Societies and Trusts, all such institutions operating in microfinance sector constitute MFIs and together they account for about 42 percent of the microfinance sector in terms of loan portfolio. The MFI channel is dominated by NBFCs which cover more than 80 percent of the total loan portfolio through the MFI channel (Sunitha, 20145-Highlights of Microfinance Status in India

1. MFIs operate in 517 districts in India spread across 27 states with total MFI client outreach as on March 2011 as 3.17 crores, while the total microcredit outstanding was Rs. 2500 crores which have been scrutinized to banks .
2. The microfinance has grown 18.75 percent in 2011 in terms of client outreach and 13.15 percent in terms of credit portfolio through MFI channels.
3. During year 2011, loan portfolio growth rate has decreased to 13.15 percent compared to 56 percent in the previous year.
4. MFIs collectively disbursed Rs. 33730 crores as loans to clients during 2010-11. Also, the average loan per client stood at Rs. 5706, which is less than that of Rs.9766 in the year 2010.
5. In 2010-11, more than one third of the MFIs displayed negative growth in client and loan portfolio.

Table-1: Broad Microfinance Clients

Class of Agency	No. of Clients(millions) March 2008
Commercial banks including RRBs small loan accounts	41.00
Primary cooperative societies borrowers (small)	28.54
Self Help Group members	47.1
MFI-Clients	14.1
Total	130.74

Source: Srinivasan N, 2009

Table-2: State wise Number of MFI Clients and Loans

Region/State	MFI clients (no.)	Loans outstan-ding (lakhs)	Region/ State	MFI clients (no.)	Loans outstan-ding (lakhs)
Northern Region			Bihar	400223	24447
Haryana	33908	3588	Jharkhand	183321	12144
Himachal Pradesh	3574	321	Orissa	162450	82412
Punjab	1804	234	West Bengal	2366397	119776
J & K	0	0	Andaman	4170 & Nicobar	87
Rajasthan	242926	22426	**Subtotal**	**4416561**	**238866**
New Delhi	67947	11315	**Central Region**		
Sub total	**350159**	**39991**	Madhya Pradesh	551235	32631
North Eastern Region			Chhattis-garh	397757	26542
Assam	163005	7740	Uttar Pradesh	812702	76437
Manipur	3005	142	Uttaranchal	64291	2974

Meghalaya	2898	185	**Sub total**	**1825985**	**138584**
Sikkim	5945	397	**Southern Region**		
Tripura	76619	3256	Andhra Pradesh	4949393	356528
Nagaland	0	0	Karnataka	3229378	214805
Arunachal Pradesh	0	0	Kerala	310646	14649
Mizoram	0	0	Tamil Nadu	2370257	119410
Sub total	251472	11721	**Sub total**	**10859674**	**705393**
Eastern Region			Grand total	20026356	1206308

Source: Srinivasan N, 2009.

ISSUES OF MICROFINANCE

There are number of hindrances which come in the way of proper growth of microfinance in India. Such issues need to be addressed so that microfinance would meet the targets for which it has been mooted. Following are some the issues.

Financial Illiteracy

Financial illiteracy among people is one of such hindrances that restrict the growth of microfinance. This makes it difficult in creating awareness of microfinance and even more difficult to serve them as microfinance clients. The SHG and JLG members are taught to do their own signature, which is claimed as educational trainings by MFIs. The worst part is that many MFIs think that this is what financial literacy means. We all know how dangerous it can be when one doesn't know how to read but he/she knows how to accept or approve it (Dasgupta and Roa, 2003).

Inability to Generate Sufficient Funds: MFIs are not able to raise sufficient funds which are the cause of worry for MFI sector. Although NBFCs are able to raise funds through private equity investments for the profit motive, such MFIs are restricted from taking public deposits. Not-for-profit companies which constitute a major chunk of the MFI sector have to primarily rely on donations and grants from Government and apex institutions like NABARD and SIDBI. In absence of adequate funding from the equity market, the major source of funds for MFIs are the bank loans, which is the reason for high Debt to Equity ratio of most MFIs. MFIs receive debt from banks against their equity and in order to increase their portfolio size they need to increase their debts for which they further need to increase their equity. After the Andhra crisis, it is reported that banks have stopped issuing fresh loans and even though currently few banks have resumed, they want MFIs to increase their equity to get fresh loans. So the only mode for the MFIs to increase their portfolio size is to increase their equity. The problem of inadequate funds is even bigger for small and nascent MFIs as they find it very difficult to get bank loans because of their small portfolio size and so they have to look for other costlier sources of fund (Sunitha, 2014).

Loan Default: Loan default is an issue that creates a problem in growth and expansion of the organization because around 73% loan default is identified in MFIs. Lack of understanding on the part of the clients, they also cannot correctly manage the loans given to them. As a result, they are not able to pay back the loan (Nasir, 2013).

Dropouts and Migration of Group Members: Majority of the microfinance loans are disbursed on group lending concept and a past record of the group plays an important role in getting new loans either through SHG-Bank linkage or through MFIs. The two major problems with the group concept are dropouts (when one or more members leave the group) and migration (when one or more members move to another group). Most MFIs lend on the basis of the past record of the group i.e. SHG or JLG and also on the individuals repayment performance. In absence of a decent past record, members are deprived of getting bigger loan amounts and additional services.

Language Barrier: Language barrier makes communication with the clients (verbal and written) is an issue that creates a problem in growth and expansion of the organization because around 54% language barrier has been identified in MFIs. As the education level of clients is low so it is difficult to communicate with them. For this reason it is also difficult for the MFIs employees to make the clients to understand the policy and related details.

Multiple Lending and Over-Indebtedness: Both of these are outcome of the competition among the MFIs. Microfinance is one such sector where the Neo-liberal theory of free market operation fails, at least to some extent. Though competition is good for many sectors but in this case it is going against both the parties. In order to eat away each other's market share, MFIs are ending up giving multiple loans to same borrowers which in some cases is leading to over-indebtedness (a situation where the borrower has taken loans more than her/his repaying capacity) of the borrower. MFIs are getting affected because borrowers are failing to make payments and hence their recovery rates are falling, while over-indebtedness is making the borrower go to depression and in some cases forcing them to commit suicide (agarwal, 2014).

CONCLUSION

Microfinance is the process or act by which credit and other financial services are made available to those sections of the society who are deprived of high standards. It helps these vulnerable sections to overcome their difficulties related to consumption and other economic needs. The loans offered through microfinance range between Rs 5000 to Rs 20000. Microfinance also helps to sort out the problem of financial exclusion which as estimated by credit agency CRISIL amounts to about 120 million households.

Main players of the microfinance are MFIs itself. Besides banks, agricultural cooperatives, corporate organizations, insurance companies, postal network also carry the function of microfinance in India. Clients stand at the core of micro finance in India and Microfinance institutions (MFIs), Non – Govt. organizations (NGOs), self-help groups (SHGS) act at micro-level and apex institutions like NABARD, SIDBI and other nationalized banks help in infrastructure development, technical support required for the success of micro finance.

Policy Recommendations

1. Definition of financial literacy needs to be redefined.
2. A central agency is also needed to be set-up which could regulate the functioning of micro finance players.
3. MFIs face high debt obligations as loans from the banks are the main source through which they raise their funds. Accepting public deposits can help them to meet these obligations.

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4

Investigating the Impact of Entrepreneurial Orientation on Performance among Women Entrepreneurs

Tisha Singh *

ABSTRACT

Purpose: *The purpose of this study is to investigate the impact of entrepreneurial orientation on performance among women entrepreneur. Further, mediating role of self satisfaction and motivation were also explored.*

Design/methodology/approach: *Data were collected from 200 women entrepreneurs working in Jodhpur city in Rajasthan (Western India) on the bases of random sampling. Statistical techniques like confirmatory factor analyses, structural equation modelling and hierarchical regression were used to analyse the data. Further, reliability and validity tests were also performed.*

Findings: *The study finds that entrepreneurial orientation has direct and indirect impact on performance through self satisfaction and motivation. Further, it was found that motivation has full mediating effect while self satisfaction is partially mediating the link.*

Research limitations/implications: *The study is limited to Jodhpur City only. It is one of the limited Numbers of Studies that has Empirically Addressed the Role of Entrepreneurial Orientation among women entrepreneur. This study will be helpful for women*

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entrepreneurs in recognising the worth of self satisfaction and motivation to improve performance and successful venture.
Originality/value: *The results extend the understanding of the role of entrepreneurial orientation in improving performance among women entrepreneur through self satisfaction and motivation that has positive impact on value creation which helps in customer management to satisfy their demands and aspirations for creating sustainable competitive advantages for women entrepreneurs.*
Keywords: *Entrepreneurial Orientation, Women Entrepreneur, Performance.*

INTRODUCTION

Women entrepreneurship has been recognised as an important source of economic growth as they create new jobs for themselves and others and also provide society with different solutions to management, organisation and business problems. However, they still represent a minority of all entrepreneurs. Women's entrepreneurship can strongly contribute to the economic well-being of the family and communities, poverty reduction and women's empowerment. The women entrepreneurs in emerging markets are facing hostile and extremely uncertain competitive situations with increased pressure to be more innovative and entrepreneurial. Also, they are playing significant role in fostering economic and social development, particularly in the small business sector (Ahmed, 2011). In this concern, Mordi et al. (2010) reveal that women entrepreneurs are widely participating in total entrepreneurial activities and are taking the risks involved in combining resources in a unique way to avail the identified opportunity through the production of goods and services. Women have been taking increased interest in recent years in income generating activities, self-employment and entrepreneurship in India. Internal and external factors such as globalisation, technological innovation, demographic and social change, level of technology deployed, innovative ability and financial support can be found as influencing business environment and women entrepreneurship (Mahmood & Hanafi, 2012).

Entrepreneurial orientation (EO) is regarded as one of the crucial factors that may affect performance as well as business success of women entrepreneur. It refers to a firm's strategic orientation based on its specific entrepreneurial processes and behaviours. It represents how firms discover and exploit new opportunities well ahead of their competitors (Lumpkin & Dess, 1996). The term entrepreneurship can be used at different levels such as individual, group and organisational (Lumpkin & Dess, 1996). Different terms have been adopted to refer to entrepreneurship such as intrapreneurship (Kuratko et al., 1990), entrepreneurial orientation (Miller & Friesen, 1982), entrepreneurial posture (Covin & Slevin, 1991), corporate venturing (Guth & Ginsberg, 1990) or strategic entrepreneurship (Ireland et al., 2003). With the increasing significance of intangible outcomes, entrepreneurship literature has started to focus more on qualitative performance of firms in current scenario. The majority of the research examining the link between entrepreneurial orientation and organisational performance is conducted more in developed economies (Wei & Ling, 2015).

The relationship between EO and the performance of an entrepreneur has become the main subject of interest in past literatures. According to Rauch et al (2009) it is likely for the firms adopting EO to perform better than those following conservative orientation. Thus, examining the significant role of EO for the success of enterprises and performance of women entrepreneur is an important research problem. Previous studies have revealed that EO significantly improves business performance (Wiklund & Shepherd, 2005; Lumpkin & Dess, 2001). However, there are some studies suggesting that EO does not have positive influence over performance (Matsuno, Mentzer, & Ozsomer, 2002; Morgan & Strong, 2003; Naldi et al., 2007). Also, there are few studies delineating that EO may have direct and indirect impact on performance depending on different environment (Zahra, 2008; Kellermanns et al., 2008). Addressing this gap in the literature, present study intends to explore the indirect relationship between EO and performance through the significant role of self satisfaction and motivation.

HYPOTHESIS FORMULATION

Entrepreneurial Orientation and Performance

Entrepreneurship is viewed as a process of discovering and exploiting business opportunities (Shane & Venkataraman, 2000). Organisational entrepreneurship has been discussed from the perspective of EO that describes how a firm operates and competes while availing the opportunities (Lumpkin & Dess, 1996). Literature suggests that EO can drive business success (Boso et al., 2012) as it enables the firms to influence the market and market behaviours by offering innovative products in emerging markets that satisfies customers' needs (Boso et al., 2012). EO is defined as the process, structure and behaviour of firms that are characterized by innovativeness, proactiveness and risk taking (Covin & Slevin, 1988; Miller, 1983). Innovativeness is defined as the willingness to place strong emphasis on research and development, new products, new services, improved product lines and global technology in the industry (Covin & Slevin, 1988). The innovativeness component of EO is important to the success of new businesses. Without innovation, young organisations would have to rely on traditional ways of doing business, traditional products/services and on traditional distribution channels. Risk taking is defined as the willingness to be bold and aggressive in pursuing opportunities and in preferring high-risk projects with opportunities for very high returns over low-risk projects with lower and more predictable rates of return (Katz & Brockhaus, 1993). Risk-taking ability is positively related to success (Frese et al., 2002). Proactiveness is defined as acting opportunistically to shape the environment by influencing trends, creating demands and becoming a first mover in the competitive market (Lumpkin & Dess, 1996). Proactive organisations are capable of developing competitive advantage by initiating and planning novel requests (Zahra & Covin, 1995). Thus, a positive relationship between proactiveness and firm performance is evident. The innovative characteristics of entrepreneurs allow creativity and experimentation in organisations which leads to the introduction of new products or services, strong research and development and technological leadership (Lumpkin & Dess, 2001). Dorenbosch et al. (2005) suggest that innovative work behaviour of individual has an important role in improving firm performance. In the rapidly changing marketplace the future profit depends upon the existing operations and businesses that need to constantly seek out for new opportunities (Wiklund & Shepherd, 2005). Firms with EO have the ability to respond to the changing environment, gain greater competitive advantage ahead of other competitors, and then lead to superior performance. Thus, we posit that:

> **H_1:** Entrepreneurial orientation significantly leads to improved performance.

Motivation and Self-Satisfaction

Differences in motivations have an important effect on the level of satisfaction and that moving from extrinsic to intrinsic motivation leads to greater satisfaction. Creating a new venture is associated with various motives such as financial benefits of starting up a business, several non-pecuniary rewards including the wish to be independent, entrepreneurial challenge and the possibility of combining work and household responsibilities (Amit et al., 2001). Two important intrinsic start-up motives include that of being your own boss and the challenge of entrepreneurship (Feldman & Bolino, 2000). Individuals who are motivated by these benefits will probably be less disappointed by unexpected financial hardship, unforeseen stress and excessively long working hours. Benz and Frey (2008) reveal that the greater independence and autonomy of self-employment increases the job satisfaction. Individual who are forcefully pushed into the self-employment because non-availability of other jobs may experience less satisfaction. The combination of work and household responsibilities appears an important consideration at firm start-up for a substantial number of women entrepreneurs. The motive of combining responsibilities leads to more satisfaction with flexibility in working hours. Individuals who start a business from the perspective of combining responsibilities may be better aware of and prepared for the necessary time investments in entrepreneurship. Therefore, we hypothesise that:

H_2: Motivation leads to more of self-satisfaction.

Entrepreneurial Orientation, Satisfaction and Performance

In the women entrepreneurship domain, the construct of entrepreneurial orientation was operationalised by Miller (1983) and Covin and Slevin (1989). The individuals with strong entrepreneurial orientations are willing to take on high-risk projects in exchange for potentially high returns and satisfaction at individual level. The firms with weak entrepreneurial orientations are highly risk-averse, non-innovative, and reactive and less satisfied (Miller, 1983). Further, satisfaction can be seen as a key measure of individual entrepreneurial success. The utility entrepreneurs derive from their start-up venture is an important determinant of venture survival. The degree of entrepreneurial satisfaction is influenced mainly by venture performance, but it may also be affected by the personal characteristics, motives for start-up and venture characteristics. Existing researches on satisfaction has primarily concentrated on explaining the satisfaction of employees rather than that of entrepreneurs (Cooper & Artz, 1995). However, studies show that self-employed individuals are more satisfied with their jobs than employees (Benz & Frey, 2008; Bradley & Roberts 2004; Hundley, 2001). Satisfaction with income is particularly relevant for entrepreneurs who start a venture to earn a living or for financial success. Although literature on entrepreneurial satisfaction is relatively scarce, various scholars have linked 'over optimism' to entrepreneurship (Camerer & Lovallo, 1999; Arabsheibani et al., 2000). Over optimism occurs when the expectations of an individual regarding an outcome exceed the realised outcome. Individual satisfaction to a (positive) difference between expected and realised outcomes. Entrepreneurs may adjust their expectations and believe that the entrepreneurial experience is satisfactory despite initial unrealistic expectations. Thus, we hypothesise that:

H_3: Entrepreneurial orientation leads to performance through self-satisfaction.

Entrepreneurial Orientation, Motivation and Performance

The analysis of entrepreneurial motivation is difficult to conduct because it lacks objectivity and varies across culture and individuals. Among the existing theories of entrepreneurial motivation, the one that has received relatively more attention is the theory of McClelland (1961) (Miner 1990; Davidsson and Wiklund 1999). From McClelland's perspective a person has a high necessity of self-recognition as starting up a new business involves assuming risks, taking on responsibilities and paying attention to the firm's finances, as much as discovering innovative manners to develop products or provide services (McClelland, 1961). However, under the scenario of unfavourable economic circumstances, non-motivation related factors are the most narrowly connected to entrepreneurship such as unemployment. To become an entrepreneur, people need to be intrinsically motivated as intrinsic motivation focuses on the internal needs for achieving competence and self-determination. This intrinsic motivation helps people to energise their behaviours in order to satisfy their desires as they seek personal challenges. These challenges require an entrepreneur to stretch their abilities and interests. It is interesting to note that a common element running through research of successful entrepreneurs identifies the "journey" rather than the "destination" as the key motivator (Vasalainen & Pihkala, 1999). Thus, on the basis of above discussion we hypothesise that:

H_4: Entrepreneurial orientation improves performance through motivation.

RESEARCH METHODOLOGY

Data Collection and Sample Design

Primary source was found relevant for gathering requisite information pertaining to the research problem and it is used in the present study as well. Primary data based on the first hand information have been collected from various entrepreneurial units located in Jodhpur city of Rajasthan through self-modified and well structured questionnaire. In order to evaluate the clarity and appropriateness of the items in the questionnaire and to finalise the initial instrument, a pilot survey was conducted on a sample of 30 respondents. For pilot testing, respondents were the women entrepreneurs who were contacted on convenience basis. After analysing the data collected during pilot survey all the items were found to be relevant and therefore, these items were considered for final survey as well. The final questionnaire was circulated among 240 women entrepreneur but only 200 respondents returned the complete questionnaires. The study is confined to Jodhpur city of Rajasthan the respondents were only women entrepreneurs working with various entrepreneurial units.

Generation of Scale Items

The items under different dimensions covering almost all the aspects of entrepreneurial orientation, motivation, self satisfaction and performance of women entrepreneurs working in various entrepreneurial units located in Jodhpur city were generated from discussions with experts in the area of human resource and review of relevant literature. To understand the measurement of entrepreneurial orientation, 10 items were generated from the work of (George & Marino, 2011) covering the dimensions of risk taking, proactiveness, innovativeness, competitive aggressiveness and autonomy. Motivation comprising 18 items covering the dimensions viz., intrinsic motivation, integrated, identified, introjected and external regulations and amotivation comprising of three items each were adopted from Tremblay et al. (2009). Seven items pertaining to self-satisfaction were generated from Huebner, Gilman, and Laughlin. (1999). Items relating to performance were extracted from Gong et al., (2009).

RESULTS AND ANALYSIS

In order to confirm the fitness, reliability and validity of all the latent constructs confirmatory factor analysis (CFA) was employed.

Results show that chi-square statistics appeared to be less than recommended 5.0 level and values pertaining to all measured models i.e., GFI, AGFI, NFI, TLI and CFI exceeded the recommended limit of .90 (Inman, Lair & Green, 2009). To ensure the internal consistency of the data we employed composite reliability test and results demonstrate that the value of composite reliability of all the latent constructs exceeded .90. Reliability of the data was also reinsured through the value of chronbach alpha which appeared to be more than .70 among all the latent constructs, which indicate internal consistency of the data. The construst-wise composite reliability is shown in **Table 1**. Furthermore, validity of the scale has been established through construct validity, which embraces convergent validity (Lim & Ployhart, 2006) and discriminant validity (Fornell & Larcker, 1981). In the present study, convergent validity has been confirmed through factor loading and average variance extracted. Results show that majority of factor loadings and average variances extracted are above .50, thus, convergent validity gets established. Discriminant validity is analysed to examine the degree to which a construct is distinct from other constructs (Hair, Black, Babin, Anderson & Tatham, 2009). **Table 2** shows that each explained variance estimate on the diagonal is greater than the corresponding inter-factor squared correlation estimates below the diagonal (Malhotra, 2007). Thus, discriminant validity gets established, thereby implying that major constructs are unique. To test the hypothesised relations of the study, present study employed SEM. The SEM results reveal that entrepreneurial orientation improves performance among women entrepreneur (â=.341, p=.000). Thus, leading to the acceptance of H1. Next hypothesis proposes that motivation leads to the self-acceptance among women entrepreneurs. Results demonstrate that motivation is significantly related to self-acceptance ((â=.262, p=.000).). Hence, leading to the acceptance of H2. To test the mediating effect of motivation and self-satisfaction, hierarchical regression was employed. It is evident from **table 3** that 'motivation' fully mediates while 'self-satisfaction' has partially mediating effect between entrepreneurial orientation and performance among women entrepreneurs. Figure 1 represents the hypothesised relations in the present study.

DISCUSSION AND CONCLUSION

It has been widely acknowledged that the success, performance and growth of small scale industries depend upon the competencies of the entrepreneur. Although entrepreneurial competencies are seen as important to business growth and success, the discussion of competencies in the entrepreneurial literature is in its early stages. The numbers of self-employed women in developed economies like UK and the USA are growing tremendously (Carter & Shaw, 2006). However, women entrepreneurs have shied away from pursuing opportunities because of the high risk involved, the amount of start-up capital needed in certain industries and the high level of technical expertise needed in certain industries (Robinson & Mcilwee, 1991). Entrepreneurial competencies have been identified relevant to the exercise of successful entrepreneurship as it is associated with the survival and development of small and new businesses (Nuthall, 2006). Women business owners are disadvantaged in their access to various entrepreneurial capitals, given their personal backgrounds and employment experiences and the socio-economic and cultural context in which their businesses operate (Carter & Shaw, 2006). Thus, through present study we are trying to highlight the significance of motivation among women entrepreneurs that helps to improve their performance. Entrepreneurial competencies are comprise of traits, personality, attitudes, social role and self-image as well as those that can be acquired at work or through training and education like skills, knowledge and experience (Man & Lau, 2005). Therefore, there are grounds for further exploration of the unique competencies exercised by female entrepreneurs i.e., self-satisfaction. Women entrepreneurs appear to be motivated to go into their own business in order to be their own boss, to get job satisfaction, for economic independence or for an opportunity to be more creative. Women entrepreneurship is not only necessary for their economic survival but also for strengthening the social system. Fostering women's entrepreneurship development is therefore crucial for economic growth and development. Studies conducted in the recent past have found that women entrepreneurs encounter more operational and strategic impediments than their male counterparts.

IMPLICATIONS

As it is evident from the results that entrepreneurial orientation significantly affects performance among women entrepreneurs through motivation and self satisfaction, there is a need to lay emphasis on the enhancement of motivation and self-satisfaction. In order to improve motivation and self-satisfaction among women entrepreneur better access to the capital should be provided. When it comes to finance, women face lots of hurdles from lack of collateral to discriminatory regulations and ingrained gender bias to avail loans and other financing that they need to start and grow business. More mentorship opportunities should be provided as it helps in providing role models and guidance to women to show the economic, social and lifestyle benefits of business ownership that could greatly enhance entrepreneurship rates. Access to the advice and guidance of business mentors is invaluable for women entrepreneurs as it helps them to overcome uncertainties. Research shows that women fear failure and have lower confidence levels than men. Thus, more education is a way out to improve their confidence. Women need to work on their confidence and their perceived abilities.

Entrepreneurship has to feel accessible to women as more training and education programs geared to women could help build confidence and reduce the fears that starting a business is a high-risk endeavour. There is a need to amplify skill development and capacity building processes for soft skills, technology and management skills. A bottoms-up approach in choosing a business venture with the mapping of the individual profile to the business opportunities and ultimately linking this to the regional advantages like natural resources and manpower will enhance the success rate. Mentoring and market linkage to support women own edenterprisest hroughnet works like women entrepreneur associations is a useful approach for women entrepreneur. Another important practice is to share resources and document and spread entrepreneurial success stories. Furthermore, government schemes, eligibility criteria, documentation and clearance mechanisms should be simplified. Smarter technology, single-window clearances, better inter-departmental co-ordination to enable simpler, faster, transparent and effective service delivery for women should be started.

LIMITATIONS AND FUTURE RESEARCH DIRECTIONS

The present study has certain limitations, which need to be addressed by future studies. Firstly, study is confined to a particular region in West India. Therefore, future studies can be conducted with greater sample covering other parts of the country. Present study has examined performance of women entrepreneur as an outcome of entrepreneurial orientation but there may be other constructs as outcomes like exploitative and explorative learning and innovative capabilities of women entrepreneurs. Thus, future research needs to incorporate these limitations for further refinement of existing literature. The generalisability of our results needs to be examined in other environmental context. Further studies need to examine the moderating effect cultural factors in order to strengthen the indirect relationship between entrepreneurial orientation and performance.

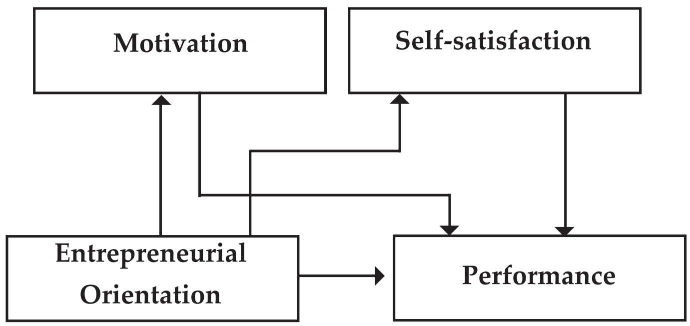

Figure 1. Relating Entrepreneurial Orientation and Performance through Motivation and Self-Satisfaction.

Table 1: Reliability and Validity of Latent Constructs

Constructs Average	Variance Composite Explained	Reliability Cronbach's	Alpha
Entrepreneurial Orientation	0.81	0.99	0.87
Motivation	0.82	0.97	0.83
Self-satisfaction	0.74	0.98	0.79
Performance	0.76	0.89	0.91

Table 2: Discriminant validity of latent constructs

	Entrepreneurial Orientation	Motivation	Self-satisfaction	Performance
Entrepreneurial Orientation	(0.81)			
Motivation	0.23	(0.82)		
Self-satisfaction	0.32	0.26	(0.74)	
Performance	0.12	0.31	0.18	(0.76)

Note: AVE is shown diagonally. Squared Multiple Correlation is shown below the diagonal.

Table 3: Motivation and Self-satisfaction Mediating the Relationship between entrepreneurial Orientation and performance

Variables	Performance	Performance	Motivation	Self-satisfaction	Performance
Control Variables					
Age	.024 (.212)	.033 (.324)	.052 (.114)	.033 (.213)	.026 (.342)
Marital status	.032 (.322)	.041 (.385)	.041 (.327)	.025 (.224)	.022 (.342)
Family Income	.011 (.235)	.051 (.293)	.037 (.312)	.016 (.314)	.041 (.236)
Independent Variable					
Entrepreneurial Orientation	.341 (.000)	.412 (.000)	.461 (.000)	.003 (.937)	.124 (.003)
Mediator					
Motivation					.431 (.000)
Self-satisfaction					.511 (.000)
Total R^2	.120	.143	.256	.278	.301
F-value	20.550	28.125	30.421	33.614	44.214

Note: Values in the parentheses represent significance level.

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5

Women Empowerment Through Entrepreneurship Development: Problems and Prospects

Israr Ahmed*

ABSTRACT

Empowerment of women means equip women to be economically independent, and have a positive self-esteem to allow them to face any complex situation and they should be capable to participate in development activities and in the process of decision making. Entrepreneurship development amongst women is an activity that promises encouraging results. In India, entrepreneurship amongst women is of latest origin. Socio-economic background is an important feature that influences the woman to start their business. Despite all the social hurdles, Indian women stand tall from the rest of the crowd and are applauded for their achievements in their respective field. She has competed with man and effectively stood up with him in every walk of life and business is no exclusion for this. These women leaders are assertive, persuasive and willing to take risks. They managed to survive and succeed in this cut- throat competition with their hard work, diligence and perseverance. The present paper is an attempt to study the factors influencing women entrepreneurship, to assess the role of micro-enterprises in the empowerment of women in terms of economic and social spheres and the constraints faced by them in small and Medium Enterprises in India.
***Keywords:** Women Empowerment, Entrepreneurship, Problems.*

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INTRODUCTION

The women consist of around 50% of global population. They share equal burden of living a life along with the man folk. Since time immemorial, we find them busy in housekeeping activities. Whenever we think about any activities other than housekeeping, it is been the man whose picture comes in our mind first. Even history reflects the same. Only few name of woman comes in our mind against the thousands names of man. It is true to India and its state of Assam too. In Assam, women's participation is significant only in agriculture, nursing and teaching. Women's contribution in other economic activities is very pitiable. (Limbu 2015)

Entrepreneurship plays a distinguished role in creating an employment prospects for rural communities, providing self-employment for those who have started-up a business of their own and enhancing the economic status of the rural sector as well. Now women are also interested to establish their own business as professionally both in the urban and rural areas due to overcome poverty, generate family income and increasing Standard of living. In this regard Faleye (1999) argued that women s development is not nearly about reducing poverty by increasing productivity, but also about women s liberation and empowerment. So it is necessary to empower women socially, economically and technologically to enable them to stand in society on their own with confidence. It includes both controls over resources and ideology, greater self-confidence and an inner transformation of one s consciousness that enables one to overcome external affairs (Sharma & Varma, 2008). In today's competitive world, there are different ways by which women get themselves empowered. Entrepreneurship development and income generating activities are a feasible solution for empowering women who leads to economic independence, the opportunity to have control over their lives, self-reliance, self-determination, and a way to achieve for themselves. Bisht & Sharma (1991) argued that the entrepreneurship of women is well thought-out to be an efficient instrument to the economic development and empowerment of women. Considering this need the government of India has begun the process of empowering women through various national policies and developmental programmers and organizing women in Self Help Groups. The Self Help Groups (SHGs) is an organization of rural poor; particularly of women for the empowering women by providing micro credit to undertake the entrepreneurial activity. (Mazumdar 2015)

Women Empowerment: According to United Nations Development program (1994) empowerment is a progression which enables individuals or groups to transform balances of power in social, economic and political relations in society. Therefore, women empowerment means giving the capacity and means to direct women's life towards preferred goals. It is a process by which women achieve greater control over resources (income, knowledge, information, technology, skill and training), decision making process, and develop the self-image of women, to become active participants in the process of change and to develop the skills to emphasize themselves.

Women Entrepreneur: A women who accepts challenging role to meet her personal requirements and become economically self-sufficient. Indian Government has defined women entrepreneurs as an enterprise owned and controlled by women having a minimum financial interest of 51 per cent of the capital and giving at least 51 per cent of the employment generated in the enterprise to women. In the simplest logic, women entrepreneurs are those women who take the front and arrange the business or industry and give employment to others. Entrepreneurship development among rural women helps to enhance their personal capabilities and increase decision making status in the family and society as a whole. (Mazumdar 2015)

LITERATURE REVIEW

Singh (2008) Obstacles faced by women entrepreneurs is being studied and it is found that obstacles in the growth of women entrepreneurship are mainly lack of interaction with successful entrepreneurs, social un-acceptance as women entrepreneurs, family responsibility, gender discrimination, missing network, low priority given by bankers to provide loan to women entrepreneurs. They recommended the corrective measures like promoting micro enterprises, unlocking institutional frame work, projecting & pulling to develop & support the winners etc. It advocates for ensuring synergy among women related ministry, economic ministry & social & welfare development ministry of the Government of India.

Rashmi Gopinathan (2010) Impact of women entrepreneurship development on families was being studied and found that majority of the respondents (75.2%) was married. Socio-cultural and religious beliefs dictate that the marriage of both sons and daughters is a sacred duty to be performed by parents but in the case of daughters especially parents feel far more pressured to marry them off as soon as possible. It has been found that decision making is very essential entrepreneurial quality and found that per most of the respondents felt that they could deal with problems "only felt that they could not deal with problems. The value of assets possessed by a family is an important indicator of a secure condition of the family. The assets in the present study have been categorized in terms of fixed assets like house, jeweler, other household gadgets and savings. It was found that in case of (66%) of respondents, assets (in terms of value) had increased while (32%) there was no substantial change and very negligible percent decrease (1.6%).

Senthil kumar, Vansantha and Varadharajan (2012) our society is still male-dominated and women are not treated as equal partners both inside and outside four walls of the house. In fact, they are treated as able, i.e. weak and dependent on men. A study on women entrepreneurship development is conducted and it is found that the Indian women get pleasure from a disadvantageous status, in the society as there is low literacy rate, low work participation rate and low urban population share of women as compared respectively of their male counterparts confirm their disadvantageous position in the society our age old socio cultural traditions and taboos arresting and women within four walls of their houses also make their conditions for the disadvantageous. These factors combine to serve as non conductive condition for the emergence and development of women entrepreneurship in the country. The enlargement of women entrepreneurship is expectedly low in the country. This indicates that very few percentages of women are involved in total self employed persons in the country.

Parveen (2013) Development of Rural Women Entrepreneurs through Workshop Training is being studied and it is found that workshops organized by different NGO's helped rural women to provide financial support, entrepreneurial education and mentorship. The study discovered that educated rural women entrepreneurs have superior business skill and abilities. Therefore they can easily access to the different markets and can start business on sustainable basis. As far as untrained rural women are concerned, they have to face a lot of problem in managing their business. Another result of this paper was that bachelor rural women entrepreneur's feel that they can face problem of availing bank loans because there is a possibility of change of their destination after marriage. So In view of unmarried women entrepreneurs getting married is the hurdle for the business because they have to bear dual responsibilities, one at home and other at work. In present scenario the percentage of unemployment among educated and qualified women is increasing in rural areas, it is necessary to promote rural entrepreneurship as it will create more opportunities for rural people**.**

Pharm and Sritharan (2013) Problems Being Faced by Women Entrepreneurs in Rural Areas" was being studied and found that majority of the women entrepreneurs were ranked as lack of strong leadership. Their leadership quality was not as good as required for being a successful entrepreneur. There were many women entrepreneurs who faces problem related to finance. Second rank was financial deficit. The third rank was lack of systematic planning and working and followed by health problem, Non-awareness of Government scheme, Non- repayment of loan by the members, Leaders misusing the group's money, other problems, Lack of Education.

Rajase karan and Sindhu (2013) the growth of Self-Help Groups (SHGs) is an evidence of the fact that women are coming out of their shells and maintaining their citizenship in the city. Self Help Group of women is being studied and found that the role of women entrepreneurs is increasing significantly every year. The participation of women has been increased from 22.3% in 1990-1991 to 31.6% in the year 2010-2011. This is a source from the World Bank report 2010-2011 & WAWE conference report. 71.5% of the women SHGs formed in 2009 and 2010. For the duration of 2010-2011, this ratio stood at 74.08%. Out of the whole figure of Self Help Groups formed, 70% belong to women.

OBJECTIVES

1. To know the impact of entrepreneurship development in women empowerment.
2. To determine how far Self Help Groups (SHGs) motivated women to undertake entrepreneurial activities.

METHODOLOGY

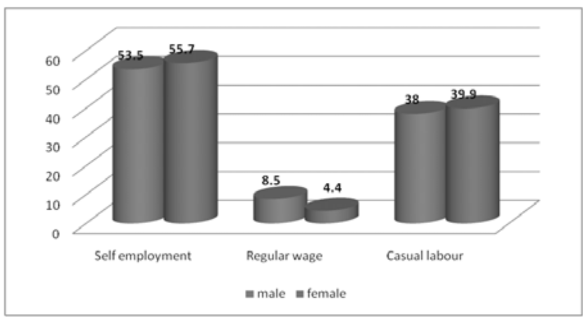
The present study is based on secondary sources. Information has been collected from various official sources like Ministry of women empowerment and child development India, Annual Economic survey of J&K, United Nations World Tourism Organization, In addition to this; data have also been collected from other reliable online sources like articles, journals and newspapers books, reports, websites and other unpublished sources.

ENTREPRENEURSHIP DEVELOPMENT THROUGH SELF HELP GROUPS

Half of the human resources is comprised of women and identified as key agents of sustainable development. Equality of women is a holistic approach towards establishing new patterns and process of development that are sustainable. The contribution of women and their role in the family as well as in the economic development and social transformation are crucial. Women represent 90 per cent of total marginal workers of the country. Rural women who are occupied in agriculture form 78 per cent of all women in usual work [Harendar Kumar, 2009]**.** Experience of NIRD action research projects tells that, the operational aspects, such as the extent of enabling that goes into the community self help processes and sharpening the mind set of women. Men and the project administrators are low or critical components that decide their extent to which empowerment may or may not take place. The role of micro-credit is to advance the socio and economic development of women and improve the status of women in households and communities. Micro entrepreneurships are strengthening the women empowerment and eradicate the gender inequalities. Self Help Group's micro credit system makes the members to involve in other community development activities. Micro credit is promoting the small scale business enterprises and its main aim is to eradicate poverty by income generating activities among women and poor. Therefore, they could achieve self-sufficiency. Now-a-days economic development is one of the factors that have changed the complete scenario of social and cultural environment within the country especially for the women.

Most of the rural women are engaged in small-scale entrepreneurship programme and self help groups are helping them in this regard. Through that they were economically empowered and attaining status in family and community. Rural women play a crucial role in farm and home system. She contributes substantially in the physical aspect of farming, livestock management, post harvest and allied activities. Her direct and indirect payment at the farm and home level alongside with livestock management operation has not only help to save their resources but also led to increase the family income. She performs various farm, livestock, post harvest and allied activities and possesses skills and indigenous knowledge in these areas. The women were empowering themselves technically to cope with the changing times and productively using their free time and existing skills for setting and sustaining enterprises. They were engaged in starting individual or collective income generation programme with the help of self-help group. This will not only create income for them but also advance the decision-making capabilities that lead to overall empowerment.

Gender wise Percentage of participation in Indian Rural Economy during year-2012 (In percent)



The above graphical representation shows 55.70% Rural women are Self Employed while the ratio of male is only 53.50%, 4.40% Rural women are engaged in regular wages while male candidate are 8.50% and casual labour comprise 39.90% of women and 38.00% of men in rural economy of India. As per result it makes us clear that concentration of rural women is being increased towards the entrepreneurship in india.

FACTORS INFLUENCING WOMEN ENTREPRENEURS

To start an enterprise is not an easy job for women entrepreneurs and at the same time running the enterprise is a greater task. A challenge is always there for these women entrepreneurs to run their enterprise successfully earning profit and ensuring the growth of the enterprises which will severely test their entrepreneurial skill and survival of the unit. These are the factors which can develop entrepreneurial skill of women.

- Building confidence
- Developing risk taking ability

- Economic independence
- Equal status in society
- Motivation
- Establishing their own creative ideas
- Greater freedom and mobility

Despite various odds against them, several women are off to run their own enterprises. Even though there has been a considerable increased in the number of women entering in entrepreneurial activity, they are being introduced to many constraints and difficulties with regard to control and decision making, social status and enthusiasm in the product or serviced in which they are dealing. It is found that women are entering more in this venture as compared to man to start their own business to make social contribution in addition to desire of exploring their inner self and fulfilling their means of livelihood.

CHALLENGES FOR RURAL WOMEN ENTREPRENEURS

The major challenges that women face in business are educational and work background, Balancing their time share between work and family, Problems of raising start-up capital, Difficulty in borrowing fund, Thought-cut completions endangered existence of small companies, Problems of availing raw-materials access to export market without intermediaries, as well as an overall psychological barrier on the part of banks, suppliers, and customers alike, are a few of these challenges. In addition to this some of the challenges faced by rural entrepreneurs are as follows-

i) Family Ties

Women in our country are very emotionally attached to their families. They are being very less practical. They are supposed to do all the household work, to look after the children and other members of the family. They are over burdened with family responsibilities like care of children lots of their time and energy. In such conditions, it will be very difficult for women to concentrate and run the enterprise successfully.

ii) Lack of Education

In 21st century, rural women in India are lagging far behind in the field of education. Most of the rural women are illiterate. Women in rural areas who are educated are provided either less or inadequate education than their male counterpart partly due to poverty, early marriage, low socioeconomic status, partly due to son's higher education. Lack of education is one of the biggest obstacles for rural women who want to start an enterprise. Due to lack of proper education, women entrepreneurs remain in dark about the development of new technology, new techniques of production, advertising and other governmental support which will encourage them to flourish.

iii) Lack of Raw Materials

Due to poor road connectivity and poor transportation, it is quite difficult to make availability of raw materials all the time in rural areas. Availability of raw materials is an essential component of entrepreneurship. Women entrepreneurs in rural areas really face a tough task in getting the required raw material and other necessary inputs for the enterprises when the prices are very high.

iv) Male Dominated Society

In our constitution there are equal rights for men and women but in real sense equality does not exist in rural areas. Women are being neglected in many spheres of life. Women are not treated equal to men. As far as rural areas are concerned, people have a set attitude that women are only for household work. Their entry to business needs the approval of the head of the family. Entrepreneurship has traditionally been seen as a male preserve and male dominated. All these put a break in the growth of women entrepreneurs. Thus male entrepreneurs become hurdle in the success of women entrepreneurs.

v) Problem of Finance

Women entrepreneurs have to undergo a lot in rising and meeting the financial needs of the business, bankers, creditors and financial institutes are not coming to the fore to provide financial assistance to women borrowers on the ground of their less credit worthiness and more chances of business failure. They also face financial problem due to shortage of finances in raw materials, work-in-progress finished goods and non-receipt of payment from customers in time.

vi) Tough Competitions

In the age of technology, women entrepreneurs face a lot of problems and challenges. Usually women entrepreneurs do not employ high technology in the process of production. In a marketplace where the competition is too high, they have to struggle hard to survive in the market against the structured sector and their male counterpart who have immense experience and capacity to adopt advanced technology in managing enterprises

vii) High cost of Production

Numerous factors including ineffective management contribute to the high cost of production which stands as a faltering block before women entrepreneurs. Women entrepreneurs face technology obsolescence due to non-adoption or slow embracing to changing technology which is a major factor of high cost of production.

viii) Low Risk-Bearing Ability

Generally women are delicate and emotional by nature in our country. An entrepreneur must have risk bearing capacity for being successful entrepreneur. But women, sometimes fail to tolerate the amount risk which is essential for running an enterprise. Lack of proper education, training and financial support from outsides also diminish their ability to bear the risk involved in an enterprises.

ix) Limited Mobility

In our country, mainly in rural area, women mobility is very restricted and has become a problem due to traditional principles and inability to drive vehicles. Moving alone and asking for a room to stay out in the night for business purposes are still looked upon with doubtful eyes. Sometimes, younger women feel uncomfortable in dealing with men who show extra interest in them than work related aspects. Thus security of women entrepreneurs is a major challenge.

x) Social Barriers

The traditions and customs prevailing in Indian societies towards women sometimes stand as a barrier before them to grow up and prosper. Castes and religions control with one another and hamper women entrepreneurs too. In rural areas, they face additional social barriers as they are always seen with suspicious eyes.

xi) Lack of Entrepreneurial Atitude

Lack of entrepreneurial ability is a major concern for women entrepreneurs. They have no entrepreneurial bent of mind. Sometimes even after attending various training programmes on entrepreneurship, women entrepreneurs fall short to tide over the risks and troubles that may come up in an organizational working.

xii) Limited Managerial Ability

Management has become a specialized job which only professional managers perform. Due to lack of proper education women entrepreneurs are not efficient in managerial functions like planning, organizing, controlling, coordinating, staffing, directing, motivating etc. of an enterprise. Therefore, less and inadequate managerial ability of women has become a problem for them to run the enterprise successfully.

CONCLUSION

It can be said that at present we are in a superior position wherein women participation in the field of entrepreneurship is increasing at a significant rate, efforts are being taken at the economy as well as global level to enhance woman's involvement in the enterprise sector. At present women have broken the monopoly of men and proved that they are not inferior to men. The SHGs and micro enterprises had major impact on social and economic life of rural women. The study concludes that there was an increase in self-confidence, self-reliance and independence of rural women due to the involvement in the entrepreneurial and other activities of SHGs. Now women entrepreneurs are aware of opportunities available to them, but there is scope for improvement in it. The economic condition of the women is now acknowledged as an indicator of a society's stage of development and therefore it becomes essential for the government to frame policies for development of entrepreneurship among women. Raised literacy level could be helpful for the SHG members to overcome cognitive constraints and to understand government policies, technical understanding and gaining required skills.

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6

Linkages Between Skill Development Productivity and Employment Potential in India

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ABSTRACT

Knowledge and skill are the key drivers of macro economic growth and socioeconomic stability. Skill development is an important driver to facilitate a cycle of high productivity, increased employment opportunities, income growth and development. Appropriate policies for skill development occupy a dominant place in the development of economy. In India, the importance of skill development has never been recognized but in today's fast growing world, various programmes, policies, educational and training centres have been established to impart skill development activities to the individuals. The objective of this research paper is to highlight the concept of skill development in India and the various programmes and policies that have been initiated for this purpose. The paper discusses various government initiatives for skill development and analyses their relationship with productivity due to availability of skilled & healthy manpower focus on India.

Keywords: *Skill Development, Productivity, Employment Opportunities, Income Growth and Economic Development*

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INTRODUCTION

Skill development is an important driver to address poverty reduction by improving employability, productivity and helping sustainable enterprise development and inclusive growth. It facilitates a cycle of high productivity, increased employment opportunities, income growth and development. However, this is just one factor among many affecting the productivity whose measurement differs for individuals, enterprise and economy (Sanghi and Srija, 2015). The Indian economy is widely expected to grow at sustained high rates over the next few decades and emerge as the second largest economy by 2050. These robust projections have much to do with the demographic profile of the country. India is slated to have one of the youngest populations in the world, with the bulk of the population figuring in the working age (Palit, 2009). One of the main reasons behind the optimism regarding the Indian economy stems from its demographic profile. India's current population of 1.2 billion is expected to enlarge to 1.8 billion by 2045. The significant aspect of this increase relates to the expansion in the size of its working age (15-64 years) population. By the year 2026, 64.8 percent of the Indian population is expected to be in the working age The India is enjoying privilege of Demographic Dividend (Kanchan and Varshney, 2015). The global workforce is expected to be overtly dominated by Indians in the next couple of decades. A study by the Boston Consulting Group shows that, while the world is expected to encounter a shortage of 47 million working people by 2020, India will have a surplus of 56 million working people. India needs to utilise its bulk of the working age population effectively, we need to impart adequate and skill its workforce (Palit 2009).

OBJECTIVE OF THE STUDY

The study has been conducted mainly to:

1. Understand the present status of skill development in India.
2. Understand the challenges in skill development in India.
3. Skill development initiatives and strategies in India and its impact on productivity, employment in India.

RESEARCH METHODOLOGY

The research paper is an attempt of exploratory research, keeping in view of the set objectives of the study the research design employed for the study is of descriptive type. The investigator procures the required data through secondary survey method. Available secondary data sourced from news articles, Books, Web, journals, magazines, articles and media reports was extensively used for the study.

PRESENT STATUS OF SKILL IN INDIA

As discussed above India is enjoying privilege of Demographic Dividend but we have quantity and quality gap in terms of skilled workforce in India. It is estimated that India will face a demand of 500 million skilled workers by 2022. But India is still struggling with the supply of skilled workforce as presently only 2% of the total workforce in India has undergone skills training. According to the Government of India estimates, 93% of workforce

employment is in the unorganized or informal sector, which is not supported by a structured skill development system (Kanchan and Varshney, 2015).

In India there is also need to consider the Education System in India. The institutional capacities show a dominance of colleges in the arts, science and commerce disciplines (Figure 1). These colleges comprise 56 percent of total higher education institutes. The shares of engineering (7%) and medical colleges (10%) are much less while that of polytechnics (6 %) is even lower (Palit, 2009). The Education system shows that students obtaining graduate degrees in arts, science and commerce disciplines are often at a loss in locating appropriate employment opportunities. This is on account of the mismatch between their skills and the requirements of the labour market, particularly those of the industry (Palit, 2009). After doing the graduation the knowledge they have gain are not able to give them specific skill required for job in both manufacturing and knowledge – intensive services.

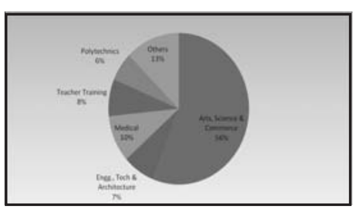

Figure 1: Share of Different Disciplines in India's Higher Education Institutions

Source: Computed from Statistics compiled by the Ministry of Human Resource Development, Government of India

The size of the current technical training infrastructure is much smaller than what is required. India currently has the capacity for training 3.1 million people per year. This is insufficient, given that every year, 12.8 million new people enter the workforce. The distribution of training capacities is unbalanced, with the industrially-advanced states of Maharashtra, Andhra Pradesh, Tamil Nadu and Karnataka, accounting for 48 percent of recognised technical training institutions. The Indian youth don't have required skill which can give them employment opportunities. The loss of employment and wages during the skill training program also acts as a disincentive to skill acquisition.

MEASURES TAKEN BY GOVERNMENT OF INDIA FOR SKILL DEVELOPMENT

The Government and industry are well aware of this reality and trying to figure out solutions for the challenges. In order to provide adequate training to the youth the government formulated the national skill development policy that laid an outline for skill development, ensuring that the youth of the country get better access to skills and knowledge (Kapur, 2014). Some of the Government Initiatives are discussed as under

The National Skill Development Policy (NSDP), announced earlier this year, attempts to address the skills mismatch in the economy from the larger perspective of the vision of 'inclusive growth' illustrated in the 11th Five-Year Plan. The policy proposes the establishment of a Skill Development Initiative (SDI). The Initiative '…*will empower all individuals through improved skills, knowledge, nationally and internationally recognised qualifications to gain access to decent employment and ensure India's competitiveness in the global market*' (Kanchan and Varshey, 2015).

A National Skill Development Corporation Board (NSDCB) and Prime Minister's National Skill Development Council was established. NSDCB is based on Public Private Partnership (PPP) under the chairmanship of the Deputy Chairman of the Planning Commission. It formulates strategies based on the decisions of Prime Minister's Council on National Skill Development (Kanchan and Varshey, 2015).

National Skill Development Agency (NSDA) was approved on 9th May2013. The NSDA is mandated to work towards coordination and harmonization of skill development efforts of the central and state governments as well as the public and private sector industries. It looks after policy changes, scheme reviews, new scheme strategies and engagement with PSUs and NGOs.

Public Private Partnership is also used quiet extensively where training programs are sponsored by private funding. Apprenticeship Act has also been implemented by the Government under which every company has to compulsorily hire a fix number of apprentices from ITI's every year to work and train at the company. The apprentice learns theory at the college and gets hand on experience at the company. This approach helps in alignment of industry's requirement for skilled talent as company's hire the candidate and then train him as per industry's requirement. Public training institutes are trying to promote expansion of public training institutes in difficult areas where private sector is not accessible (Kanchan and Vashney, 2015). As part of a national mission, Bosch India along with National Skill Development Corporation (NSDC) is working to achieve its objective of fulfilling the growing need for skilled manpower across sectors in India. Funding from NSCD and skill development competence has join hands to develop and deploy a vocation training model for making underprivileged children employable. It will help in providing a pool of high quality skilled manpower to the industry.

LINKAGE BETWEEN SKILL DEVELOPMENT, PRODUCTIVITY AND EMPLOYMENT

Skill building is viewed as an instrument whose main purpose is to enhance the efficiency, productivity and contribution towards the different sectors of the economy such as industries, agriculture, manufacturing, education, communications and so forth (Kapur, 2014). After accomplishing the studies young youth start searching of new jobs in primary, secondary and tertiary sectors. To get the employment the youth need to be skilled so that they can get required jobs. Skill building is meant to empower an individual and improve his/her social acceptance within the society. Skillful and productive individuals are always accepted and recognized everywhere; they are always in high demand (Kapur, 2014).

Skill development is the focus area of the government Policy. Government is also aware of the need of skill development in people and have taken various initiatives for this also Foundations are being laid by the three tier structure of Prime Minister's National Council, National Skill Development Coordination Board (NSDCB) and National Skill Development Corporation (NSDC) for a more positive role of public, centre and states, private and third sector communications and borders for harnessing the benefits of demographic dividend (Kapur, 2017). Moreover, with the passage of the Companies Act 2013, the mandate for Corporate Social Responsibility has been formally introduced and it is likely that the total CSR spends will increase for employability linked programs to promote skill development.

Skill development program enhance productivity in informal economy and reduces poverty and risk of underemployment (Sanghi and Srija, 2015). The lack of access to good education and training are responsible for low skill, low productive employment and poverty. In India 70 per cent of the labour force reside in rural areas and depend on low productive agricultural activity where there is huge underemployment leading to low level of productivity. The high

proportion living in poverty among women in India is due to their concentration in low productivity work (Sanghi and Srija, 2015) .

Skill development programs are helpful for the economy to generate productivity of the people which ultimatelty leads to employment. The success of the major programmes of the current Government viz; Make in India, Digital India, Smart City, Namami Gange, Swachh Bharat depends on the success of the Skill India Mission in skilling and reskilling 460 million by 2022. The skill development programmes to promote entrepreneurship are also equally important namely- Self-Employment and Talent Utilization scheme (SETU), Atal Innovation Mission (AIM), Start Up India to promote bank financing in the country (Sanghi and Srija, 2015).

PROBLEMS AND STRATEGIC ACTIONS IN THE IMPLEMENTATION OF SKILL DEVELOPMENT INITIATIVES IN INDIA

As a fast growing developing economy, besides white and blue collar, India also needs Grey collar- knowledge workers which include ICT skills, problem solving, analytical and effective communication skills and rust collar-skilled workers at the grass root level in currently unorganized sector and un-benchmarked sectors like construction, agriculture and related trade. Government, industry leaders are constantly from time to time are launching new skill development initiatives but somehow it is not reaching the casual workers who dominate the Indian work-force. Stakeholders (Industry leaders, Government, etc) have realized that none of them can work in isolation. They will need to collabourate as the stake involved is huge. Mandatory Monitoring and Quality Certifications should be in place which will ensure high standards training programmes with prime focus on enhancing the employability. Sector specific Labour Market Information System (LMIS) at national and state level is to be established for reducing the skill mismatch which can help in the reliable and realistic assessment of economic trends and labour market. Supply and demand of skilled manpower can be mapped with the help of Human Resource Planning (HRP) which is also one of the important componcents. These exercises can help to anticipate skill gap over a period of time at different levels, sectors and geographical areas. Efforts have to be implemented to increase the number of skilled personnel within the country and on the basis of their skills they should be able to accomplish something for themselves and find employment not only in industries but in all kinds of sectors education, transport, manufacturing etc (Kapur, 2017). The skilled workforce must be employed by employment exchange. Counselling, placement and guidance can be provided by strengthening and upgrading the Employment Exchanges. The certificate in skill development programme must be compulsory for the people to apply in the various jobs. It is essential to improve the education system so that the graduates will come out with atleast one technical skill of their choice. So that we have demographic dividend of not only working population but the skilled working population.

Establish a 'National Skill Inventory' and a 'National Database for Skill Deficiency Mapping' for facilitating a meaningful exchange between employers and potential job-seekers. Enhance capacities of employment exchange systems by upgrading them to counselling centres. Enlarge the scope of the 'Skill Development Centre' programme into a 'Virtual Skill Development Resource Network' for web-based learning (Kapur, 2017 and Kanchan and Varshney, 2015). Mandatory Monitoring and Quality Certifications should be in place which will ensure high standards training programs with prime focus on enhancing the employability. Sector specific Labour Market Information System (LMIS) at national and state level is to be established for reducing the skill mismatch which can help in the reliable and realistic assessment of economic trends and labour market. A designated agency should work on generating information from the LMIS and HRP exercises. Government employers, national, state and local level training providers, trainees and prospective trainees should be disseminated with information so collated so that they can use it in their skill development plans.

In a male dominated society, there has always been a limited scope to develop their skills for women and girls in rural areas due to social, economic and cultural constraints. The payment of wages is also on lower side. A designated agency should design the courses and introduce them at various levels on the basis of emerging opportunities for skill development and employment generation. Socio-economic empowerment of rural women can be attained by investing in their skill development. They can be provided with basic education, technical training and other women extension services. Support by self help groups and NGOs can help in improving their conditions by making them understand the importance of basic education and also by making the change in attitude of society towards women.

Young population even after having degree is not able to fit in the industry due to lack of expertise to compete. The vocational training should start from High School. Students should be made industry ready by making the curriculum for professional courses such as Engineering and MBA in a way that provides complete on the job training.

CONCLUSION

Prime Minister Narendra Modi in his maiden speech said, "Skill development should be accompanied by a spirit of '*Shram-evJayate*' – giving dignity to labour." Skill development and entrepreneurship is one of the top most priorities of the new Government due to which first time an independent ministry has been created to take the mandate forward. Finally, it is important that the intended beneficiaries of the skill development program join training programs with an inspiration to learn and make them self-reliant to live a better life. (Kanchan and Varshney, 2015). Presently 80% of the workforce in India (rural and urban) doesn't possess any identifiable and marketable skills. Therefore, bridging this gap through various skill development initiatives could make India the global hub for skilled manpower, and also result in a surplus of skilled manpower of approximately 47 million 2020 (FICCI). Skill development always leads to progress of the individual and the kinds of skills and knowledge that he acquires may not be applicable immediately but it always proves to be beneficial in the long run (Sanghi and Srija, 2015 and Kanchan and Varshney, 2015). In India, the concept of skill development has been largely recognized and many programs and policies are being formulated to initiate this concept not only amongst the individuals in urban areas but in rural areas as well. NSDCB and NSDC are the organizations that have formulated policies for skill development amongst the individuals and besides these there are vocational training centers. In India, rural masses are still in a backward condition, steps therefore have been implemented to develop skills amongst them for the purpose of obtaining self-sufficiency in resource utilization, governance and leadership. Human Resource planning can help us to know supply and demand of skilled manpower. So that we can get current manpower and future manpower requirement in the economy and give necessary skill to the people.

To conclude for skill development to be a driver of productivity requires improvement in quality, relevance and accessibility of training by all the sections of population particularly marginalized and poor with poor education level. The key question that requires immediate answers are how to measurer contribution of skill development to productivity and employment growth; what policies support enterprise development; what is the role of various stakeholders; skill mapping for a country of India size on local levels and how to strengthen the coordination between different institutions for better results (Sanghi and Srija, 2015).

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7

An Analytical Study of Indian Derivative Markets

Sameer Gupta & Sunil Bhardwaj***

ABSTRACT

A derivative as defined in the Securities Contracts (Regulations) Act is a security derived from a debt instrument, share, loan, whether secured or unsecured, risk instrument or contract for differences or any other form of security. The last two and half decades have witnessed many-fold increase in the volume of international trade and business due to globalization and liberalization across the world. This has led to volatility in financial assets prices, interest rates and exchange rates subsequently exposing the corporate world to financial risk. In this present dynamic business environment management of risk has become very critical for the survival of MNCs. Therefore the emergence of derivative markets in India is attributed to the need of effective and less costly risk management tools for predicting the price of underlying assets. To reduce the extent of financial risks by providing commitment of price of an asset at future date is the basic feature of these financial instruments which had made them popular in the recent times. Since its inception in June 2000, derivatives market has exhibited exponential growth both in terms of volume and number of contract traded. The market turnover has grown from Rs.2365 Cr. in 2000-2001 to Rs. 94370301.61 Cr. in 2016-17. Currently the derivatives market contributes approximately 93 per cent

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of the total traded value in the secondary market and within a short span of time derivatives trading in India has surpassed cash segment in terms of turnover and number of traded contracts. This piece of research tries to give in-depth analysis of Indian derivative markets encompassing concept, types, applications, historical perspective and growth of Indian derivative market.

Keywords: *Derivatives, Financial Risk, Business Environment, Financial Instrument, Volatility, Cash Segment, Contracts.*

INTRODUCTION

The last two and half decades have witnessed many-fold increase in the volume of international trade and business due to globalization and liberalization across the world. This has led to volatility in financial assets prices, interest rates and exchange rates subsequently exposing the corporate world to financial risk. Risk is a characteristic feature of all financial transaction. Over time, variations in the prices of agricultural and non-agricultural commodities occur as a result of interaction of demand and supply forces. In this present dynamic business environment management of risk has become more critical for the survival of MNCs. Minimizing risk/cost/efforts and maximizing earnings is the fundamental of financial management. Derivatives are also such financial products which help people to maximize returns on their investments by taking minimum risk and efforts. The emergence of derivative markets in India is attributed to the need of effective and less costly risk management techniques for predicting the price of underlying assets. Derivatives are risk management tools that enables risk- sharing and facilitates the efficient allocation of capital to productive investment activities.

METHODOLOGY

The study is organized into three sections.

Section-I deals with the concept, types, features, applications of derivatives

Section-II deals with historical perspectives and growth of Indian Derivatives Market.

Section-III deals with analysis and conclusion

Section I

1. Concept of Derivatives

Derivatives were developed to secure the supply of commodities both in time and geographical distance as well as to protect against changes in prices and to mitigate risks. Derivatives fostered trade and contracts evolved over history primarily to meet the specific needs of commodities traders. In addition, derivatives were for instance instruments for farmers to insure themselves against a crop failure, for merchants to finance their future commercial activities, for 'ventures' to obtain funds for their expeditions but also for governments and churches to raise money. The primary objectives of any investor are to bring an element of certainty to returns and minimize risks. Derivatives are contracts that originated from the need to limit risk.

Derivatives are the financial contracts such as options or futures, which derive their value from spot price time series, which is called the underlying or base. The terms contracts are often applied to denote the special traded instrument. Today derivatives play a key part in the international financial system. The most important contract types are futures and options, and the most important underlying markets are equity, bonds, treasury bills, commodities and foreign currencies. For examples, farmers of Turmeric may wish to contract to sell their harvest at a future date to eliminate the risk of a change in prices by that date. Such a transaction would take place through a forward or futures market. This market is the derivative market, and the prices on this market would be driven by the spot market price of turmeric which is the **'underlying'** or **'base'** and other market conditions.

The Oxford dictionary defines a derivative as something derived or obtained from another, coming from a source; not original. *The general definition of derivatives means to derive something from something else.* Some other meanings of word derivatives are:

- a derived function: the result of mathematical differentiation; the instantaneous change of one quantity relative to another; df(x)/dx, which means a variable which has been derived from another variable.
- b derivative instrument: a financial instrument whose value is based on another security,

Which means that derivative is a financial product which has been derives from another financial product or commodity.

1.1. Definition of Financial Derivatives

D.G. Gardener defined the derivatives as; a derivative is a financial product which has been derived from market for another product. The securities contracts (Regulation) Act 1956 defines "derivative" as under section 2 (ac). As per this 'Derivative' includes

(a) "a security derived from a debt instrument, share, loan whether secured or unsecured, risk instrument or contract for differences or any other form of security."

(b) "a contract which derived its value from the price, or index of prices at underlying securities."

The above definition conveys that the derivatives are financial products. Derivative is derived from another financial instrument/ contract called the underlying or base. A derivative derives its value from underlying assets.

Accounting standard SFAS133 defines "a derivative instrument is a financial derivative or other contract which will comprise of all three of the following characteristics:

(i) It has one or more underlying asset, and one or more notional amount or payments provisions or both. Those terms determine the amount of the settlement or settlements.

(ii) It requires no initial net investment or an initial net investment that is smaller than would be required for other types of contract that would be expected to have a similar response to changes in market factors.

(iii) Its terms require or permit net settlement. It can be readily settled net by a means outside the contract or it provides for delivery of an asset that puts the recipients in a position not substantially different from net settlement.

1.2. Underlying Asset in a Derivatives Contract

There are a wide range of financial assets that have been used as underlying, including equities or equity index, fixed-income instruments, foreign currencies, commodities, credit events and even other derivative securities. Depending on the types of underlying, the values of the derivative contracts can be derived. As defined earlier, the value of a derivative instrument depends upon the underlying asset. The underlying asset may assume many forms:

i. Commodities including channa, potato, coffee beans, guar seed etc
ii. Metals like bullions (gold & Silver), copper, zinc, nickel & lead etc
iii. Energies like crude oil & natural gas
iv. Foreign currencies like dollar, pound, euro, yen etc
v. Bonds of different types, including medium to long term negotiable debt securities issued by governments, companies, etc.
vi. Shares and share warrants of companies traded on recognized stock exchanges and Stock Index
vii. Short term securities such as T-bills; and
viii. Over- the Counter (OTC) money market products such as loans or deposits.

1.3 Major Participants in Derivatives Market

1. Hedgers

Hedgers participate in the derivative market in order to compensate for the fall in the value of their assets by the increase in the value of the derivative contract. They use derivatives markets to reduce or eliminate the risk associated with price fluctuations of an asset. Majority of the participants in derivatives market are hedgers. Prices of foreign currencies, petroleum, equity shares, commodities and other instruments fluctuate all the time, and pose a significant risk to those whose businesses are linked to such fluctuating prices. To reduce or eliminate this risk, modern finance provides a method called hedging. Derivatives are widely used for hedging.

2. Speculators

Speculators tries to earn profit by anticipating changes in market prices or rates of assets or credit events in the derivative market. They transact *futures* and *options* contracts to get extra leverage in betting on future movements in the price of an asset. The activity of speculators is more risky and there are chances of both the potential gains and potential losses by usage of derivatives in this venture. However, it is difficult to differentiate the two in practice. As pointed out by Jarrow and Turnbull "Hedging – risk reduction – speculation – risk augmentation is flip sides of the same coin."

3. Arbitrageurs

Arbitrageurs try to take advantage of discrepancies between prices of more or less the same assets or competing assets in different markets. They attempts to make profits by locking in a riskless trading by simultaneously entering into transaction in two or more markets. If, for example, the price of an asset is higher in future market in comparison to spot market, they will buy in spot market and sell in future market and earn profits. In short arbitrageurs earn profits by exploiting market imperfections.

1.4. Applications of Financial Derivatives

Some of the applications of financial derivatives can be enumerated as follows:

1. Management of Risk

This is most important function of derivatives. Risk management is not about the elimination of risk rather it is about the management of risk. Financial derivatives provide a powerful tool for reducing or eliminating of risk that individuals and organizations face in the ordinary course of businesses. Use of derivatives is very popular in hedging foreign exchange and financial risk.

2. Efficiency in Trading

Financial derivatives allow for free trading of risk components and that leads to improving market efficiency. Traders can use a position in one or more financial derivatives as a substitute for a position in the underlying instruments. In many instances, traders find financial derivatives to be a more attractive instrument than the underlying security. This is mainly because of the greater amount of liquidity in the market offered by derivatives as well as the lower transaction costs associated with trading a financial derivative as compared to the costs of trading the underlying instrument in cash market.

3. Speculation

It is an act of trading in an asset or conducting a financial transaction that has a significant risk of losing most or the entire initial amount with the expectation of maximizing gains. With speculation, the risk of loss is more than offset by the possibility of a huge gain, otherwise this can leads to financial destruction in an organization. However, these instruments act as a powerful instrument for knowledgeable traders to expose themselves to calculated and well understood risks in search of a reward, that is, profit.

4. Price Stabilization Function

Derivative market helps to keep a stabilizing influence on spot prices by reducing the short term fluctuations. In other words, derivatives reduce both peak and depths and leads to price stabilization effect in the cash market for underlying asset. The other uses of derivatives are observed from the derivatives trading in the market that the derivatives have smoothen out price fluctuations, squeeze the price spread, integrate price structure at different points of time and remove gluts and shortage in the markets. Derivative market helps to keep a stabilizing influence on spot prices by reducing the short-term fluctuations. In other words, derivative reduces both peak and depths and leads to price stabilization effect in the cash market for underlying asset.

5. Price Discover

An important application of derivatives is the price discovery which means revealing information about future cash market prices through the futures market. Derivatives markets provide a mechanism by which diverse and scattered opinions of future are collected into one readily discernible number which provides a consensus of knowledgeable thinking.

1.5. Classification of Derivatives

Derivatives can be classified in different ways like linear and non-linear, OTC (over the counter) and Exchange Trade, financial and non-financial etc. But for making our study more convenient and clear we have classified them into two categories as shown in Figure1: financial derivatives and commodity derivatives. In case of financial derivatives underlying assets or base are stocks, currencies, bonds and other interest rates bearing securities etc and in case of commodity derivatives, underlying asset or base can be commodities like agriculture commodities (wheat, channa), metals (gold, silver) or energy (natural gas) etc.

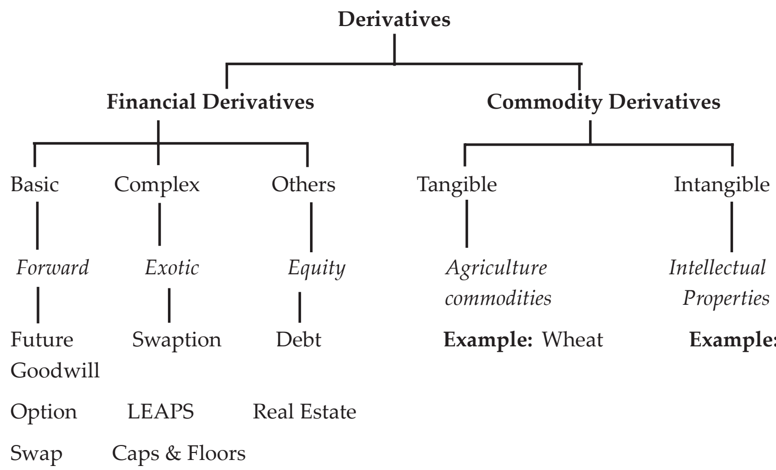

Figure 1: Types of Derivatives

1.5.1. Forward Contract

It is the simplest form of derivative contracts. A forward contract is an agreement between two parties a buyer and a seller to purchase or sell an asset at a later date at a specified price agreed upon today. Forward contracts, sometimes called forward commitments, are very common in everyone life. Any type of contractual agreement that calls for the future purchase of an asset at a price agreed upon today and without the right of cancellation is a forward contract. In case of a forward contract the price which is paid/ received by the parties is decided at the time of entering into contract. The specified price in a forward contract is referred to as the delivery price. The forward price for a particular forward contract at a particular time is the delivery price that would apply if the contract were entered into at that time. It is also important to differentiate between the forward price and the delivery price. Both are equal at the time of entering into contract but as time passes, the forward price is likely to change whereas the delivery price remains the same. Forwards contracts are traded over-the- counter and are not dealt with on exchanges unlike futures and option contract and no margin is generally paid in this contracts. Forward contracts are exposed to liquidity and counter party risk as they are bilateral contracts. Each contract is custom designed, unique in terms of contract size, expiration date, asset type and quantity etc.

In case the party wishes to reverse the contract, it has to compulsory go to the same counter party, which may dominate and command the price it wants as being in a monopoly situation. Forward contract are very popular in foreign exchange market as well as interest rate bearing instruments. Most of the large and international banks quote the forward rate through their forward desk lying within their foreign exchange trading room. Forward foreign exchange quotes by these banks are displayed with the spot rates.

1.5.2. Futures Contract

Future contracts are agreements between two parties to buy or sell a specified asset at a specified time and place on a predetermined price. Future contracts are traded on organised stock exchanges like NSE, BSE, NCDEX, MCX etc thus imparting liquidity to these transactions. These contracts are standardized in terms of quality, quantity, price quotation, date, delivery place (commodities), time of maturity and manner of maturity. Future contracts require margins and are subjected to daily settlement procedure known as Mark to Market. Daily settlement determines the profit and loss and the investors who incur losses pay them every day to investors who make profits. There is clearing house for the smooth conduct of transaction. They are supervised and monitored by regulatory authorities like SEBI which further add to safety of these contracts unlike forward contracts.

Example: Stock Future or equity futures, Stock Index futures, Currency futures, and Interest Rate bearing securities like Bonds, T- Bill Futures.

1.5.3. Options Contract

Unlike forwards and futures, options are the contracts which give the option buyer/holder the right, but not the obligation to either buy or sell a specific asset/security for a specified price known as exercise price, on or before a specified date known as expiration date. Option contracts can be of different types c*all* options, p*ut* options, OTC (Over the Counter) options, exchange traded options, American options and European options. Call option contract gives the buyer/holder of option the right to buy, not obligation to buy a specified asset/security at exercise price on or before the expiration date. Similarly put option give the buyer/holder of option right not obligation to sell a specific asset/security at exercise price on or before expiration date. Option contracts give the buyer/holder right to buy or sell but on the other hand it the obligation of the option seller/writer to buy or sell the specific asset/security if the option holder exercise his right. If the options are exercised, however, the option writer will be liable for covering the costs of any changes in the value of the underlying that benefit the buyer. Options have high degree of risk to the option writers.

The option buyer/holder pays the option seller/writer an amount for the right to buy or sell known as option premium. If the option holder thinks that situation is not in his favor to exercise his right he can abstain from it thus loosing option premium to option writer. On the other hand if option holder thinks that situations are in his favor and exercising the option can give him profits he will exercise the contract and earn profits. Therefore it is said that option contracts gives limited losses and unlimited profits to option holder.

In case of exchange traded options contract are standardized and traded on recognized exchanges, whereas OTC options are customized contracts traded privately between the parties. American-style option the contract can be exercised before the expiration date whereas European style option, the contract can only be exercised on the expiration date.

1.5.4 Swaps Contract

Swaps are agreements between two counterparties to exchange a series of cash payments for a stated period of time. The periodic payments can be charged on fixed or floating interest rates, depending on contract terms. The calculation of these payments is based on an agreed-upon amount, called the notional principal amount or simply the *notional*. The two commonly used swaps are interest rate swaps and currency swaps.

Interest rate swaps: These involve swapping only the interest related cash flows between the parties in the same currency.

Currency swaps: These entail swapping both principal and interest between the parties, with the cash flows in one direction being in a different currency than those in the opposite direction.

Exotic Option: Vanilla option has only two features: strike and expiry. An exotic is any option that has additional features such as barrier, averaging, rebate, etc. Due to these features, exotics are usually not listed but have to be traded directly between institutions, or OTC (over-the-counter). Hence the exotic market has very low volume as compared to vanillas. Exotic traders have much more to worry about as compared to vanilla traders, who are mostly concerned with delta risk. In contrast, exotic traders are faced with all sorts of volatility, skew and higher order risks.

Swaption: A swaption is a contract which has characteristics of both swaps and options. Swaption is the option to enter into an interest rate swap or some other type of swap. In exchange for an option premium, the buyer gains the right but not the obligation to enter into a specified swap contract with the issuer on a specified future date.

LEAPS: It means long Term Equity Anticipation Securities which actually options of longer terms than other more common options. Today LEAPS are available on approx 2500 equities and 20 indexes. Like the basic options the buyer of LEAPS is known as holder and its seller is known as writer. It is the writer's responsibility to manage the LEAPS whenever holder wants to exercise it. These contracts have recent history and typically extent for terms of 2 years. They always expire in the month of January.

Interest Rate Cap: An interest rate cap is actually a series of European interest call options (called caplets), with a particular interest rate, each of which expire on the date the floating loan rate will be reset. At each interest payment date the holder decides whether to exercise or let that particular option expire. In an interest rate cap, the seller agrees to compensate the buyer for the amount by which an underlying short-term rate exceeds a specified rate on a series of dates during the life of the contract. Interest rate caps are used often by borrowers in order to hedge against floating rate risk.

Interest Rate Floor: Floors are similar to caps in that they consist of a series of European interest put options (called caplets) with a particular interest rate, each of which expire on the date the floating loan rate will be reset. In an interest rate floor, the seller agrees to compensate the buyer for a rate falling below the specified rate during the contract period. A collar is a combination of a long (short) cap and short (long) floor, struck at different rates. The difference occurs in that on each date the writer pays the holder if the reference rate drops below the floor. Lenders often use this method to hedge against falling interest rates.

Section-II: Historical Perspectives and Growth of Indian Derivatives Market

Derivatives markets in India have been in existence in one form or the other for a long time. Forward trading in commodities is believed to exist in India from ancient times (period of Kautilya's Arthashastra). But in the modern era the Bombay Cotton Trade

Association started futures trading way back in 1875, just a decade after the CBOT traded its first future contract. Gujarath Vyapar Mandali was setup in 1900 for future trading in oil seeds, ground nut, caster seed and cotton seeds etc. The chamber of commerce at Harpur established the futures exchange for wheat trading in 1913, the first futures exchange for bullion futures in Mumbai in 1920 and similar exchanges come up in Rajkot, Jamnagar, Kanpur, Delhi and Calcutta. In Calcutta Hessain Exchange Ltd in 1919 and East Indian Jute Association Ltd in 1927 were established further and these two exchanges merged in 1945 as East India Jute and Hessin Ltd to conduct the organized trading of futures contracts in raw jute and related goods. Meanwhile, many other exchanges started in country to trade in diversified commodities **(Shaik Masood and T Satyanarayana Chary, 2016).** The last decade, beginning the year 2000, saw lifting of ban on futures trading in many commodities. Around the same period, national electronic commodity exchanges were also set up (**Ashutosh Vashishtha and Satish Kumar, 2010).** Derivatives trading commenced in India in June 2000 after SEBI granted the final approval to this effect in May 2001 on the recommendation of L. C Gupta committee. Securities and Exchange Board of India (SEBI) permitted the derivative segments of two stock exchanges, NSE and BSE, and their clearing house/corporation to commence trading and settlement in approved derivatives contracts. Initially, SEBI approved trading in index futures contracts based on various stock market indices such as, S&P CNX, Nifty and Sensex. Subsequently, index-based trading was permitted in options as well as individual securities. The following table 1 represents the chronological order of development of Indian derivative markets in details:

Table 1: Development of Derivatives Market of India in a Chronological Order

S. No	Progress Date	Progress of Financial Derivatives
1	1952	Enactment of the forward contracts (Regulation) Act
2	1953	Setting up of the Forward Market Commission
3	1956	Enactment of Securities Contract Regulation Act 1956
4	1969	Prohibition of all forms of forward trading under section 16 of SCRA
5	1972	Informal carry forward trades between two settlement cycle began on BSE

6	1980	Khuso Committee recommends reintroduction of futures in most commodities
7	1983	Govt. amends bye-laws of exchange of exchange of Bombay, Calcutta and Ahmedabad and introduced carry forward trading in specific shares
8	1992	Enactment of SEBI Act
9	1993	SEBI prohibits carry forward transactions
10	1994	Kabra Committee recommended future trading in Nine commodities
11	1995	G.S Patel Committee recommended revised carry forward system
12 13	14th Dec.1995 1996	NSE asked SEBI for permission to trade index futures Revised system restarted on BSE
14	18th Nov.1996	SEBI setup LC Gupta Committee to frame draft for index future
15	11th May 1998	L C Gupta submitted report
16	1st June 1999	Interest rate swaps/forward rate agreements allowed at BSE
17	7st July 1999	RBI gave permission to OTC for interest rate swaps/ forward rate agreements
18	24th May 2000	SEBI gave permission to NSE & futures and options on an Indian index
19	25th May 2000	SEBI gave permission to NSE & BSE to do index futures trading
20	9th June 2000	Equity derivatives introduced at BSE
21	12th June 2000	Commencement of derivatives trading (index futures) at NSE
22	31st Aug 2000	Commencement of trading future & options on Nifty at SIMEX
23	1st June 2001	Index options launched at BSE
24	June 2001	Trading on equity index options at NSE
25	July 2001	Trading on stock options at NSE
26	9th July 2001	Stock options launched at BSE
27	July 2001	Commencement of trading in options on individual securities
28	1st Nov. 2001	Stock futures launched at BSE
29	Nov 2001	Commencement of trading in futures on individual securities
30	9th Nov. 2001	Trading of single stock future at BSE
31	2003	Trading of interest rate futures at NSE, Launch of future & options CNX IT index, Commodity exchanges like MCX and NCDEX were setup.

32	2004	Weekly option of BSE
33	June 2005	Launch of future and options in Bank Nifty Index
34	2007	NSE launched derivatives on nifty midcap-50, Nifty Junior & CNX 100
35	2008	BSE trading on chotta-sensex (mini) began, F&O on sectoral indices and currency derivatives introduced
36	2008	On NSE Trading of Mini index F&O and currency derivatives were introduced, S&P CNX Defty F&O
37	August 2009	Launch of interest rate future at NSE, BSE-USE from alliance to develop currency & interest rate derivative market
38	2010	BSE Launched option on BOLT, Introduction of European style option at NSE
39	2011	Commencement of 91 day GOI trading bill futures by NSE, NSE Launched derivatives on CNX PSE & CNX infrastructure indices and launch of futures and options on global indices, namely S&P 500 and Dow Jones Industrial Average.
40	2012	BSE launched trading in BRICSMART indices derivatives, NSE commence trading in future and option contracts on FTSE 100 index
41	29th Nov. 2013	Launch of currency derivative segment (BSE CDX) by BSE
42	2014	Launch of interest rate future by BSE and NSE
43	2015	NSE launched nifty 50 index future trading on TAIFEX & FMC was merged with the Securities and Exchange Board of India (SEBI).

Source: Official website of BSE, NSE & MCX

The derivatives trading on NSE commenced with S&P CNX Nifty Index futures on June 12, 2000. The trading in index options commenced on June 4, 2001 and trading in options on individual securities commenced on July 2, 2001. Single stock futures were launched on November 9, 2001. The index futures and options contract on NSE are based on S&P CNX. In June 2003, NSE introduced Interest Rate Futures which were subsequently banned due to pricing issue. Indian commodity derivatives market has been rationalized in 2003 and futures contracts trading has seen upturn in terms of volume and value surge. It is very clear through the statistics that 53 commodities notified and permitted for futures trading in 2003 by forward market commission that moved to 113 in agricultural, and non-agricultural commodities futures contracts. Derivative market of India has registered a remarkable growth in the recent decade as analysed from the tables below and the same trends seem to be continuing in future. NSE alone accounts for major portion of derivative trading in India.

Table 2: Business Growth of NSE in all Segments

Year	Total No. of Contracts	Total Turnover (Rs. Cr.)	Average Daily Turnover(Rs. Cr.)
2016-2017	1399746129	94370301.61	380525.41
2015-2016	2098610395	64825834.30	262452.77
2014-2015	1837041131	55606453.39	228833.14
2013-2014	1284424321	38211408.05	152236.69
2012-2013	1131467418	31533003.96	126638.57
2011-2012	1205045464	31349731.74	125902.54
2010-2011	1034212062	29248221.09	115150.48
2009-2010	679293922	17663664.57	72392.07
2008-2009	657390497	11010482.20	45310.63
2007-2008	425013200	13090477.75	52153.30
2006-2007	216883573	7356242	29543
2005-2006	157619271	4824174	19220
2004-2005	77017185	2546982	10107
2003-2004	56886776	2130610	8388
2002-2003	16768909	439862	1752
2001-2002	4196873	101926	410
2000-2001	90580	2365	11

Source: Official website of NSE

Table 2 shows the business growth of NSE in total number of contracts traded and their total turnover and average daily turnover in respective years. NSE started its business with a total number of 90580 contracts in the year 2000-01 with a turnover of rs 2365 cr. Starting from 2000-01 NSE has registered a continuous growth in terms of total number of contracts traded and their respective turnover. In the year 2016-17 total number of contracts traded at NSE in all segments was 1399746129 whose total turnover was rs 94370301.61 cr with average daily turnover of rs 380525.41 cr.

Table 3: Product wise turnover at NSE

Year	Index Future Turnover (Cr.)	Stock Futures Turnover (Cr.)	Index option Notional Turnover Cr.)	Stock Option Notional Turnover (Cr.)	Total Turnover (Cr.)	Average Daily Turnover (Cr.)
2016-17	4335940.78	11129587.14	72797287.69	6107485.87	94370301.61	380525.41
2015-16	4557113.64	7828606.00	48951930.60	3488173.75	64825834.30	262452.77
2014-15	4107215.20	8291766.27	39922663.48	3282552.18	55606453.39	228833.14
2013-14	3083103.23	4949281.72	27767341.25	2409488.61	38211408.05	152236.69
2012-13	2527130.76	4223872.02	22781574.14	2000427.29	31533003.96	126638.57
2011-12	3577998.41	4074670.73	22720031.64	977031.13	31349731.74	125902.54
2010-11	4356754.53	5495756.70	18365365.76	1030344.21	29248221.09	115150.48
2009-10	3934388.67	5195246.64	8027964.20	506065.18	17663664.57	72392.07
2008-09	3570111.40	3479642.12	3731501.84	229226.81	11010482.20	45310.63
2007-08	3820667.27	7548563.23	1362110.88	359136.55	13090477.75	52153.30
2006-07	2539574	3830967	791906	193795	7356242	29543
2005-06	1513755	2791697	338469	180253	4824174	19220
2004-05	772147	1484056	121943	168836	2546982	10107
2003-04	554446	1305939	52816	217207	2130610	8388
2002-03	43952	286533	9246	100131	439862	1752
2001-02	21483	51515	3765	25163	101926	410
2000-01	2365	-	-	-	2365	11

Source: Official website of NSE

Product wise analysis from the table 6 shows that there is increase in the turnover in all derivative products traded on NSE. Average daily turnover has increased from rs 410 cr in all products in 2001-02 to rs 380525.41 cr in 2016-17 which is in concurrence with the trends of turnover in all derivative segments.

Table 4: Business Growth at BSE in all Segments

Year	Total Contracts	Total Turnover (Rs Cr)	Average Daily Turnover (Rs Cr)	Trading Days
2016-17	123538	6939.29	27.98	248
2015-16	106209394	4475008.32	18117.44	247
2014-15	505478869	20362741.42	83797.29	243
2013-14	301942441	9219434.32	36730.81	251
2012-13	262440691	7163576.66	28654.31	250
2011-12	32222825	808475.99	3246.89	249
2010-11	5623	154.33	0.61	255
2009-10	9028	234.06	0.96	244
2008-09	496502	11774.83	48.46	243
2007-08	7453371	242308.41	965.37	251
2006-07	1781220	59006.62	236.97	249
2005-06	203	8.78	0.03	251
2004-05	531719	16112.32	63.69	253
2003-04	143224	5021.81	19.77	254

Source: Official website of BSE

Table 4 shows the business of BSE in all derivative segments which does not show much encouraging trends. In comparison to NSE the derivative trading at BSE is far behind in terms of number of contract traded, total turnover and average daily turnover of these contracts. Moreover there are fluctuations in the derivative business of BSE. The stock exchange has registered growth in total number of contracts traded till 2014-15 but was unable to keep the same trends in future. After inception of trading in 2003-04 BSE has witnessed lowest business in the year 2005-06.

CONCLUSION

The country has one of the most matured and vibrant exchange traded derivative markets among developing countries of the world. The growth of derivatives in the recent times has surpassed the growth of equity segment in major stock exchanges of India.

Country shows very encouraging growth pattern in derivative market with respect to number of contracts, variety of contracts and total turnover of contracts traded which can be compared with the derivative market of many developed countries of the world. The analysis from the above tables also suggests that NSE is market leader in derivative trading in India. The performance of BSE is not encouraging both in terms of volumes and numbers of contracts traded in all product categories. The volatility in financial asset price, integration of financial markets internationally, innovations in financial engineering, sophisticated risk management tools, safe and secure electronic trading and the choices of risk management tools have been driving the growth of financial derivative market in India.

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8

Implementation of Knowledge Management in Telecommunication Sector (Jammu): An Empirical Analysis

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ABSTRACT

Knowledge Management is a process enables organizations to learn, create, develop and apply necessary knowledge which makes organisations more profitable, competitive and innovative. The purpose of this paper is to determine the level of knowledge management being practiced in Telecommunication organisations. Questionnaire method has been used to collect data from employees working in the private telecommunication organisations. Extensive review of literature has been done to frame the dimensions of Knowledge management. Questionnaire has been duly purified and validated before the data analysis. One sample 'T' test has been used to check the level of knowledge management in telecommunication sector. The result revealed that employees have high perception about knowledge management practices in their organisations. This study encourages on the different processes of KM to increase the innovative capabilities and competitive advantage.

Keywords: *Knowledge Management, Confirmatory Factor Analysis, Telecommunication Sector.*

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INTRODUCTION

In the present dynamic era economic value of knowledge has become greater than the value of physical products. It is not accidental that the stock market value of a number of companies far exceeds the visible assets of their balance sheet (Berce et al, 2008). This difference is due to "Intellectual Capital" or more specifically it's "Knowledge Assets". In an economy characterized by global competitiveness and constantly shifting markets, these knowledge assets can provide today's companies with the competitive advantage they are looking for. After the successes and failures of previous managerial trends like Total Quality Management (TQM) and Business Process Reengineering (BPR), managers are now realizing that last untapped resource is the knowledge of employees and of the organization as a whole. In the new economy, knowledge is not just another resource alongside the traditional factors of production- labour, capital and land but the only meaningful resource today (Nonaka and Takeuchi, 1995). As a result, knowledge management (KM), i.e. the combination of management principles and technology that seeks to improve the performance of individual and organizations by maintaining and leveraging the value of knowledge assets, has emerged into a mega trend.

The popularity of KM increased rapidly in the 1990s and in the beginning of the 21st century (Edvardsson, 2009). The origin of KM is, to some extent, related to the development of information communication technology (ITC) (Strouse, 2001; Edvardsson, 2009). Advanced ICT technologies have been the center of knowledge codification. Such technology facilitates KM, especially in large, geographically dispersed organisations.

A conceptual understanding of knowledge management (KM) can be approached from various perspectives, such as philosophical, religious, cognitive, practical, etc. The KM literature has focused on the practical perspective, discussing it, for example, in the data-information-knowledge continuum (Davenport et al, 1998; Duffy, 2000). ' KNOWLEDGE' can be thought of as an information that changes something or somebody either in the most basic form by becoming grounds for actions or by making an individual capable of different or more effective action (Drucker, 1998). It is a fluid mix of framed experience (Davenport et al, 1998). On the other hand 'MANAGEMENT Process' includes a range of activities ranging from learning, collaboration, and experimentation to integration of diverse sets of tasks and implementation of powerful information systems, such as the internet, intranets and extranets (Bhatt, 2002). Organisations learn and acquire knowledge through their routines which are embedded in specific organisational histories (Bhatt, 2002). Therefore KM can be defined as a systematic discipline and a set of approaches to enable information and knowledge to grow, flow, and create value in an organization. This involves people, information, work-flows, best practices, alliances, and communites of practice (Bharadwaj and Saxena, 2005).

Despite the popularity of KM, there is no single universally acceptable definition available. Most definitions are, however, similar on one point: they take a very practical approach to knowledge, that is, how knowledge can contribute to organizational effectiveness (Hlupic et al., 2002).In holistic terms, Knowledge management must be seen as a strategy to manage organizational knowledge assets to support management decision making to enhance competitiveness, and to increase capacity for creativity and innovation . Therefore, the objective of a firm applying knowledge management is simply to make the right knowledge available at the right time at the right place.

Knowledge Management authors have classified knowledge in different ways. Some authors differentiate technical and strategic knowledge (Liebeskind, 1996). However the more common types of knowledge are tacit and explicit knowledge (Nonaka, 1994; Nonaka and Konno, 1998; Cavusgil et. al, 2003).

Tacit Knowledge: The term 'TACIT KNOWLEDGE' was first coined by Polanyi (1958). It is the knowledge that people have in their minds. It is more of an 'unspoken understanding' about something that is more difficult to write down. In fact, most people are not aware of the knowledge they themselves possess or of its value to others. It is considered more valuable because it provides context for people, places, ideas and experiences. It generally requires extensive personal contact and trust to share effectively. It involves perceptions, insights, experiences and craftsmanship (Kidwell et al., 2000).It can be personal, difficult to manage and transfer. To give an example, Highway Code provides the explicit knowledge for the driver, but who uses his/her tacit knowledge to drive different cars, on different roads, in different countries, and with steering wheel on the other side.

Explicit Knowledge: Explicit knowledge is documented information that can facilitate action (Nonaka, 1994). It can be expressed in formal, shared language. It can be packed, codified, communicated and transferred. Some of the examples of explicit knowledge are found in commercial publications, e-mail, internet, database, organizational business records and self –study material etc (Nonaka and Teece, 2001). Information and communication technologies are mainly used to manage the explicit knowledge. Hence it is tangible in nature that can be procured and preserve and shared with a high degree of accuracy. It can be categorised as either structured or unstructured (Cong and Pandya, 2003). Structured knowledge is the data or information organised in a particular way for future retrieval. This includes documents, databases, and spreadsheets etc. In contrast, e-mails, images, training courses, and audio and video selections are examples of unstructured knowledge because the information they contain is not referenced for retrieval.

Table: Descriptions and Characteristics of Explicit and Tacit knowledge by Various Authors

CITITATION	EXPLICIT KNOWLEDGE	TACIT KNOWLEDGE
Choo (2000)	Product, patents, databases	Observations
Clarke & Pollo (2001)	Codified, formal, reports , manual	Face-to- face collaboration
Davenport & Grover (2001)	Easily codified	Direct interaction
Haldin &) Herrgard (2000	Handbooks, lectures, newsletters	Intution, personal skills
Meso & Smitt (2000)	Copyrights, patents, trademarks	Mental modles, beliefs

All the above mentioned types of knowledge are present in an organization. The aim of KM practices is to maximize organizational and individual knowledge and use it for the benefit of the organisation (Kidwell et al, 2000) and accomplishment of the organisational goal. in order to achieve organisational goal different strategies can be followed to manage knowledge in proper and systematic ways.

KNOWLEDGE MANAGEMENT STRATEGIES/TECHNIQUES

Hansen et al., (1999) defined two different types of strategies that can be used to manage different types of knowledge with a view to achieve end goals of an organisation and they are termed as 'Codification' and 'Personalization'.

CODIFICATION STRATEGY

It refers to the codification and storage of knowledge in databases, where it can be accessed and used readily by anyone in the company. Organizations use these strategies investing heavily in ICT like Internet, knowledge mapping, electronic libraries. This increases effectiveness and growth (Hanse et at., 1999). The essence of this strategy, the technical explanation, is to transform the knowledge of organizational members into explicit knowledge so that management efficiency can be enhanced through information technology (Raelin,2008).

PERSONALIZATION STRATEGY

It depends on people to people connection. It refers to the personal development of knowledge through discussions, meeting, conversation etc, this strategy is primarily used to solve unique problems where tacit personal knowledge is needed (Edvardson, 2009). It is this knowledge that can enhance the firm's competitiveness with the help of implicit knowledge (Raelin, 2008). In this strategic focus is on investment in learning and creation of new capabilities. (Clegg and Clark, 1999).

Hansen et al., (1999) warned against mixing strategies. They suggested using one strategy and applying the second to support the first because knowledge based activities include the creation, acquisition, sharing, conversion, utilisation, protection and approach together these comprise "Knowledge Management" (Shieh-chien, et al., 2005) i.e. dimensions of knowledge management. All these dimensions give full support to Knowledge management (KM). The organization will have to efficiently combine all the above discussed parameters i.e. creation, acquisition, conversion, sharing, utilization and protection by applying appropriate knowledge approach i.e. use of information technology which give strength to organizations in their innovation process and gain the competitive advantage. Innovation is extremely dependent on the availability of knowledge whereas competitive advantage of an organization depends on the quality, quantity, creation, use and application of knowledge.

KNOWLEDGE MANAGEMENT IN TELECOMMUNICATION SECTOR

In the present dynamic world telecommunication-sector is responsible for making the world a global village with the entrance of the knowledge-based economy; telecommunication organisations face even more severe and strict competition in the global market place (Chang, et al., 2006). Knowledge is the greatest competitive advantage for all types of companies but it is integral for I.T. sector companies. Only firms participating in the creation and utilisation of knowledge can hope to enjoy the rewards of business reform in today's knowledge-based economy (Haldin and Herrgard 2000). Knowledge management, therefore, becomes a majority method for the telecommunication organisations to survive in this knowledge based economy as it requires utmost attention to be kept updated and solve the day to day problems. Further, these organisations depend on hundreds of or thousands of knowledge workers all over the world, it is important for them to communicate and share their knowledge (Schonstron, 2005). Therefore, telecommunication organisations now-a-days are willing to make investments to capture as much as possible from their most experienced workers. Large telecommunication companies are creating chief knowledge officer positions (Strouse, 2001) which reveals the fact that the telecommunication industry believe the intellectual assets have value (Minogue White, 2006).

Strouse (2001) has stated several components that are important for effective KM system in telecommunication organisations.

1. IT supports needs to be adequate both in scale and communication response time.
2. Data-bases should include user-friendly search capabilities.
3. Processes need to support the facilitation of information retrieval and must be in place to assist in the creation of new information.
4. Tools in the search engine need to pinpoint, so that the proper knowledge can be acquired when required.
5. Effective incentive and supportive core values should be encouraged to the most expert employees to share their knowledge.
6. System performance metrics should be maintained in order to help to determine the criteria for new data to enter the system.

From the above discussion it can be concluded that implementation of knowledge management practices is imperative for telecommunication-organisations. They need it to survive the challenges of knowledge-based economy, achieve better organisational performance through value added innovation that can give a competitive edge to the organisation.

OBJECTIVE

1. To explore the level of knowledge management in telecommunication sector.
2. To validate the knowledge management scale.

HYPOTHESIS

The era of industrialization and information age has made the telecommunication industry expand into diversified functions to support the growth of technological advancement for better services demanded by any nation (Yusof, 1998). The impact of global knowledge based economy has increased due to the shifting winds of change in today's business environment where the marketplace is increasingly competitive and the rate of innovation is rising (Schonstron , 2005). Therefore, knowledge has become a crucial asset in reducing these uncertainties and the only sustainable source of competitive advantage (Hlupic et al, 2002). As such the management of knowledge has been recognized as a competitive weapon for the telecommunication industry to move forward and to chart more successes in the uncertain future (Chong, et al. 2006). A systematic knowledge management system can help for organizing and managing non-structured data, accelerating the learning of new staffs, speeding up the index mechanism, enhancing the reserve of data and have a better decision making support. Accordingly, all telecommunication organisations are employing the services of the KM consultant to help them to build up a knowledge management system to increase the intelligence of the organisation by building and leveraging knowledge. So, the hypothesis generated from the given literature is:

Hypothesis: Knowledge Management is being highly practised in telecommunication organisations**.**

RESEARCH DESIGN AND METHODOLOGY

In order to make the study more accurate and objective, following steps have been taken.

GENERATION OF SCALE ITEMS

The statements of the questionnaire were finalized after reviewing the existing literature and after detailed discussions with the experts and interaction with the local managers of the leading telecommunication organisations. The questionnaire comprised two sections. The first section was concerned about the demographic profile of the employees of telecom sector, where they were asked about the name of their organisation, department, designation, qualification, age, gender and length of service. It was followed by knowledgement management scale.

KNOWLEDGE MANAGEMENT SCALE (KMS)

The second section comprised with 48 statements regarding Knowledge management under seven dimensions. The dimensions are Knowledge Sharing (Yi, 2009), Knowledge Acquisition, Conversion (Berce et al., 2008), Utilization (Berce et al., 2008) Creation (Nonaka, 1994), Protection and Approach (Sher & Lee, 2003). Knowledge management has been measured on 5 point Likert scale.

SAMPLE AND RESPONSE RATE

The population for the study comprised 1190 employees working in the telecommunication organisations in Jammu. To determine the sample size, a pilot survey of fifty respondents selected conveniently from all the telecommunication organisations in Jammu was conducted to work out the mean and standard deviation in the population with the help of the following formula (Mukhopadhya, 1998, p.21-31)

1.96*S.D" N-n/n*N=0.05*mean

Key: S.D=Standard Deviation, N= Total population, n= Sample population, Mean = sample mean.

After determining the mean and standard deviation in the population 1190, the sample size was worked out at 57 which were too small for application of multivariate techniques. So it was decided to find out the sample size according to number of items to be used for studying knowledge management. Every item requires 5 -10 respondents (Hair *et al*. 2006). This research construct contained 48 items, so it was decided to take 480 as the sample size. The selection of employees was done on the basis of proportionate sampling by the mean of following formula

n/N*Sample size (Malhotra, 2002, p. 266-291) (Table 1).

Key: n= number of employees, N=Total population

Convenient sampling technique has been used for data collection.

The data was collected from employees working in telecommunication organizations in Jammu. The list of employees in each company was not provided by the management. So it becomes difficult to identifying the numbers of employees in each category or group. Permission could not be obtained for personal contacts in the working hours. So respondents were contacted during lunch hours. Only 331 employees responded properly. Hence the response rate came to sixty-eight percent.

Table 1: Total Number of Employees Contacted and Number of Responses Received

Name of the Company	Total Numbers of Employees	Number of Employees Contacted	Number of Questionnaires Received	Percentage
Reliance	210	84	84	100%
Aircel	250	101	86	85%
Airtel	180	73	45	62%
Vodafone	300	121	85	70%
TataIndicom	**250**	**101**	**31**	**31%**

SCALE PURIFICATION – EXPLORATORY FACTOR ANALYSIS (EFA)

The multivariate data reduction technique of factor analysis has been used for the study. The primary purpose of factor analysis is to define the underlying structure in a data matrix. It involves examination of interrelationships (correlations) among a large number of variables and reduction of large number of variables into few manageable and meaningful sets. Factor analysis was carried out through the Statistical Package for Social Sciences (SPSS, 15.0 versions) to simplify and reduce the data. It was carried with Principal Component Analysis method along with orthogonal rotation procedure of varimax for summarizing the original information with minimum factors and optimal coverage. The statements with factor loading less than 0.5 and Eigen value less than 1.0 were ignored for the subsequent analysis (Hair et al., 2006). The data reduction was performed in three steps- First in the anti-image correlation the items with value less than 0.5 on the diagonal axis were deleted. In the second step the extracted communalities were checked (amount of variance in each variable) and items with values less than 0.5 were ignored for the subsequent analysis. In the third step in rotated component matrices statements with multiple loadings and values less than 0.5 were ignored. The detailed analysis is as under:

PURIFICATION OF KNOWLEDGE MANAGEMENT SCALE (KMS)

Factor analysis reduced the 48 statements to 22, which got compressed under seven factors namely KS (F1), KAP (F2), KCR (F3), KP (F4), KCO (F5), KU (F6) and KA (F7) respectively. The high KMO value and chi- square value in Bartlett's test of sphericity (0.756 and 1487.313) revealed the sample adequacy for factor analysis. The total variance explained by these factors has arrived at 71 percent (Table 2). Eigen value of each factor is greater than one (Table 2). The ordering of factors shows their respective importance. Knowledge sharing, Knowledge approach and Knowledge creation are of great importance in this construct. Each is explaining about twelve percent of the total variation followed by Knowledge protection, Knowledge conversion, Knowledge utilization and

Table2 Summary of Results of Overall Factor Analysis of Knowledge management data.

Factors	Mean	S.D	F.L	Com	E.V	KMO	V.E	Alpha value
KS (F1)					2.437	0.756	12.183	0.7899
Brains Brain storming sessions	4.06	1.39	0.750	0.628				
Team- meeting	4.09	0.89	0.865	0.731				
Share success stories	3.36	0.91	0.875	0.769				
KAP (F2)								0.7641
Knowledge formalization	4.11	0.83	0.837	0.758	2.407		12.036	
Standard Data	4.15	0.88	0.814	0.672				
Corporate Data	4.13	0.89	0.747	0.604				
IT specialists	4.10	0.84	0.795	0.512				
KCR (F3)								0.7562
Customer knowledge	4.10	0.85	0.834	0.754	1.985		11.927	
Social benefits	4.14	0.76	0.796	0.653				
According to Problems	4.09	0.85	0.705	0.589				
KP (F4)								0.7800
Protecting Trade marks	4.12	0.87	0.810	0.758	2.068		10.342	
Protects knowledge	4.19	0.92	0.795	0.670				

Importance of protection	4.17	0.89	0.746	0.639				
KCO (F5)								0.7158
Absorption of knowledge	4.12	0.82	0.837	0.750	1.527		10.633	
Organization knowledge	4.12	0.86	0.750	0.647				
Replacement- knowledge	4.19	0.81	0.741	0.620				
KU (F6)								0.7010
Improvement	4.09	0.79	0.642	0.675	1.334		10.671	
Better utilization	4.06	0.83	0.604	0.683				
Find out weakness	4.02	0.71	0.532	0.500				
KA (F7)								0.7800
Knowledge distribution	4.07	0.95	0.847	0.760	1.867		9.330	
Opportunities	4.04	0.93	0.752	0.699				
Competitors	3.98	0.92	0.708	0.688				
Total		71.129	0.844					

Knowledge acquisition (Table 2).

Notes: S.D. = standard deviation, F.L. = factor loadings, Com =communalities extracted, KMO= Kaiser-Meyer-Olkin, E.V. = Eigen value, V.E. = variance explained.

SCALE VALIDATION - CONFIRMATORY FACTOR ANALYSIS (CFA)

CFA is a tool that enables us to either confirm or reject our preconceived theory. It is used to provide a confirmatory test of our measurement. It is based on measurement theory. It specifies series of relationship that suggest how measured variables represent a latent construct that is not measured directly (Hair et al, 2005).

In present study before running CFA, EFA was carried out to restrict the number of indicators. After EFA, CFA was run and items with standard regression weight less than 0.5 were deleted (Hair et al, 2005).

MEASUREMENT MODEL DEVELOPMENT FOR KNOWLEDGE MANAGEMENT

The Knowledge Management construct comprised with sub scales namely, Knowledge Sharing, IT Approach, Acquisition, Creation, Utilization, Conversion and Protection (Fig1). The result of CFA on all sub scales revealed that all the manifest variables are highly loaded on their latent construct (Table 3). The fit indices of the specified measurement model have also yielded excellent results with (x^2/df= 1.93 p <0.001, GFI= 0.910, AGFI= 0.884, CFI=0.911, RMR=0.045 and RMSEA=0.054).

Table 3 shows that all standardized regression weights are substantial and significant at p<0.001. This measurement model did not contain any cross- loadings either among the measured variables or among the error terms. These results supported the unidimensionality, convergent and discriminant validity of all constructs in the final measurement model (Hair et al, 2005).

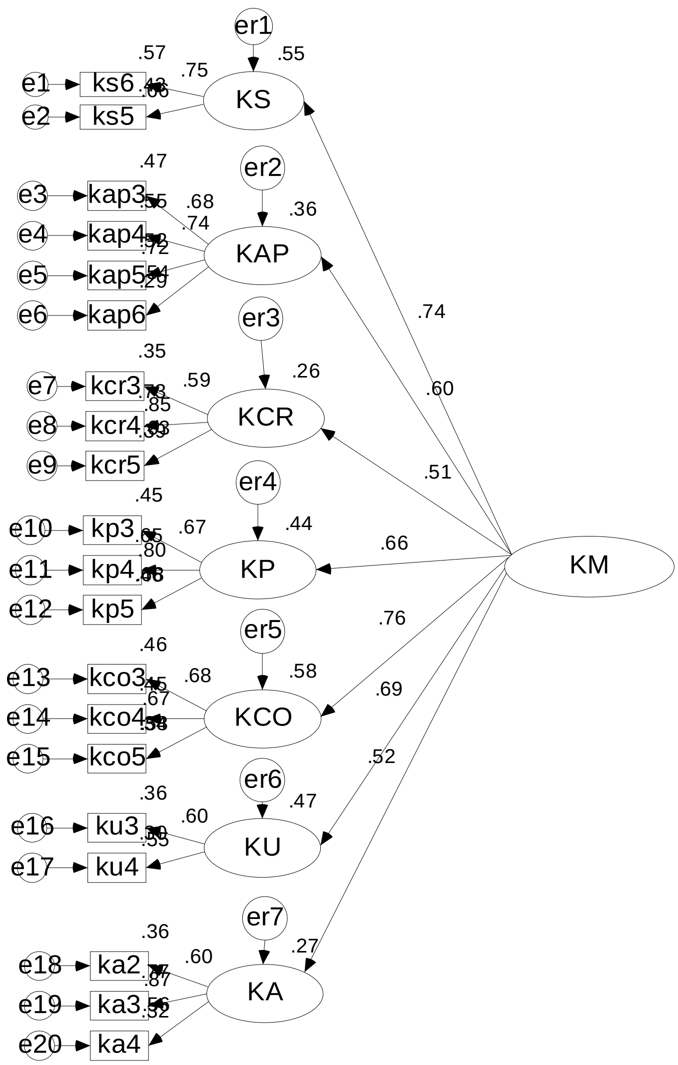

Fig 1: Measurement Model of Knowledge Management

KEY: KS5——KA4 are the manifest variables of sub-scales, KS—KA are the sub-scales of knowledge management scale, e1——e20 are the error terms of manifest variables, er1—er7 are the error terms of sub-scales of knowledge management model, KM—Knowledge Management.

Table 3 showing SRW, CR, P-VALUE AND R^2 of knowledge management model

Latent Variables	Manifest Variables	SRW	CR	P-value	R^2
KAp	KAp4	0.742	10.342	0.001	0.450
	KAp3	0.684	Ref		0.554
	KAp5	0.723	10.160	0.001	0.517
	KAp6	0.546	8.158	0.001	0.295
KP	KP3	0.665	Ref		0.450
	KP4	0.807	10.206	0.001	0.647
	KP5	0.681	9.629	0.001	0.459
KS	KS5	0.660	Ref		0.568
	KS6	0.748	7.744	0.001	0.429
KCr	KCr3	0.599	Ref		0.353
	KCr4	0.838	8.501	0.001	0.729
	KCr5	0.639	8.420	0.001	0.395
KCo	KCo3	0.660	Ref		0.456
	KCo4	0.681	8.494	0.001	0.451
	KCo5	0.590	7.835	0.001	0.338
KA	KA2	0.599	Ref		0.359
	KA3	0.874	8.249	0.001	0.765
	KA4	0.562	7.934	0.001	0.315
KU	KU4	0.602	Ref		0.363
	KU3	0.600	5.225	0.001	0.304

RELIABILITY

The reliability of knowledge management scale was assessed through the cronbach's alpha, which assesses the internal consistency of the scale. The alpha reliabilities for each of the dimension of knowledge management (Table 2) are above 0.7, indicating internal consistency.

The construct reliability of Knowledge management scale in CFA was tested with the help of following formula

CR= (Sum of standardised loadings)^2 / (Sum of standardised loadings)^2 + Sum of error terms

The value of the scale is greater than 0.9, (Knowledge management = 0.966) thereby indicating strong construct reliability.

VALIDITY

FACE VALIDITY/ CONTENT VALIDITY

The content/ face validity of the construct i.e. Knowledge management, was duly assessed through review of literature and discussions with the subject experts, managers and other employees of Telecom sector i.e Airtel, Aircel, Vodafone, Tata Indicom and Reliance.

CONVERGENT VALIDITY

Convergent validity refers to the extent to which the measures correlate with other measures that were designed to measure the same thing. High correlations indicate that the scale is measuring the concept (Hair et al., 2005). A scale with Bentler- Bonett coefficient delta values of 0.90 or above implies strong convergent validity. Since the Bentler Bonnet coefficient delta value for knowledge management scale (0.934) indicating strong convergent validity.

MEASUREMENT AND ANALYSIS OF KNOWLEDGE MANAGEMENT

The overall degree of assessing knowledge management in Telecommunication sector is very high (4.11) at five- point scale. Knowledge management, being a multifaceted phenomenon was calculated on the basis of various dimensions. The detailed analysis of each dimension is as under.

KNOWLEDGE SHARING

The total mean derived from different items of knowledge sharing came to 4.07. CFA resulted into two items. The item "Team meeting" is highly related with knowledge sharing (SRW=0.749). Most of the employees are involved in the team–meeting (M=4.09) of the organization, which gave solutions to their problems. The relation between the item "Brain storming" and knowledge sharing is also high (SRW=0.660). Regular brainstorming sessions are held which increases their knowledge and reduces their problems. The detailed analysis of this dimension revealed that brainstorming session and team meetings are necessary components of sharing knowledge among employees (Table 2)

KNOWLEDGE ACQUISITION

The knowledge acquisition is the ability to seek new knowledge and enhance the knowledge management in the organisation. Knowledge acquisition is an important source of new knowledge for a firm (M=4.06). CFA of knowledge acquisition resulted in three items. The item "Knowledge about new opportunities" is highly related with knowledge acquisition (SRW=0.874). The knowledge is being acquired about new opportunities (M=3.98) for the purpose of growth and diversification of the business. The knowledge is always distributed throughout the org (M=4.07). The organisations acquire about the competitors (4.04) to remain in the market (Table 2)

KNOWLEDGE CONVERSION

The factorial mean of this dimension has arrived at 4.15. The item "Organization of knowledge" highly reflects the construct (SRW=0.681). The organizations store the organised knowledge (M=4.12). It makes knowledge useful and promote the effective and efficient management. The item "Integration of knowledge" is significantly related with construct (SRW=0.660). The organization integrates different source and types of knowledge (M=4.12). Proper integration of knowledge increased the capabilities of the organization. The organizations also replace the irrelevant knowledge (M=4.19) as it increases its efficiency. The overall analysis of this dimension explains that integration, organization of useful knowledge and replacement of outdated knowledge are the important components of knowledge conversion (Table 2).

KNOWLEDGE UTILISATION

Knowledge utilization means the actual use of knowledge. The total mean of the dimension has arrived at 4.11. The item "Knowledge utilization to change competitive advantage" is highly related with the scale (SRW= 0.600). The organizations utilize knowledge for competitive advantage (M=4.09) and for problem solving (M=4.06). The detailed analysis revealed that effective utilization of knowledge can result in competitive advantage and help in solving problem in an organization (Table 2).

KNOWLEDGE CREATION

The overall mean of this dimension has figured out at 4.11. CFA result showed that three items highly related with latent construct. The item "Creation of knowledge for social benefits" is highly related with the construct (SRW=0.838). Knowledge is created to provide social benefits (M=4.14) and solve the problem (M=4.09) faced by the organization. Knowledge created through customers feed back (M=4.10) is also used for social benefits. The detailed analysis indicates that knowledge is created on the basis of customer feedback for the purpose of social benefits as well as to solve the problem (Table 2).

KNOWLEDGE PROTECTION

The total mean of this dimension has arrived at 4.16. The item "protection of knowledge embedded in individuals highly reflects the construct (SRW= 0.807). The organizations are utilizing this source highly (M=4.19) and frame extensive policies and procedures for protecting trade secrets (4.12). Further, the importance of protecting knowledge is also communicated to the employees (M=4.17). The detailed analysis reveals that knowledge protection is the ability to secure knowledge from inappropriate uses, which is being highly practiced in selected organizations (Table 2).

KNOWLEDGE (IT) APPROACH

Knowledge approaches are the activities that make knowledge management successful in an organization. Modern age is the age of science. So information technology (IT) is an important approach in the knowledge management. The total mean of this dimension has arrived at 4.13. The relationship of item "Standardized data" with the construct is quite high (0.742). Most of the employees (83%) use IT system to enable knowledge formalization across the organization (4.11). These organizations have IT specialists who design the program (M=4.16) for the corporate data to be shared among employees (4.13), which is identified and standardized across the organization (4.15). IT is being used by organization to perform specific tasks as efficiently as possible (Table 2).

Extent of Knowledge Management on Telecommunication Sector

In order to test the level of knowledge management in telecommunication organisations. One Sample't' test was used. Here the sample mean was 4.11 and the test value was 4.00 (Table 4). The results revealed a significant difference between observed and test values (t= 4.460, sig.0.00). Hence the hypothesis that KM is being highly practised in telecommunication organisations stands accepted.

One-Sample Test

Test Valum=4						
	T	df	Sig.(2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
gkm	4.460	320	.000	01.913	.0610	.1573

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9

Assessing the Leadership in J&K Public Sector Corporations

Vaishali & Sandeep Patyal***

ABSTRACT

This paper investigates the perception of operating and top level employees regarding leadership behaviour in J&K Public corporations. Data were collected from 242 employees working in four public corporations in J&K. Exploratory factor analysis and t-test were used to analyse the data. Results revealed significant mean difference between operating and top management employees' perception regarding leadership. Limitations and future research is also discussed.

Keywords: *Leadership, Public Sector, Top Management, Operating Management*

INTRODUCTION

Trends toward deregulation, privatization and a negative growth environment have forced administrators of public sector undertakings to rethink traditional bureaucratic structures, traditional policies & procedures and to become more entrepreneurial (Galbraith & Lawler, 1993; Mohrman, Cohen & Mohrman, 1995). In addition, the increasing frequency of restructuring, downsizings and re-engineering, as well as re-organisations due to mergers and acquisition, have forced managers

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to critically re-evaluate their organisational routines (Haspeslagh & Jemison, 1991). These changes have led to the development of new organisational forms such as 'network organisation' and the 'boundaryless' organisation (Ashkenas, Ulrich, Jick & Kerr, 1995; Quinn, 1992). The successful performance of employees in any organisation depends on effective leadership behaviour which can be defined as series of attitudes, characteristics and skills used by a manager in different situations in accordance with individual and organisational values (Mohammad & Hossein, 2006). In other words, it is a process of interaction between leaders and followers where the leader attempts to influence followers to achieve a common goal (Antonakis, Avolio & Sivasubramaniam, 2003).

Literature across samples & cultures also provided widespread support for positive association between group/shared leadership and higher performance for individuals, groups, intra organisational activities and organisations (Gupta et al., 2010; Hmieleski et al., 2012; Liu, Hu, Li, Wang & Lin, 2014; Ramthun & Matkin, 2014). Pearce and Conger (2003) argued that shared leadership is one of the best ways to encourage team based work which also supports employee empowerment. It positively influences objective team performance, self ratings of team effectiveness, manager and customer ratings of team effectiveness, functional teams and team based knowledge work (Bligh et al., 2006; Burke et al., 2006; Pearce et al., 2004; Pearce & Sims, 2002). Positive association of group ratings comprising open communication, supportiveness, training & experience with leadership has been empirically validated for group behaviour (Gladstein, 1984).

Leadership styles are in fact the pattern of behaviour, governance & supervision which a leader usually adopts in enhancing the performance of his employees. Participative leadership style is associated with increased feelings of empowerment, job satisfaction (Omar & Hussin, 2013) and employee performance (Benoliel & Somech, 2010; Belas, 2013). On the contrary, transactional leadership style characterises leadership in strong masculine qualities, as it include competitiveness, hierarchical authority, high control for the leader (Braun, Peus, Weisweiler & Frey, 2013, Haider & Riaz, 2010). It has been found that laissez faire leadership style significantly but negatively influences employee satisfaction and employee performance. In their study on leadership styles in education sector, Bateh & Heyliger (2014) showed that transformational and transactional leadership strongly influenced job satisfaction as compared to laissez faire style which had negative influence on job satisfaction. Researchers revealed positive relation between supervisors' communication competence and employee job satisfaction. Besides, warmth among employees, mutual trust, respect and rapport between employees' and superiors were found to be significant predictors of the job satisfaction (Belias & Koustelios, 2014). Teams with coordinated type of shared-leadership perception demonstrated significantly higher levels of team performance as compared to teams with distributed-fragmented leadership and teams with no leaders (McIntyre & Foti, 2013).

HYPOTHESES AND OBJECTIVES

The present study is based upon the following hypothesis and objectives:-

On the basis of literature review, the following hypothesis is framed:

'There exists significant mean difference in the perceptions of operating and top management employees about the dimensions of leadership'.

The objectives of the study are:

a. To investigate corporation-wise mean perception regarding type of leadership among employees.
b. To analyse socio-economic dimension wise employees' perception with regard to leadership.
c. To assess mean difference in the perception of operating and top management about the dimensions of leadership.

RESEARCH METHODOLOGY

The various aspects of research methods are discussed as under:

Instrument

For gathering the primary data, a questionnaire was framed after thorough review of extant literature and deliberations with experts. Various studies were considered for framing the questionnaire. The questionnaire comprised some items of demographics viz., gender, age marital status, qualification etc. and items measuring leadership behaviour were based on five point Likert scale ranging from 5 to 1, where 5 means strongly agree and 1 means strongly disagree. Questions relating to personal information and suggestions were kept open ended.

Data Collection

The designed questionnaire after pre testing and refinement was distributed among all the employees of four J&K Public Corporations i.e., J&K State Forest Corporation, J&K State Road Transport Corporation, J&K Cement Limited and J&K State Industrial Development Corporation. Four J&K Corporations with 242 employees and effective response from 175 employees were surveyed to elicit primary information. Of the total 175 respondents, 28 belonged to The Jammu & Kashmir Cement Limited (J&KCL), 32 The Jammu and Kashmir State Industrial Development Corporation (J&KSIDCO), 44 The Jammu and Kashmir State Road Transport Corporation (J&KSRTC) and 71 The Jammu and Kashmir State Forest Corporation (J&KSFC). Designation was divided into 5 levels namely board, top, upper, middle and lower level and the number of employee contacted were 1, 1, 11, 75, and 87 respectively. As far as qualification is concerned, majority of the respondents were matriculates (47%) followed by graduates (39%) and post graduates (12%). Out of 175 respondents, 2% of employees were below 25 years of age, 12% between 25-35 years, 32% between 35-45 years and 54% between 45-58 years of age. Male employees accounted for 70% of the respondents and 93% respondents were married. 20% employees have 1-2 numbers of dependents, 73% have 3-5 dependents and the remaining 7% have 5-10 numbers of dependents. Income – wise, 83 employees fall between Rs.4,000-Rs.10,000 per month, 35 employees between Rs.10,000-Rs.15,000, 29 employees between Rs.15,000-Rs.20,000 and the remaining 28 were having salary above Rs.20,000 per month. Majority of the contacted employees have above 15 years length of association with their respective Corporations.

Table 1: Demographic profile

S.No.	Variable	Description	Number	% age
1.	**Name of the department**	The J&K Cement Ltd.	28	16
		The J&K SIDCO	32	18
		The J&K SRTC	44	25
		The J&K State Forest Corporation	71	41
		Total	**175**	**100**

2.	**Designation**	Lower level	87	49
		Middle level	75	43
		Upper level	11	06
		Top level	01	01
		Board	01	01
		Total	**175**	**100**
3.	**Qualification**	Matric	83	47
		Graduate	69	39
		Post-graduate	20	12
		Others	03	02
		Total	**175**	**100**
4.	**Age**	Below 25 years	04	02
		25 – 35 years	21	12
		35 – 45 years	56	32
		45 – 58 years	94	54
		Total	**175**	**100**
5.	**Gender**	Male	122	70
		Female	53	30
		Total	**175**	**100**
6.	**Marital Status**	Married	163	93
		Un married	12	07
		Total	**175**	**100**
7.	**No. of dependents**	1 – 2	35	20
		3 – 5	128	73
		5 – 10	12	07
		Total	**175**	**100**
8.	**Income of Employee**	Rs. 4,000 – Rs. 10,000	83	47
		Rs. 10,000 – Rs. 15,000	35	20
		Rs. 15,000 – Rs. 20,000	29	17
		Above – Rs. 20,000	28	16
		Total	**175**	**100**

9.	**Length of association**	1 – 5 years	13	07
		5 – 10 years	21	12
		10 – 15 years	22	13
		Above – 15 years	119	68
		Total	**175**	**100**

RESULTS

Table 2 depicts Corporation-wise mean perception regarding type of leadership favoured by the employees. In J&K State Forest Corporation, employees prefer 'Effective leadership helps in transferring the norms, values, beliefs & assumptions of organisational members' with mean value 3.20 as compared to 'Leadership creates flexible mode of management that is open to new ideas' with mean value 2.79. In J&K State Road Transport Corporation, employees prefer 'Effective leadership provides sense of direction around which employees can learn & grow' with mean value 2.91. In J&K Cement Ltd., employees favour 'Effective leadership helps in transferring the norms, values, beliefs & assumptions of organisational members' and 'Dynamic leadership persistently & positively contributes to organisational growth' with mean value at 3.86. In J&K State Industrial Development Corporation, employees opines 'Effective leadership helps in transferring the norms, values, beliefs & assumptions of organisational members' with mean value 4.25. Overall, employees prefer transformational type of leadership i.e. 'Effective leadership helps in transferring the norms, values, beliefs & assumptions of organisational members' with mean value 3.55 and least favoured 'Leadership creates flexible mode of management that is open to new ideas' with mean value 3.09.

Table 3 shows mean level among employees with regard to 'Dynamic leadership persistently & positively contributes to organisational growth'. Unmarried employees, upper level employees, other than matric, graduates & postgraduates, male employees in the range of 45-58 years of age, earning above Rs.20,000 per month, having 1-2 number of dependents and 1-5 years of length of association prefer 'Dynamic leadership persistently & positively contributes to organisational growth' with mean values at 3.46, 4.27, 3.67, 3.26, 3.38, 4.00, 3.71and 3.46 respectively as compared to married employees, lower level employees, matriculates, female employees who are below 25 years of age, earning between Rs.4,000-Rs.10,000 per month, having 5-10 number of dependents and 5-10 & 10-15 years of length of association with mean values at 3.23, 3.03, 3.02, 3.23, 2.75, 2.87, 2.67 and 2.86 respectively.

Table 4 shows the output from independent t-test measuring significance of mean difference between operation level management & top level management with regard to nine dimensions of leadership namely ' Superiors support and encourage any request for training and learning', ' Team work is encouraged as a way of learning from others' , 'Effective leadership helps in transferring the norms, values, beliefs & assumptions of organisational members', 'Dynamic leadership persistently & positively contributes to organisational growth', 'Effective leadership inculcates the willingness to learn among employees', 'Effective leadership provides sense of direction around which employees can learn & grow', 'Leadership creates flexible mode of management that is open to new ideas', 'Effective leadership enhances collaboration & team work among department' and 'Leadership and learning fosters new thinking and new approaches'. For the test, lower & middle level employees are designated as operating level management whereas top level management included upper, top and board level management. As evident from the table, the results of t-test revealed that designation wise, there exists significance mean difference between operating and top management employees' perception about three dimensions of leadership, as value of $p<0.05$ level of significance. The three statements are 'Dynamic leadership persistently & positively contributes to organisational growth', 'Effective leadership inculcates the willingness to learn among employees' and 'Leadership creates flexible mode of management that is open to new ideas'. For the remaining, no mean difference exist between top and operating management with regard to six dimensions of leadership. Thus, the hypothesis ***'There exists significant mean difference in the perceptions of operating and top management employees about the dimensions of leadership'*** holds true on three dimensions and rejected on six dimensions.

DISCUSSION

Leadership refers to a process in which a person tries to influence a set of individuals in the pursuit of achieving individual, group and organisational objectives. Leadership is not confined to people who occupy top position in the organisations and can be displayed even by a person who has not been assigned a formal position in the organisation. It is needed at all the levels in an organisation and requires voluntary cooperation and team work by means of influence, persuasion and charisma. Leaders must facilitate the development of employees while telling their subordinates the expected standards for performance & advising them how to improve and overcome shortcomings in performance, or even better, how to improve performance when employees are currently meeting or even exceeding standards. Further, participative leadership should be encouraged that increases the participants' understanding of each other which results in greater tolerance and patience towards others. Leaders should strive for management-employee-cohesiveness and build trust & have faith in each employee's self- management ability, reward and successes. Leaders should set challenging goals for subordinates and displays confidence in their ability to meet the standards of excellence. They must show consideration for the employees' needs & their welfare, focusing and developing satisfactory interpersonal relations among group members.

Understanding and managing people's behaviour in J&K Public Corporations is quite challenging jobs for managers because of complexities involved in the process, unstable economic environment, consistent dismay performance, undue political interference in functioning and neglect of organisational factors such as organisational structure, work systems, organisation culture & behaviour etc. A revival plan based on open & transparent objective discussions, institution of grievance handling machinery, linking salaries & incentives with capacity & work load, participatory leadership, capacity building workshops for supervisors and periodic changes in job designs for reducing monotony at work place that would articulate and systematise the operational core of human behaviour at work.

LIMITATIONS AND FUTURE RESEARCH

Despite efforts to maintain objectivity, reliability and validity of the study, certain limitations be considered while generalising findings of the study. The scope of the study is limited to four J&K Public Corporations functioning in Jammu district. Though census method was used in data collection but the effective response rate was 72.31%. Data from J&K State Road Transport Corporation were collected when its functioning was disrupted due to strikes. Future researchers can consider comparison between public and private sector employees. Besides, the role of mediators and moderators in leadership- performance relationship can also be checked in future studies.

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Table 2: sCorporation-wise mean Perception Regarding Type of Leadership Favoured by the Employees

Statements	**Corporations**				
	JK State Forest Corp.	**JK State Road Transport Corp.**	**JK Cement Ltd.**	**JK Small Industrial Develo-pment Corp.**	**Mean**
Effective leadership helps in transferring the norms, values, beliefs & assump-tions of organisational members	3.20	2.89	3.86	4.25	**3.55**
Dynamic leadership pers-istently & positively cont-ributes to organisational growth	3.01	2.66	3.86	4.06	**3.40**
Effective leadership inculc-ates the willingness to learn among employees	2.45	3.25	4.13	**3.21**	3.01
Effective leadership provi-des sense of direction around which employees can learn & grow	2.90	2.91	3.50	4.00	**3.33**
Leadership creates flexible mode of management that is open to new ideas	2.79	2.39	3.18	4.00	**3.09**
Effective leadership enha-nces collaboration & team work among department	3.07	2.48	3.43	3.94	**3.23**
Mean	3.00	2.63	3.51	4.06	3.30

Table 3: Mean Level Among Employees with Regard to Style of Leadership

S.No.	Variable	Description	Mean
1.	Gender	Male	3.26
		Female	3.23
		Sub-total	**3.25**
2.	Designation	Lower	3.03
		Middle	3.33
		Upper	4.27
		Top	4.00
		Board	4.00
		Sub-total	**3.73**
3.	Qualification	Matric	3.02
		Graduation	3.41
		Post-graduation	3.55
		Others	3.67
		Sub-total	**3.41**
4.	Age	Below 25 yrs	2.75
		25-35 yrs	3.14
		35-45 yrs	3.11
		45-58 yrs	3.38
		Sub-total	**3.10**
5.	Marital status	Married	3.23
		Unmarried	3.46
		Sub-total	**3.35**
6.	Income	Rs.4000-10,000	2.87
		Rs.10,000-15,000	3.35
		Rs.15,000-20,000	3.50
		Above Rs.20,000	4.00
		Sub-total	**3.43**
7.	Length of association	1-5 yrs	3.46

		5-10 yrs	2.86
		10-15 yrs	2.86
		Above 15 yrs	3.35
		Sub-total	**3.13**
8.	Number of dependents	1-2	3.71
		3-5	3.18
		5-10	2.67
		Sub-total	**3.19**

Table 4: Mean Perception Between top and Operating Level Employees with Regard to Dimensions of Leadership Using Independent T-test

S.No.	Dimensions of Leadership	Designation of Employees	Mean Level	t- test	Significance Result	(2 – tailed)
1.	Team work is encouraged as a way oflearning from others	Operating Level Top Level	2.87653.3846	-1.252	0.212	Insignificant
2.	Superiors support and encourage anyrequest for training and learning	Operating Level Top Level	2.74693.3077	-1.499	0.136	Insignificant
3.	Effective leadership helps in transferring the norms, values, beliefs & assumptions of organisational members	Operating Level Top Level	3.37044.0000	-1.840	0.067	Insignificant
4.	Dynamic leadership persistently & positively contributes to organisational growth	Operating Level Top Level	3.17284.2308	-3.106	0.002	Significant
5.	Effective leadership inculcates the willingness to learn among employees	Operating Level Top Level	3.03704.0769	-2.832	0.005	Significant
6.	Effective leadership provides sense of direction around which employees can learn & grow	Operating Level Top Level	3.12964.0769	-1.751	0.082	Insignificant
7.	Leadership creates flexible mode of management that is open to new ideas	Operating Level Top Level	2.91363.6923	-2.026	0.044	Significant
8.	Effective leadership enhances collaboration & team work among department	Operating Level Top Level	3.07413.9231	-2.267	0.25	Insignificant
9.	Leadership and learning fosters new thinking & new approaches	Operating Level Top Level	3.01234.0000	-2.535	0.12	Insignificant

Level of significance at 95 %

10

Effectiveness of Government's Non – Financial Support Measures for SMEs Development

Rahul Gupta*

ABSTRACT

Small and Medium Enterprises (SMEs) constitute the essential ingredients in the lubrication and development of any economy because of the important role they play in employment generation, reducing regional imbalances and development of other sectors. Recognising the importance and fragility of SMEs, Government authorities throughout the world have been providing numerous assistance measures as a part of their industrial policies. These support measures includfinancial assistance like subsidies and tax incentives and other non-financial support measures like export promotion programs, skill development programs, business advisory services etc. The purpose of the study is to evaluate the effectiveness of non-financial support measures provided by different Governments to SMEs on the basis of review of literature available in this context. On the basis of literature reviewed, the study finds that the non-financial support measures are generally ineffective for the development of SMEs. The support measures provided by most of the Governments focus on large scale enterprises and not on small and medium businesses and several deficiencies exist in the provision of these support measures to SMEs like complex procedures to avail the assistance, large number of formalities to be completed, lack of

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coordination between agencies providing the support, poor implementation of support policies, inefficient communication of support available to SMEs etc.
Keywords: *SMEs, Government assistance, Non-financial support measures, development.*

INTRODUCTION

Over the last two decades, the number of small and medium enterprises (SMEs) has increased significantly and more people and organisations depend on these manufacturers to produce the needed products. World over thousands of SMEs are set up annually. All the policymakers and organisations are well aware of the importance of their role, survival and effective performance in economic development (Hodgetts & Kuratko, 2001, cited in Nazemi & Shirazi, 2010). Generally SMEs are vulnerable and very few manage to survive more than five years. Government authorities throughout the world, recognising both the importance and the fragility of SMEs, have created agencies and set up numerous development support and assistance measures (Giacomo, 2004; Secrieru & Vigneault, 2004; Mason & Harrison, 2004; Klonowski, 2010). Entrepreneurship and industrial support measures provided by various governments and their agencies can be classified into financial assistance and other non-financial support measures. Subsidies and tax incentives are the two important financial measures found in most of the Government industrial support policies. The non-financial support measures being provided to SMEs to boost their performance and industrial activity include export promotion programs, skill development programs, business advisory services, easy and preferential procurement of raw materials, marketing assistance programs etc. Economic literature suggests that there are two rationales for a government to support SMEs. First is the generation of positive externalities. Government support measures to SMEs can have positive spillovers so that other firms or society would benefit (Griliches, 1992). A second rationale is derived from the fact that government support provide information on SMEs to financial institutions and potential investors and help to fill the gap between SMEs and potential investors (Myers & Majluf, 1984; Greenwald, Stiglitz & Weiss, 1984). So, the objective of the present study is to evaluate the effectiveness of non-financial support measures provided by different Governments to SMEs for their development, by the review of literature available in this context.

The rest of the paper is structured as follows. Section 1 highlights the definitions of SMEs used in various countries. Section 2 discusses the importance of SMEs. Section 3 relates to the review of studies evaluating the effectiveness of Government's non – financial support measures for SMEs development. In the end, section 4 provides the conclusion.

DEFINITION OF SMALL AND MEDIUM ENTERPRISES (SMEs)

Different abbreviations and terminologies are used by different organisations and countries for indicating small and medium scale enterprises. For instance, the term small and medium scale enterprises with abbreviation SMEs is used commonly in the European Union, the United States of America, Germany and Belgium whereas in South Africa, the term small, medium and micro enterprises with abbreviation SMMEs is usually used (Emmanuel & Daniya, 2012). Also, different countries use different criteria to define/classify SMEs. For instance, in European Union, Germany, Belgium and the United States of America, SMEs are defined/classified on the basis of number of employees employed by the enterprises whereas in Malaysia, annual sales turnover and number of full time employees criteria is used to define SMEs (Emmanuel & Daniya, 2012; Hung et al., 2011). Further in most of the countries only manufacturing industries are associated with SMEs.

In India, with the enactment of Micro, Small and Medium Enterprises Development Act (MSMED Act) in October 2006, the standard term micro, small and medium Enterprises with abbreviation MSMEs is used. The criteria for enterprises to be classified as micro, small or medium enterprises as per MSMED Act, 2006 is given in the table below:

Table 1: Investment ceiling for classification of MSMEs as per MSMED Act, 2006*

	Investment Ceiling for Plant and Machinery or Equipments	
Classification	**Manufacturing Enterprises**	**Service Enterprises**
Micro	Upto Rs. 25 lakh	Upto Rs. 10 lakh
Small	Above Rs. 25 lakh upto Rs. 5 crore	Above Rs.10 lakh upto Rs. 2 crore
Medium	Above Rs. 5 crore upto Rs. 10 crore	Above Rs. 2 crore upto Rs. 5crore

Source : Ministry of Micro, Small and Medium Enterprises, Government of India. (2008-09). ***Micro, small and medium enterprises in India; An overview.*** **Retrieved fromhttp://dcmsme.gov.in/ssiindia/MSME_OVERVIEW09.pdf**

IMPORTANCE OF SMEs

Small and medium enterprises (SMEs) constitute the essential ingredients in the lubrication and development of any economy (Emmanuel & Daniya, 2012). The strategic importance of SMEs in national economic development is widely recognised by many countries, developed and developing countries alike (Abdullah, 1999). SMEs play a key role in shaping economies throughout the world. They are a source of growth and innovation in the country and provide jobs to its citizens. SMEs are believed to offset economic decline and help restructure the existing industries. A healthy SME sector is critical to the economy and imperative for economic growth as it creates six out of every ten new jobs, beside spearheading an industrial transformation from traditional industries to the high technology sector (Audretsch, 2001; Freel, 2003; Dibrell, Davis & Craig, 2008), being at the forefront of developing innovations with a clear competitive advantage (Audretsch, 2001; Low & Chapman, 2007), and making significant inroads in developing global markets (Lituchy & Rail, 2000; Karagianni & Labriandis, 2001; Acedo & Florin, 2006; Salvato, Lassini & Wiklund, 2007). SMEs add value to every country as they generate foreign currencies through export, and have potential to grow into larger enterprises. These enterprises are also important as domestic producers of cheap import substitution consumer goods especially for low-income groups, and as supporting industries producing components, tools and spare parts for larger enterprises. Further being less reliant on formal markets and formal credit, SMEs are able to respond more quickly and flexibly to sudden shocks and their development is considered as a tool for economic survival during the crisis periods of the developed and developing countries (Tambunan, 1992; Goh & Chew, 1996; Berry, Rodriguez & Sandee, 2001).

EFFECTIVENESS OF GOVERNMENT'S NON-FINANCIAL ASSISTANCE MEASURES FOR SMES

Development

A number of studies have tried to evaluate the effect of Government's different non-financial supports on SMEs performance and development. For instance, Doctors and Wokrutch (1983) examined the State Government economic programs designed to encourage small business development in an area designated as Region III by U.S Small Business Administration (Dalaware, Maryland, Pennysylvania, Virginia, West Virginia and the District of Columbia). The researchers found that most States and local economic development programs were focused towards large businesses and are not effective for small business development. Also, the new development programs in Region III had only tentative financial and political support. Crick (1997) investigated whether differences exist between managers of U.K Small and Medium Sized Enterprises in various stages of internationalisation in relation to their awareness and frequency of use of the programs, together with their perceptions about the timeliness, reliability and availability of the export assistance schemes. The study reported that differences existed between the firms in different stages of internationalization in relation to their behaviour and perceptions towards Government export assistance. Similarly, another study on quality of export incentives was conducted by Tesfom and Lutz (2008), who assessed the effectiveness of export promotion and support services on the basis of perceptions of manufacturers in a small new African country, Eritrea. The researchers found that the quality of export support services was low and also that small enterprises in Eritrea have less access to export support services than larger firms. In a study done by Abdullah (1999), he ascertained the accessibility of support programs provided by Government agencies and institutions to small and medium enterprises in Penang (Malaysia). The results revealed that a large proportion of small and medium enterprises did not gain access to the support programs and out of the small and medium enterprises which gained Government support, only a few had more than two types of available assistance while the others had only one or two types of support. Also, Shamsuddoha, Ali and Ndubisi (2009) examined the effects of Government export assistance programs on internationalisation of small and medium enterprises from Bangladesh. The researchers found that the usage of market development related Government assistance influenced internationalization significantly, both directly and indirectly, whereas finance and guarantee related export assistance had only direct effect on internationalisation of small and medium enterprises.

Cooke and Wills (1999) in their study assessed the Government programs to promote collaboration amongst small and medium enterprises for improving the innovation capacity by increasing social capital through networking. The study found that policies in support of enhanced innovation that aim and succeed to build up social capital for small and medium enterprises through networking and collaboration improved the business performance of small and medium enterprises and their innovation and knowledge exploitation to the newly formed social capital. Similarly, North, Smallbon and Vickers (2001) assessed the appropriateness of the public and quasi public policy instruments to support innovative activity in small and medium enterprises in London Lee Valley region. The results reveal that the overall impact of public policy measures on the innovative capabilities of small and medium enterprises was partial and selective as very less firms were assisted by these support initiatives and the awareness of the support available among the small and medium enterprises was very low. The study suggested to adopt a more strategic, integrated and coordinated approach to provide innovation support to strengthen the innovative capabilities of the small and medium enterprises. Further, Wren and Storey (2002) assessed the impact of publically provided subsidised soft business support (assistance for consultancy advice towards marketing) under the U.K Enterprise Initiative on the performance of small and medium sized enterprises. The study concluded that the soft business support had no impact on the survival of micro sized small and medium Enterprises but it was most effective for the mid-range small and medium enterprises. Also, Tambunan (2005) reviewed Government policies on small and medium enterprises development with a clustering approach in Indonesia for identifying the extent of contribution of these policies to the dynamics of small and medium enterprises' clusters in the country. The study found that in many cases the small and medium enterprises' cluster development policies had not been successful and the main reasons of failures were the neglect of cluster linkages to markets and limited support from Local Government and private organisations. Lee (2006) also evaluated Government's various policy instruments to promote occupational skills development for small and medium enterprises in Korea over a long period of its economic development history including the experience of the pilot small and medium enterprises training consortium project and assessed the possibility of replicating that project in other developing countries. The study concluded that various policy instruments to make small and medium enterprises active in developing their workers' capability before the pilot project did not work well . However, the pilot project reviewed by the researcher demonstrated that when small and medium enterprises were given institutional/technical assistance in addition to financial incentives, small and medium enterprises willingly made investment in their workers which in turn increased the productivity of the workers.

Hansen, Rand and Tarp (2009) in their analysed the influence of direct Government assistance during start up and other forms of interactions with State institutions on long run performance of small and medium enterprises in manufacturing sector in Vietnam. The study found that Government support during start up had no significant impact on enterprise survival but has a positive impact on long term revenue growth rate. Further, Oh et al. (2009) evaluated the effect of credit guarantee policy of Korean Government on the growth rates of different performance indicators of small and medium enterprises in the post crisis period. The study revealed a significant impact of credit guarantees on firms' ability to maintain their size and increase their survival rate but an insignificant impact on firms' ability to increase their research and development and investment and their growth in productivity. Antonites and Truter (2010) in their study identified the issues in the procurement processes that hamper small, medium and micro enterprises when supplying to Local Government and also assessed whether Government and more specifically Local Government create an enabling environment that supports the development and growth of small, medium and micro enterprises in South Africa. The study revealed that several deficiencies exist in the procurement process within the context of small, medium and micro enterprises like difficulty in complying with requirements of Local Government in different aspects such as completing tender documents and having the necessary paperwork in order, long payment cycles of municipalities, lack of consistency in procurement processes, inefficient communication of support available to small, medium and micro enterprises etc. The study also found that the environment created by Government was inconsistent and complicated making it difficult for small, medium and micro enterprises to supply to Government. Further, Klonowski (2010) provided a comprehensive evaluation of the Government assistance programs to small and medium enterprises and assessed the effectiveness of these programs in stimulating development of small and medium enterprises sector in Poland. The study reported that the Polish Government support programs were poorly structured, fragmented and untargeted and also that those programs did not meet the actual needs of the small and medium enterprises sector and hence were poorly used. Another study by Nazemi and Shirazi (2010) identified the key strategies and methods adopted to support manufacturing firms and to assess the effectiveness of Government support policies in Iran. The results reported clear difference between small manufacturing firms' expected supports and what was delivered by the Government. Yusoff and Yacoob (2010) in their study explored the evolution of Government business support services in Malaysia starting from prior Independence period to the New Economic Policy era and in the contemporary period. The study found that the Government business support services did not offer wide range of services to support business development before New Economic Policy and the effective role of Government unearthed during the New Economic Policy period with a number of new agencies established to strengthen the entrepreneurial activities. The study also reported that the utilization rate of Government business support services in Malaysia is low. Similarly, Yusoff, Yaacob and Ibrahim (2010) investigated the awareness of the business advisory services provided by various Government agencies among micro sized Small and Medium Enterprises and examined the relationship between the awareness and the demographic factors of micro sized small and medium enterprises in Kelantan, Malaysia.. The study found that there was a low level of awareness and assurance of the existence of business advisory services and there was no significant relationship between demographic factors of business and the awareness of business advisory services among the micro sized small and medium enterprises.

Ali, Paguio and Breen (2011) examined the role played by Local Governments in facilitating and supporting the home based businesses (HBBs) in the State of Victoria, Australia. The researchers found that the observed council initiatives cater only to the requirements of first three stages of business cycle i.e. inception, survival and growth with minimal initiatives for the growth stage and it also pointed out the lack of strategic consideration in the design and provision of home based business assistance. Further, Hung et al. (2011) conducted a quantitative study to examine the real contributing factors towards excellence performance among top small and medium enterprises in Malaysia and to review the effectiveness of Government support program. Government support was not perceived as an important critical factor contributing to success of small and medium enterprises. Lee, Sohn and Ju (2011) also investigated the effect of Government's role in boosting the economic activities among Korean women entrepreneurs. The study found that Government support process has the highest effect and government support policy has the least effect on the satisfaction and performance of women entrepreneurs. Similarly, Emmanuel and Daniya (2012) identified the role of Government and other financial institutions in the development of small and medium scale enterprises by examining several policies aimed at developing small and medium scale enterprises in Nigeria. The results of the study revealed that several policies aimed at small and medium scale enterprises' development failed to stand the test of time due to poor implementation, erratic financing of schemes initiated by Government and other administrative bottlenecks which made it difficult for existing and prospective small and medium scale enterprises to have easy access to funds set aside for their development.

CONCLUSION

SMEs play a very important role in employment generation, reducing regional imbalances and development of other sectors and inturn in the development of the country. Government authorities throughout the world have been providing numerous assistance measures to SMEs as a part of their industrial policies for their development, to improve their performance and to boost industrial activity. These support measures can be classified into financial assistance like subsidies and tax incentives and other non-financial support measures like export promotion programs, skill development programs, business advisory services etc. The present study tries to summarise the literature available to the best of knowledge in order to assess the effectiveness of non-financial support measures provided by different Governments to SMEs. On the basis of literature reviewed, the study finds that the non-financial support measures proved ineffective for the development and growth of SMEs. The support measures provided by most of the Governments focus on large scale enterprises and not on small and medium businesses. The study also find that several deficiencies exist in the provision of thse support measures to SMEs like complex procedures to avail the assistance, large number of formalities to be completed, lack of coordination between agencies providing the support, poor implementation of support policies, inefficient communication of support available to SMEs etc. So, the support measures should be reoriented to focus more directly on assisting small and medium businesses and should be provided readily and cheaply to SMEs. Further, the procedures for availing these assistance measures should be eased out, the formalities and documentation should be reduced. Also, seminars and awareness programs should be conducted by the Government authorities and various industrial associations to provide awareness to the SMEs about the various support measures available to them and about the procedures of availing those assistance measures.

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11

Green Consumerism: Unwinding Consumer Behavior Towards Eco-Friendly Products

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ABSTRACT

The effective and efficient use of environment or eco-friendly resources and prevention of the same for future has witnessed to the concept of green consumerism. Green Consumerism is the practice in which consumers buy those products which have been produced in such a manner that natural environment is less harmed or there is negligible damage to the natural resources. In order to be competitive and for long run sustainability, nowadays, the organizations are focusing more towards green manufacturing, green packaging, green advertising, recycling or energy saving products. Moreover, the Consumer has potential to purchase environmental friendly products against the conventional products available. Thus, it has been seen that the consumer behavior towards buying eco-friendly products have been drastically increasing. This change in purchasing behavior rise curiosity to conduct the present study. The given paper is an attempt to study the concept of green consumerism and green products. The study also highlights theoretically the consumer buying behavior towards eco-friendly products.

Keywords: *Green Consumerism, Consumer behavior, Eco-friendly.*

INTRODUCTION

Continuous increase in the garbage and effluent from the factories has increased the pollution many folds. This pollution affects the

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environment and depletes natural resources radically. So far, it has been a concern of the present day. The recent extensive smog in the capital state we witnessed across as a result of burning crop residual is another example of pollution. It doesn't affect only the human health but natural flora and fauna to a great extent. Thus, every day environment is getting depleting and affecting natural resources as well. The food which we eat, water we drink and air in which we breathe, all are contaminated. As a result, it directly or indirectly affects our health. Thus, there has been concern and change in the mind setup to reduce these effects. Using renewable and eco-friendly products is the first step towards this concern. In addition, focus should be on the products manufactured from the readily available and non- renewable resources.

The effective and efficient use of environment or eco-friendly resources and prevention of the same for future has witnessed to the concept of green consumerism. Green Consumerism is the practice in which consumers buy those products which have been produced in such a manner that natural environment is less harmed or there is negligible damage to the natural resources. Moreover, the Consumer has potential to purchase environmental friendly products against the conventional products available. Thus, it has been seen that the consumer behavior towards buying eco-friendly products have been drastically increasing. This change in purchasing behavior rise curiosity to conduct the present study. In order to be competitive and for long run sustainability, nowadays, the business organizations are focusing more towards the concepts of going green, being green, green manufacturing, green packaging, green advertising, green fashion, recycling or energy saving products etc. Before moving ahead let us understand certain important terms.

Going Green/ Being Green: Green is an environmental term which is defined as products or services that have a reduced mal-effect on health and the environment when compared with competing products that provide the same functionality.

Eco or environmental friendly products: The word eco-friendly means products that do not harm the globe and its environment. These products are also known as sustainable products. They provide benefits for the people economically, socially, environmentally, while preserving the flora **and fauna.** These products are environmentally safe from its extraction of raw materials to production, utilization and final disposal. (online Blog, accessed on 20 Nov 2017).

Thus, environmental friendly products are those that best meet the aims of environmental responsible management (i.e., using resources efficiently and minimizing chemical contamination).

Green manufacturing: the term can be looked at in two ways- the manufacturing of green products, particularly those used in renewable energy systems and clean technology equipments of all kinds, and the greening of manufacturing- reducing pollution and waste by minimizing natural resource use, recycling and re using what has been considered waste and reducing emissions (Andrew, 2012).

Green packaging: refers to any change made by a product manufacturer or service provider to lessen the environmental impact of the materials or processes involved in packaging the products and services while their deployment to the end-user. Typical examples are green dot on many packages of the products. Also, eco-friendly packaging materials are less toxic; reduce environmental damage and decrease pollution levels as well as having a lower carbon footprint.

Green advertising: is a specific type of advertising that is centered around the promotion of factors having to do with the environment. Here, the focus is to promote the product around the premises of environment or environmental situations.

Recycling or energy saving products: is the process of converting waste materials into new materials and objects. Recycling saves energy by reducing or eliminating the need to make materials from scratch.

Green washing: The practice of making an unsubstantial or misleading claim about the environmental benefits of a product service or technology.

Green marketing: Environmental claims can be a powerful marketing tool. Companies are increasingly using environmental claims in an attempt to differentiate themselves and their products from the competition. These claims come in a wide range of forms, including statements about environmental sustainability, recycling, energy and water efficiency or impact on animals and the natural environment. According to Pride & Ferrell (1993), Green marketing also alternatively known as environmental marketing and sustainable marketing refers to an organization’s efforts at designing, promoting, pricing and distributing products that will not harm environment.

Green Consumerism: According to Moisander (2007), Green consumption is related to environmentally responsible consumption where consumers consider the environmental impact of purchasing, using, and disposing of various products, or using various green services. In other words green consumerism is the practice in which consumers buy those products which have been produced in such a manner that natural environment is less harmed or there is negligible damage to the natural resources.

Green consumerism is the regular practice of consumption of only environmentally friendly products that do not cause any damage to human health and do not threaten the functions and working of any natural ecosystem. Studies show that it is the most cost-effective approach for implementing cleaner production efforts (online, accessed on 20 Nov 2017).

REVIEW OF LITERATURE

Green consumerism is not all about delivering environmental benefits rather it is more of moral satisfaction for the alternative which is inadequate in nature (Cohen and Murphy, 2001). The production of each and every product have their environmental impact, however it may be meager. Thus, the effort is to further minimize it. The ever shrinking of natural resources, raw material and increasing pollution lead business organizations to work on the products and services which are environmental safe. Thus, the eco-friendly products are being introduced by modern organizations in order to reduce their affect on environment.

Also, environmentally or eco-friendly products are good for human health and nature as well. It has been observed that consumers act more altruistically after mere exposure to green products than after mere exposure to conventional products (Sehgal and Singh, 2010). Thus, many products like shopping jute bags, energy saving bulbs, rechargeable batteries, organic food, herbal products, stainless steel, eco-friendly paper, paper shredders and many more are in use nowadays. Use of eco-friendly paper i.e. paper which is manufactured from used paper undeniably reduces the harm to environment compared to manufacturing of traditional paper. Also, it has been seen that the consumers with positive attitude about eco-friendly paper have strong purchase intention towards the product (Kumar and Anand, 2013).

In order to protect the environment, consumers as well as many business organizations are paying more attention to eco-friendly products and services over conventional products. Thus, organizations are looking towards gaining competitive edge in the green market industry by trying to re-design and re-packaging their products into more environmental friendly products (Geetha and Jenifer, 2014). Green consumerism is a form of consumption that is well-suited with the preservation of the environment for the present and for the next generation flora and fauns. It deals with the consumer's responsibility for addressing environmental problems through adoption of environmentally friendly behaviors, such as the use of organic products, clean and renewable energy and the research of goods produced by companies with zero, or negligible impact (Connoly and Prothero, 2008).

One of the studies by Bertoli, et.al. (2014), categorized consumers into two types. Firstly, the prevention-type consumers that feel a moral duty towards an eco-friendly standard of living and other the promotion-type that are more focused on their aspirations and their thoughts and don't strongly experience the pressure to quickly respond to more friendly environmental. In addition to this, based on gender opinion, green consumerism has been also divided into two categories. Firstly, self-transcendent values like woman who are more willing to engage in sustainable consumption and secondly self-enhanced values like men who are less interested in green behavior (Pinto, 2014).

In an another study, it has been revealed that an individual's environmental concern and knowledge and the product's functional and green attributes are major drivers whereas high price and inconvenience in purchasing the product are major barrier towards consumer green purchase behavior (Joshi and Rahman, 2015). The emerging depiction of green consumerism is of a practice that is strongly influenced by consumer values, norms, and habits, yet is highly complex, diverse, and context dependent (Peattie, 2010). Further, it has been seen that green consumer behavior is not only affected by attitude, but also by various other personal and situational factors. Thus, these factors can either strengthen or weaken the strength of attitude-behavior relationship (Joshi and Rahman, 2015).

Promotion of green products directly or indirectly plays important role in buying behavior. Various studies revealed that promoting environmental friendly methods can set the business organizations distant from their competitors and attract new consumers who want to buy products and services from an environmentally friendly business. Also, promotion of these green products attempts to influence green consumer behavior and stimulate green product purchase (Sehgal and Singh, 2010). Thus, reducing the environmental impact of business will definitely improve the sustainability of business. If the organizations are less dependent on natural resources than their competitors and have ways to deal with rising costs due to climate change, obviously those business organizations will have a superior chances of long-term success and sustainability as well.

IMPORTANCE OF GREEN CONSUMERISM

With the increase in the awareness regarding the products which are environment friendly and have low environmental impact, green consumerism gained its importance many folds. In order to implement pollution management strategies, the concept of green products and their production played very crucial role. Since, the primary responsibility of any organization is to maintain environment balance; severe steps should be taken by business organizations to control the pollutants as well as the wastes. In addition to it, for developing greener consumerism, cooperation should be required from consumers, communities and civil society. Despite of various initiatives and control strategies by business organizations, the government support is also required. Thus, major barrier to green consumerism can be largely overcome by their constant support.

CONCLUSION

From the extensive literature review it has been seen that with the increase in awareness regarding constant damage to environment, the consumers have been continuously asking for eco-friendly products. Thus, there has been a clear raise in demand for such products. Business organizations are using the eco-friendly or green processes right from cradle to death. It has been witnessed also that the green products have increased competition among businesses houses to generate more environmental friendly products. In addition to it, green packaging lessens the environmental impact as the materials or processes involved in packaging the products and services are eco-friendly. Recycling or energy saving products are in great demand as less energy is required in converting waste materials into new materials and objects. Recycling saves energy by reducing or eliminating the need to make materials from scratch. Above all government has also taken keen interest and provides several measures that have supported and facilitated such initiatives by business organization.

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12

Policies & Schemes of Medicinal Plants Farming: An Innovative Effort Towards Livelihood Security in Indian Himalayan Region

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ABSTRACT

Medicinal Plants are globally valuable source of herbal products. Indian Himalayan Region is gifted with a rich prosperity of medicinal plants and is also known as mega hotspot of biological diversity and is one among the 10th most forested areas in the world. The demand of raw material was increases constantly, and the supply rate was very less. Raw material used in pharmaceutical industries of which 90 % came from wild sources. The hill tribal's and other communities living in Himalayan region depend on wild resources for their livelihood. Due to over-exploitation, the populations of various species of medicinal plants are disappearing at an alarming rate from the wild. To fulfill the demand and supply rate of raw material and to uplift the economic status of Himalayan communities, the Government of India initiates the various schemes and policies for the promotion of livelihood options by strengthening of medicinal plants cultivation sector. In this context, Ministry of AYUSH and National Medicinal Plant Board was created for the implementation of missions and schemes. The ministry of AYUSH along with National Medicinal Plant Board launched various missions such as national mission on medicinal plants, national mission on Amla and Aroma

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mission, etc. In present study, we had attempted to be aware about the species which is banned for exploitation from the wild, prioritized and subsidized species which are recommended for cultivation and their trade, etc. and from this study, we concluded that about 29 species of medicinal plants were banned for export from wild. About 35 species of high altitude medicinal plants were prioritized for 30, 50 and 75 % subsidy to farmers. In this study, we also enquire about the market price of variety of species.

INTRODUCTION

Medicinal and Aromatic Plants (MAPs) gaining wide popularity globally due to its widespread importance as a source of raw material for pharmaceutical industries and traditional health care system (Dubey et al. 2004). About 70-80% of people worldwide primarily rely on traditional medicines derived from plants to meet their health needs (Farnsworth and Soejarto 1991; Pie 2001). Due to better cultural acceptability, compatibility with the human health and lesser side effects, the demand of herbal medicines for the treatment of various ailments steadily increases day by day. It is estimated that about 85% of herbal medicines used to curing of different ailments derived from MAPs and to ensure the livelihood of millions of people directly or indirectly. Considering the importance of MAPs in global economy, WHO has estimated the present demand of MAPs and concludes that approximately US $ 14 billion per year and it is likely to be increased more than US $ 5 trillion in 2050.

Indian Himalayan Region (IHR) is a mega hotspot of biological diversity and is one among the 10th most forested areas in the world (Myers 2000). It is estimated that annual turnover of herbal medicines from India is 1, 77,000 Metric tonne for which 960 species of plants are in active trade with various traditional and modern therapeutic uses (Samant et al. 1998). Estimates indicate that at least 90% of medicinal plant species are extracted from the wild (Anonymous 1997); and that 69% of the material is collected through destructive harvesting, which suggests that medicinal plants are drastically threatened from wild (Dhar et al. 2000). Excessive anthropogenic pressures have been identified as the major causes of decline in the population and accessibility of the medicinal plants in the Himalayan region**.** With increasing demand and renewed global interest in traditional ethnopharmacy, coupled with the increasing preference for natural substances in the healthcare system, the natural stock of medicinal plants of Indian Himalayan Region is under pressure. The harvesting of MAPs constitutes an integral part of local livelihoods, contributing from 3 to 44% (average

12%) of annual household income (Olsen & Larsen, 2003). In high altitude areas, income generation activities are limited due to weak infrastructure and limited agricultural land, which has serious consequences upon the living standard of the local inhabitants. Apart from massive value to human health worldwide, Himalayan MAPs have the power to act as an engine of growth for the rural economies and catalyze livelihoods for the poor inhabitants. Despite the rich heritage of the Himalayas, the people of the region face a 'vertical gradient of poverty' that puts 30-40% of them below the poverty line, with an average of 47% of underemployment as well. Although the wealth of medicinal plants found in Himalayas, they benefit only marginally from the trade of medicinal plants harvested from the region, in the form of collector's wages. If high-value herbs to be cultivated by small & marginal farmers in their lands, they would as cash crops serve to lift many of the Himalayan poor out of the clutch of poverty. Most Himalayan Medicinal plant species are high-value species and fetch a premium price in the market. Such type of practices make farmers self-confident and self-dependent for boosting their socioeconomic status. Government of India in coordination with state governments taken the initiatives and framed some mission and schemes to boost the economic status of farmers through Medicinal plants cultivation. Especially the ministry of AYUSH was created by government of India (2002) for strengthening the herbal and Ayurvedic sector. Presently, Ministry of AYUSH and Ministry of Environment and Forest (MoEF) along with other coordinating agencies like National Medicinal Plants Board (NMPB) and State Medicinal Plant Boards (SMPBs) are working jointly for improving the medicinal plants conservation and cultivation sector.

AIM OF THE STUDY

The aim of present study is to examine the policies and schemes, launched for the promotion of medicinal plants cultivation sector and for uplifting the livelihood security of communities living in high altitude regions of Himalayan states.

OBJECTIVES

The study was aimed with the following objectives:

- To examine the familiar medicinal plants banned for harvesting from the wild.
- To analyze the Mission and Schemes of government framed for the endorsement of medicinal plants cultivation sector.
- To examine the efforts done by government for the exploration of raw material market of valuable species.

METHODOLOGY

The present study was fully based on secondary sources, and the data was collected from various sources such as published research articles, review papers, Magazines and online newspapers, etc. The official website of National Medicinal Plant Board (NMPB) was also consulted and the relevant information has been recorded.

Familiar Medicinal Plants Species Banned for Export from Wild:

About 90% of the medicinal plants used by the Indian Pharmaceutical Industries today are collected from the wild sources. In Indian Himalayan Region less than 20 species of plants are under commercial cultivation, and many of these have their uses for other purposes like perfumery/condiments/spices, etc. The bigger supply of the raw material is procured by pharmaceutical industries from the drug dealers in the markets of big cities and many small cities of the country. These drug dealers of the cities in-turn procure them from the so-called unknown sources. 90% of raw material ultimately came from natural sources of various parts of the Himalayan region collected by unskilled forest-dwelling communities and purchased at a nominal cost. Several medicinal plants species have now been assessed as endangered, vulnerable and threatened due to over-harvesting. It is reported that for 1 kg dry weight of *Picrorhiza kurroa 300-400* plants were uprooted from the wild (Uniyal et al. 2011) and have led to reduction in population of some of the high demand medicinal plants. The Government of India has put 29 high altitude medicinal plants species, threatened in the wild, in the negative list of export as shown below table 1.

Table.1: Important Medicinal Plant species banned for export from wild

Medicinal Plants Banned for Export from wild		
	Botanical Names	**Common Names**
1.	*Cycas beddomei*	Beddomes cycad
2.	*Vanda coerulea*	Blue Vanda
3.	*Saussurea costus*	Kuth
4.	*Paphiopedilium spp.*	Lady’s Slipper Orchids
5.	*Nepenthes khasiana*	Pitcher plant
6.	*Ranathera imschootiana*	Red Vanda

7.	*Rauvolfia serpentina*	Sarpagandha
8.	*Ceropegia spp.*	Ceropegia burbosa Roxb.)
9.	*Frerea indica*	Shindal Mankundi
10.	*Podophyllum hexandrum*	Indian Podophyllum
11.	*Cyatheaceae spp.*	Tree Ferns
12.	*Cycadaceae spp.*	Cycas ciricinalis Linn.
13.	*Dioscorea deltoidea*	Elephant's foot
14.	*Euphorbia spp.*	Euphorbias
15.	*Orchidaceae spp.*	Orchids
16.	*Pterocarpus santalinus*	Red Sanders
17.	*Taxus wallichiana*	Common Yew
18.	*Aquilaria malaccensis*	Agarwood
19.	*Aconitum spp.*	Vatsnabh, Aconitum
20.	*Coptis teeta*	Mamira
21.	*Coscinium fenestratum*	Calumba wood
22.	*Dactylorhiza hatagirea*	Salampanja
23.	*Gentiana kurroo*	Kuru, Trayamana
24.	*Gnetum species*	Gnetummontanum Markgraf
25.	*Kaempferia galanga*	Galanga, Kencur
26.	*Nardostachys grandiflora*	Jatamansi
27.	*Panax pseudoginseng*	Ginseng
28.	*Picrorhiza kurrooa*	Kutki
29.	*Swertia chirayta*	Chirayata

(Source: NMPB)

NATIONAL MISSION ON MEDICINAL PLANTS (NMMP)

The National Medicinal Plant Board (NMPB) was set up a through a Government Resolution notified on 24th November 2000 under the Chairmanship of Union Health & Family Welfare Minister. The government took the major initiative on the direction of National Medicinal Plants Board (NMPB), Department of Ayurveda, Yoga, Unani, Siddha and Homeopathy (AYUSH), Ministry of Health and

Family Welfare, the National Mission on Medicinal Plants was launched. The primary objective of this scheme is to strengthen the cultivation sector and to boost economic status of farmers whose are actively engaged in farming of medicinal and aromatic plants. In the beginning, total budgetary allocation of Rs. 630 crores for year 2008–2012 was sectioned. The main aim of the mission is to provide livelihood opportunities to farmers and increase value-added products export, while secondary objectives included promoting cultivation, coordination, and linkage between different users, creating a linkage between allied services and market and implementing and supporting quality certification system for medicinal plants sector. But this mission was not come effectively on ground level. The percentage of farmers whose are benefitted by the scheme is very less in number. A majority of farmers, living in rural areas of many states were unaware about the scheme, and they were not benefitted.

NATIONAL AYUSH MISSION (NAM)

The newly formed BJP Government in the leadership of Hon'ble Prime Minister Shri Narendra Modi took the new initiative, and centrally sponsored scheme of National Mission on Medicinal Plants" (NMMP) had been merged with "National AYUSH Mission (NAM) from 2015-16 onwards and is continuing with the same activities. Under this scheme financial assistance was provided to growers to develop nurseries for cultivation of medicinal plants for AYUSH purpose. The information regarding financial assistance was shared by Minister of State (Independent Charge) for AYUSH, Shri Shripad Yasso Naik in reply to a question in Rajya Sabha on 26th April 2016. Under this scheme, the project based financial assistance of Rs. 6.25 lakhs per unit is provided for creation of medicinal plant cultivation nurseries covering an area of 1 hectare. As per scheme guidelines, the assistance is provided to the extent of 100% to public sector / SHGs and 50% of the cost subject to a ceiling of Rs 3.125 Lakhs to private sector.

PHYTO-PHARMACEUTICAL MISSION

The mission was launched to achieve the target of several economically important medicinal plants. Under this mission a minimum of 6000 hectares of additional area would be brought under cultivation of various aromatic and medicinal crops generating employment among rural youth. Creating trained and skilled manpower leading to an estimated income enhancement of farmers in the range of Rs 25,000 to 75,000 per hectare depending upon the crop that farmers would grow in their fields.

RECOMMENDED SUBSIDIZED SPECIES OF MEDICINAL PLANTS FOR HILLY REGIONS

National Medicinal Plants Board (NMPB) is implementing a new 'centrally sponsored scheme of National Mission on Medicinal Plants' with a total outlay of Rs 630 crore during the 11th Plan. The scheme aims at supporting market-driven cultivation of medicinal plants prioritized according to their demand in the Ayush and herbal industry. The scheme is being implemented in a mission mode in selected clusters through growers' cooperatives, self-help groups, production companies, etc. with backward and forward linkages for nurseries, post-harvest management, marketing and quality certification.

Table. 2: Recommended Species of Medicinal Plants for Cultivation in Hilly regions with 30%, 50% and 75 % Subsidy.

S.No	Botanical Name	Common Name	Type of Plant	Admissible Subsidy %
1	Artemisia annua Linn.	Artemisia	Herb	30
2	Bacopa monnieri (L.) Pennell	Brahmi	Herb	30
3	Bergenia ciliata Stern.	Pashnabheda	Herb	30
4	Caesalpinia sappan Linn.	Patang	Shurb	30
5	Catharanthus roseus	Sadabahar	Herb	30
6	Coleus vettiveroides K.C. Jecob	Hrivera	Herb	30
7	Convolvulus microphyllus Sieb ex Spreng	Shankhpushpi	Herb	30
8	Cassia angustifolia Vahl	Senna	Herb	30
9	Coleus barbatus Benth.	Pather Chur	Herb	30
10	Emblica officinalis Gaertn	Amla	Tree	30
11	Hedychium spicatum Buch Ham. Ex-Smuth	Kapur Kachari	Herb	30
12	Ocimum sanctum Linn.	Tulsi	Herb	30
13	Withania somnifera (Linn.) Dunal	Ashwavgandha	Herb	30
14	Dactylorhiza hatagirea (D.Don) Soo	Salampanja	Herb	50

15	Hippophae rhamnoides	Seabuckthorn	Tree	50
16	Inula racemosa Hk. F.	Pushkarmool	Herb	50
17	Panax pseudo ginseng Wall	Ginseng	Herb	50
18	Taxus wallichiana Linn.	Thuner,Talispatra Shrub		50
19	Rauwolfia serpentina Benth Ex. Kurz	Sarpgandha	Herb	50
20	Rheum spp.	Adapalene	Herb	50
21	Viola Odorata	Bunafsha	Herb	50
22	Valeriana wallichi	Indian Valerian	Herb	50
23	Zanthoxylum alatum	Timoor / tejbal	Shrub	50
24	Aconitum ferox Wall/A. balfouri	Vatsnabh	Herb	75
25	Aconitum heterophyllum Wall. ex Royle	Atees	Herb	75
26	Aconitum chasmanthum Stapf	Vatsnabh	Herb	75
27	Berberis aristata DC.	Daruhaldi	Shrub	75
28	Coptis teeta Wall.	Mamira	Herb	75
29	Gentiana Kurroo Royle	Trayamana	Herb	75
30	Nardostachys jatamansi DC.	Jatamansi	Herb	75
31	Picrorhiza kurroa Royle ex Benth.	Kutki	Herb	75
32	Polygonatum cirrhifolium Wall.	Mahameda	Herb	75
33	Podophyllum hexandrum Royle T.S. Ying	Bankakri	Herb	75
34	Saussurea costus C.B. Clarke	Kuth	Herb	75
35	Swertia chirata Buch-Ham	Chirata	Herb	75

(Source: NMPB)

TOP 10 HERBAL TRADE CENTRES/MANDIES IN INDIA

In India, the major top ten trade centres/mandies of Medicinal Plants were situated in Amritsar, Bengaluru, Chennai, Dehradun, Delhi, Jaipur, Kolkata, Lucknow, Mumbai and Neemuch. The price of raw material was fixed by these mandies every month. Mostly the costs of 50 important plant species were fixed by them and which is displayed at the web page of National medicinal Plant Board for the assistance of traders as well as farmers. If we compared the price lists, we have seen price fluctuations in every month. The price range of 50 important species was mentioned in table below during the month of December, 2016.

Table. 3: Price List of 50 Important Species of Medicinal Plants in 10 Trade Centres / Mandies (lower-highest)

	Botanical Name	Trade Name	Part	Price / Per Kg
1	Acorus calamus	Bach	Root	73-110
2	Adhatoda vasica	Adusa	Whole Plant	21-65
3	Aloe barbadensis	Gwarpatha	Leaf (Dried)	35-52.5
4	Alpinia galanga	Kulanjan	Root	18-180
5	Andrographis paniculata	Kalmegh	Whole Plant	23-52
6(a)	Asparagus	Satawari racemosus	Root (Nepali)	520-750
6(b)	Asparagus	Satawari (MP) racemosus	Root	160-225
7	Azadirachta indica	Neem	Leaf	17-47.5
8	Bacopa monnieri	Brahmi	Whole Plant	28-80
9	Berberis aristata	Daruhaldi	Wood	31-75
10	Bergenia ciliata	Pakhanved	Root	49-105
11	Boerhaavia diffusa	Punarnava	Whole Plant	40-110
12	Boswellia serrata	Kunduru	Gum	172-290
13	Carthamus	Kusum tinctorius	Flower	690-810
14	Cassia angustifolia	Senna	Leaf	37-70
15	Cedrus deodara	Devdaru	Wood	25-65
16	Chlorophytum arundinaceum	Safed Musli	Root	1875-2800
17	Coleus forskohlii	Coleus	Whole Plant	170-255
18	Commiphora mukul	Guggul	Gum	580-1050
19	Crocus sativus	Kesar	Stigma	141000-275000
20	Embelia ribes	Vai-Vidang	Seed	635-900

21	Emblica officinalis	Amla	Fruit	67-90
22	Glycyrrhiza glabra	Mulathi	Root	115-240
23	Gymnema sylvestre	Gudmar	Leaf	45-120
24	Hibiscus moschatus	Mushkdana	Seed	140-290
25	Inula racemosa	Pokharmool	Root	125-250
26	Kaempferia galanga	Kapoor-Kachri	Root	295-450
27	Lawsonia inermis	Mehandi	Leaf	45-85
28	Nardostachys jatamansi	Jatamansi	Root	850-1300
29	Ocimum sanctum	Tulsi	Leaf	40-105
30	Paris polyphylla	Doodh Bach	Root	2300-4500
31	Picrorhiza kurroa	Kutki	Root	725-1200
32	Piper longum	Pippli (Lambi)	Fruit	585-800
33	Plantago ovata	Isabgol	Husk	460-650
34	Plumbago zeylanica	Chitrak	Root	110-175
35	Rauwolfia serpentina	Sarpagandha	Root	650-1250
36	Rheum australe	Padamchal	Root	85-138
37	Rubiac ordifolia	Majith	Root	165-240
38	Santalum album	Chandan (White)	Wood	10000-12000
39	Saussurea costus	Kuth (Bitter)	Root	270-390
40	Sida cordifolia	Bala	Whole Plant	18-75
41	Swertia chirayita	Chiraita	Whole Plant	325-550
42	Terminalia arjuna	Arjun	Bark	24-62
43	Terminalia bellirica	Behda	Fruit	15-35
44	Terminalia chebula	Harda	Fruit	17-38
45	Tinospora cordifolia	Gilo	Stem	27-57.50
46	Tribulus terrestris	Gokhru	Fruit	88-192
47	Valeriana wallichii	Tagar	Root	360-500
48	Vetiveria zizanioides	Khas-Khas	Root	105-138
49	Withania somnifera	Ashwagandha	Root	250-285
50	Zanthoxylum oxyphyllum	Timur	Seed	330-460

(Source: NMPB, Dec., 2016)

NEED OF AWARENESS AMONG FARMERS

The situation of farmers was terrible about the policies and schemes, launched by government for the promotion of herbal sector particularly in hilly regions. Presently the condition of farmers in Himalayan region was worsening; majority of the farmers, engaged in farming have not skilled properly. Majority of the farmers were not aware about the schemes and policies, launched for economic development of rural communities. In some Himalayan states viz., Himachal Pradesh and Uttarakhand, medicinal plants were cultivated at large scale, but the trade of raw material drag the farmers backward. Prime Minister Sh. Narendra Modi on 25 August 2017, while addressing an event organised by Bharatiya Agri Industries Foundation (BAIF) in Pune through video conferencing made an appeal to bring focal point on organic and allied sectors in order to empower farmers for enhancing their economic status. He mentioned here that, "Farming is not just about farming wheat, pulses and mustard."There is economic scope for medicinal and aromatic plants cultivation sector. Farmers' income can be increased if focus is given on this sector. We need to bring awareness among farmers about it. Stressing on need to empower farmers, he said if we do not empower farmers; our dream of new India will remain unfulfilled. Progressive farmers and agriculture departments were supposed to inform farmers about any farm product or material can be used (SME, Times).

CONCLUSION

The present attempt concluded that, farmers have a lot of opportunities for uplifting their economic status in the medicinal plants cultivation sector. We have needed to create the awareness among rural communities about the policies and schemes launched for the conservation, sustainable utilization as well as for boosting the socioeconomic status of rural communities.

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13

Hippophae Salicifolia (Seabuckthorn): Source of Economic Development in Higher Himalayan Region

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ABSTRACT

Hippophae salicifolia D. Don is widely distributed in Indian Himalaya but the species has not gained so much popularity and is used only by the people residing in the vicinity of its natural pockets. It has a strong nutritional potential, fruit juice and pulp are considered rich in Vitamin C, A, E, B, amino acids, minerals, and other phytochemicals. Oil obtained from seeds and pulp has special consideration, both pulp and seed oil is rich in carotenoids, flavonoids, tocopherol and omega fatty acids. It also posses antimicrobial, antioxidant and anti stress properties. The present manuscript reviewed the scientific basis of economic importance of H. salicifolia, *which represented its great commercial value to uplift the rural economy of Indian Himalaya.*
Keywords: *Hippophae sallicifolia, Nutraceuticals, Oil, Antioxidant and Tocopherols*

INTRODUCTION

The Himalayan region has fabulous wealth of flora and fauna, some of them are of great importance. *Hippophae* (Sebuckthorn) is among those genus of plants which is valuable with its multiferous benefits.

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Hippophae species are used in Materia Medica of several traditonal medicinal systems (Suryakumar and Gupta, 2011) with its high nutritional value as well as medicinal importance (Achaarya *et al*., 2010). Genus *Hippophae* belongs to the family Elaeagnaceae and order Daphnales, commonly known as Seabuckthorn and Leh berry in India. Presently six species of the genus *Hippophae* have been reported in all over the world, *viz H. rhamnoides, H. salicifolia, H. tibetana, H. gonicarpa, H. gyantensis*, *H. neurocarpa*. Three species have been from Indian cold desert *i.e. Hippophae rhamnoides* L., *H. salicifolia* D. Don. and *H. tibetana* Schlecht. These species are distributed in higher elevations of Indian Himalayas from Ladhakh (J&K) to Lahul Spiti (HP), Uttarakhand, Sikkim and Arunanchal Pradesh (Chauhan, 1999).

H. salicifolia is a less explored species of Seabuckthorn, preferred to grow in lower altitude (6500-9000 feet) and distributed in north western region of Pakistan, Himachal Pradesh, Uttarakhand and north-eastern India (Rausi, 1971; Singh 1994; Gupta and Ahmed 2010). Due to its high nutritional and medicinal value, the species also gained importance along with other species of *Hippophae. H. salicifola* is a deciduous, dioecious, thorny, small tree or erect shrub with reddish brown bark. Leaves are broad, oblong, lanceolate, stellately pubescent above when young, densely white- tomentose or stellately hairy beneath, usually 5-10 cm long and leaf margins are curved. Flowers in clusters, male flowers are yellow-brown with two scaly leaves and usually with four stamens. Female flowers are short-stalked and two-lobed with exerted stigma. Fruits are yellow to orange in color having black to brown solitary seed with shining surface (Chaurasia *et al*., 2009).

Various studies revealed that *H. salicifolia* is also rich in all valuable biocomponents like *H. rhamnoidies*. All plant parts such as leaves, shoot, bark, fruits etc. are considered rich source of numerous bioactive compounds such as flavonoids (isorhamnetin, quercetin, myricetin, kaempferol and their glycoside compounds), carotenoids (â and ä-carotene, lycopene), vitamins (C, E, K), tannins, triterpenes, glycerides , palmitic, stearic and oleic acids, and some essential amino acids (Xiao, 1980). These properties of *H. salicifolia* provides nutritional securities as well as the many ways of income genration to the rural people of those Himalayan region, which having abundance of *H. salicifolia* growing pockets .

AIM OF THE STUDY

The aim of present study is to access the economic potential of Seabuckthorn (*Happophae salcifolia)*, a well known plant of higher Himalayan region.

OBJECTIVES

The study was aimed with the following objectives:

- To analyze the food, cosmetics and herbal tea potential.
- To analyze the health supplements and nutraceutical potential.

METHODOLOGY

The present study was fully based on secondary sources and the data was collected from various sources such as published research articles and review papers, etc.

FOOD AND FOOD ADDITION POTENTIAL

Complete benefits of *H. salicifolia* are not utilized properly by local people of *H. salicifolia* growing region. Locally it is used for chutney, juice, substitute of tomatoes, fuel wood and fencing, sometimes in veterinary and medicinally in regions of its natural habitat (Dhyani *et al*., 2010). Various studies have highlighted the nutritional and medicinal value of the fruits, seeds, leaves and bark of *H. salicifolia* (Yadav *et al.,* 2006). Yadav *et al.,* 2006 studied the properties of fruit juice of *H. salicifoia* growing in Harshil region of - Uttarakhand and found that, Juice acidity (% citric acid) ranges from 4.89 – 7.93, TSS (ºB) (Juice) from 7.07 - 10.00, TSS: Acidity ratio from 1.24 - 1.76, Juice (%) from 70.70 - 79.23. Juice percentage in the berries of Harshil region was higher than earlier findings of Chauhan, 1999, Heilsher and Lorber, 1996 which reported 65-68 percent juice yield in berries of *H. rhamnoides*. They also concluded that high and wide variability of acidity and total soluble solids indicated the importance of this species used in preparation of value added products such as ready to serve beverages, jam, jellies, candies etc. *Hippophae* spp. is considered important mainly due to the nutritional value of its fruits; Vitamin C (ascorbic acid) is present as a nutrient of primary importance in them and reported highest in *H. salicifolia* (Singh, 2009) among all the species of Seabuckthorn. The juice of this species is also rich in carotenoids (156.7 mg /L), flavonols (350.53 mg /L, Singh and Sawhney, 2005), vitamin E (33.1mg /kg, Singh and Singh, 2001) and minerals like - Zn, Cu, Fe, Ca, Mg, Na and K (Singh *et al*., 2001). Such properties of *H. salicifolia* fruits are providing nutritional securities and opportunities for income generations for local people by preparing value-added products (jam, jellies, squash, and pickles).

HERBAL TEA POTENTIAL

Hippophae spp tea is sold in the market by different brands under different trade names, which is mainly prepared by leaves and dried fruit pulp of *H. rhamnoides*. Chemical profiling of *H. salicifolia* proofed its strong potential as a candidate for herbal tea producing plant. The market of herbal tea is gradually increasing in the global scenario, due to its high antioxidative potential. Sea buckthorn leaves posses various antioxidative nutrients and bioactive substances. Leaves barks and fruits of *H. salicifolia* are rich in polyphenols, flavonoids and other antioxidative compounds (Goyal *et al*., 2011; Wani *et al*., 2013). Besides its antioxidative richness, *Hippophae* tea also provides various health benefits like weight lose antimicrobial, anti inflammatory and anti-arthritis, properties, soothing,energizer,anti-stressand stimulants (www.healwithfood.org).

H. SALICIFOLIA AS HEALTH SUPPLEMENTS AND NUTRACEUTICALS:

Hippophae spp. is rich in flavonoids, polyphenols, vitamin C, vitamin E, dietary fibers, antioxidants and unsaturated fatty acids etc. Fruits juice and pulp are considered rich in Vitamin C, Provitamin A, Vitamin E, Vitamin B, amino acids, minerals, and other phytochemicals, thereof *Hippophae* sp. have the potential for the development of health supplements and nutraceuticals (Dwivedi *et al*., 2009). Most effective health supplement of *Hippophae* in the global market is its oil, for omega 7 fatty acids, obtained from its pulp and seed oil. Palmitoleic acid is an important omega fatty acid present in sufficient amount in all *Hippophae spp.* The species is known for its lower susceptibility to oxidation as compared to other polyunsaturated fatty acids, providing stability during frying and baking (Thakur *et al.,* 2015). Both seed and pulp oil of *Hippophae spp.* is rich in carotenoids, tocopherols and sterols which significantly differ in its chemical characteristics. Fatty acid composition of *H. rhamnoidies* along with *H. salicifolia* studied by Ranjith *et al.,* 2006 and Singh and Gupta, 2015 revealed, the chemical composition of oil of both the species which shares many common features. Various fatty acids studied differ quantitatively but their existences were found in both species**,** pulp and seed oil of *Hippophae spp.* are rich in saturated and unsaturated fatty acids involving the essential fatty acids *viz.* alpha-linolenic acid, linoleic acid and conditionally essential fatty acid like gama-lnolenic acid.

These studies proved that *H. salicifolia* is suitable for human consumption, consists high value of key unsaturated fatty acids (UFAs) such as linoleic acid (15.0, 16.1, 15, 14.3%), á -linolenic acid (1.3%). In *H. salicifolia* ã –Linolenic acid is present in both pulp and seed oil (0.043, 0.056 %) whereas, it is present in traces in *H. rhamnoidies.* Other FAs (Fatty acids) are either in the range of *H. rhamnoides* or slightly in higher or lower concentrations. The fatty acids profile of *H. salcifolia* proves that pulp and seed oil of *H. salicfolia* can also be commercialized as omega fatty acid supplements. Total UFAs are generally higher in pulp oil, and total SFAs (Saturated fatty acids) are higher in seeds oil, so according to needs, plant source should be selected. Ranjith *et al.,* 2006 revealed that, *H. salicifolia* fruit pulp is rich in flavonols, vitamin C and also contain carotenoids and tocopherols and thus can be used for the production of antioxidative products. Carotenoid contents is the basis of commercial trade of sea buckthorn oil (Beveridge, 1999) although *H. salicifolia* contain a lower amount of carotenoids than other *Hippophae* species, still the content is favorable enough. On the basis of these studies, it could be suggested that, *H. salicifolia* can be explored for production and commercialization of various *Hippophae* health supplements and nutraceuticals.

COSMETICS POTENTIAL

Essential fatty acids, long chain alcohols, and sterols in the products are essential nutrients supporting the regeneration of skin cells and restoration of skin barrier structure (Yang *et al*., 2009). Role of Linoleic acid in the skin is significant due to its capacity to strengthens the lipid barrier of the epidermis, protection against transepidermal loss of water and maintaining skin metabolism normal. In oily and acne, prone skin use of Linoleic acid leads to improvement of the work of sebaceous glands, unblocking of pores and decrease in the number of comedos and eczemas (Zieliñska and Nowak, 2014). Flavonoids, carotenoids, and tocopherols not only protect the skin from oxidative damage but also alleviate the effects of sunburn, stimulate healing and soothe irritations (Yang *et al*., 2009). On keeping these benefits in mind various cosmetics are produced with *H. rhamnodies* such as oral beauty supplements, base of creams, emulsions, cosmetic milks and creams, ointments, hair conditioners and shampoos, cosmetic masks, lipstick and lip balms, bath fluids etc. *H. salicifolia* is also rich source of flavonoids, vitamin C, and E, fatty acids, carotenoids and various cosmetically essential fatty acids, proving itself as a strong candidate in cosmetic industry.

FODDER POTENTIAL

The studies on the chemical composition of *Hippophae spp.* found that leaves and fruits are very rich in total crude proteins, digestible nutrients, vitamins and other nutrients, as compared with other feed and fodders fed to animals. Various poultry and cattle feed were prepared by CSK Agricultural University Palampur, Himanchal Pradesh by Seabuckthorn species using leaves, fruits, and cakes. This positively enhanced the overall health of poultry and cattle and increase egg and milk production. In Indian Himalaya where farmers and cattle grazers solely depend on grasses and some higher fodder plants for nourishing their animals, in high altitude areas during dry cold seasons processed leaves and fruit cakes of *H. salicifolia* can be used as a source of animal feed due to the presence of its nutritional component.

Table 1: Physico-chemical properties of oil (% w/w) of H. salicifolia and H. rhamnoies

Parameters	H. salicifolia	H. rhamnoides
Refractive index	1.473	1.473
Butyro- refractometer Reading	71	71
Specific gravity	0.922	0.916
Acid value	4.66	4.01
Peroxide value	18.30	17.50
Iodine value	154.95	150.35
Saponification value	184.32	230.20
Unsaponifiable matter	0.78	0.60
Vitamin E	27.68	30.80

(Source: Kaushal and Sharma, 2011)

Table 2: Comparative Characterstics of H. salicifolia and H. rhamnoides

S. No.	Parameters	H. salicifolia	H. rhamnoidies	References
1	Fruit size (gm/100 seeds)	30-35	8-27	Singh, 2009

2	Seed size (gm/100 seeds)	0.943-1.142	1.103	Singh, 2009
3	Crude protein (Leaves %)	21.6	17.5-20.5	Singh, 2009
4	Total fat content (Leaves %)	4.6	3.5-4.8	Singh, 2009
5	Total oil content (%)	2.0, 10.5	3.2- 4.6, 8.8-14.6	Ranjit *et al*., 2006Singh *et al*. 2005
6	Vitamin C/100g fruits	29840, 947 mg	4877, 219-642	Singh *et al*. 2005
7	Flavonols (mg/kg fruits)	428 , 350.3	308, 208- 308	Singh and Sawhney, 2005
8	Carotenoids (mg/kgfruits)	163.7 mg/kg	156.7	Singh and Sawhney, 2005
9	Minerals	Zn, Cu, Fe, Mg, Na, K	Zn, Cu, Fe, Mg, Na, K	Gupta and Singh,2005
10	Tocopherols (mg % oil)	248.2 (seed), 134.3 (pulp) 33.1 mg	88.4 mg	Ranjit *et al*., 2006 Lu, 2005Singh and Sawhney, 2005

CONCLUSIONS AND FUTURE PERSPECTIVES

H. salicifolia is distributed in Himalayan states of India from western to north- eastern Himalaya in subtle form, most of the native people was not aware about its existence and its multifarious purposes. It is traditionally used in these valleys as food, fodder, fencing and medicinal purposes. The biochemical profiling of leaves, fruit and barks of *H. salicifolia* is closely similar to *H. rhamnoides* and proofs its modern approaches for utilization as value added food products, health supplements, nutraceuticals, medicinal agent, and cosmetic uses. Unlike the *H. rhamnoides,* this species has not gained much popularity due to less exploration, thus more studies are needed in all possible beneficial aspects of the species, so that further steps could be taken in commercialization and industrialization of the species. By this local livelihood can be uplifted in remote areas of the Indian Himalayan region, which are situated in highly inaccessible areas where unemployment and migration for employment are the main problems. So it can be concluded that *H. salicifolia* can be used as the alternative of *H. rhamnoides* and have the potential to uplift the economy of the local rural people of high altitude areas of various Indian Himalayan states.

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14

Demographic Profile and Socio Economic Status of Scheduled Caste and Scheduled Tribe Population in Rural Areas of West Bengal

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ABSTRACT

After Independence, the Constitution of India prepared two schedules for identifying various tribal and low caste groups, which are officially called 'Scheduled Tribes' (ST) and 'Scheduled Castes' (SC) respectively. They have a long cultural heritage, and they are concentrated in the eastern states of West Bengal, Bihar and Orissa. Total population of West Bengal at 2011 census has been 91347736. Of these 21463270 persons are scheduled castes (SCs), constituting 23.50 percent of the total population. On the other hand, 5296953 persons are scheduled tribes (STs), constituting 5.80 per cent of the total population. The state has registered 9.09 percent decadal growth of the ST population and 16.32 percent of SC population. The share of scheduled tribe population in urban areas is a meager 8.34 per cent and 91.66 in rural areas in West Bengal where as the share of scheduled caste population in urban areas is 20.35 per cent and 79.65 per cent in rural areas in West Bengal. The tribal are exploited more. In the present study, it is seen that West Bengal is one such state, where the tribal community could not share the fruit of development programs equally like other caste people. It also increases discrimination among the rural and urban people, between have and have not family. Poor people become poorer.

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INTRODUCTION

The tribal existence within larger Indian society is often quite distinctive on various counts, namely the ecological and environmental circumstances of their habitation, lifestyle and culture, social organization, kinship and inheritance patterns, religious beliefs and practices. There are indeed often several socio cultural ingredients to distinguishing a tribal group from the mainstream population (MAHARATNA, A, 2002). Dr. Ambedkar also had a vision for socially and economically disadvantaged sections. Indian Government has officially recognized the various castes. In contemporary literature the scheduled caste are referred to as Dalit. The Indian Government has taken many steps to uplift the socioeconomic status of this Dalit population with a lot of plans. From the past the scheduled caste, community of India have faced various problems in terms of social and economical development. Though Indian Government after freedom launched various programmes and schemes for the betterment of these people, the desired goal is not achieved yet.

Biradar and Jayasheela (2007) in their study opined that educational status in respect of Scheduled Castes and Scheduled Tribes is significantly lower as compared to others. Although the rate of literacy increased significantly, a greater illiteracy continued to exist in respect of Scheduled Castes/ Scheduled Tribes as compared to that of non-SCs/STs.

Noor Mohammad (2006) in his study analyzed the socio-economic transformation of scheduled castes. He found that there are rural-urban variations in the educational level of the scheduled castes. The rural scheduled castes are less educated than that of urban counterpart. Various programmes and policies of rural development in general and agricultural development in particular have resulted into economic prosperity of the masses including the Scheduled Castes. Further, he found that Scheduled Castes have adopted more than one occupation.

Sudha Pai (2000) in his study found that Scheduled Castes constitute disadvantaged, economically poor and socially backward groups. Owning little land, with low levels of literacy, they suffer from low levels of urbanisation, employment and wages due to lack of rapid industrial development.

In addition to the population encompassed within the caste system, India also has a large number of native tribes. India has one of the largest tribal populations of any country - tribes represent about 7 percent of the total population (Chattopadhyay 1978; Debi 1978).

OBJECTIVE

To assess the status of Scheduled Caste (SC) and Scheduled Tribe Population (ST) in rural areas of West Bengal

METHODOLOGY

This is a theoretical research paper, where secondary information produced by different authors and researchers has been used. For obtaining necessary information, I have consulted various books; journals as well as websites.

STUDY AREA

The state of West Bengal have been selected for the study which lies between the latitude of 21°252 N to 26°502 N and longitude of 86°302 to 89°582 E. It spreads over an area of about 80,968 sq. Km. Extending from the foot of Darjeeling Himalayas in the north to Bay of Bengal to the south (maximum stretch of about 580 km.) and from the edge of Chotanagpur high lands in the west to the border of Bangladesh and Assam in the east (maximum stretch of about 200 km). It comprises 19 district of West Bengal.

Demographic Characteristics of West Bengal (2011 Census)

Background Characteristics	Number	Percentage
Population Size	91276115	100.00
Population Size(Males)	46809027	51.28
Population Size(Females)	44467088	48.72
Population size (Rural)	62183113	
Population size (Urban)	29093002	
Population size (Rural Males)	31844945	51.21
Population size (Rural Females)	30338168	48.79
Population size (Urban Males)	14964082	51.44
Population size (Urban Females)	14128920	48.56
Population density (Total, Persons per sq km)	1028	
Sex ratio (Females per 1000 males)	950	
Sex ratio (Rural)	953	
Sex ratio (Urban)	944	
Literacy rate, 7+ yrs (Persons, Per cent)	61538281	76.26

Literacy rate, 7+ yrs (Males, Per cent)	33818810	81.69
Literacy rate, 7+ yrs (Females, Per cent)	27719471	70.54
Literacy rate, 7+ yrs (Rural, Per cent)	39213779	72.13
Literacy rate, 7+ yrs (Urban, Per cent)	22324502	84.78
Literacy rate, 7+ yrs (Rural Males, Per cent)	21848197	78.44
Literacy rate, 7+ yrs (Rural Females, Per cent)	17365582	65.51
Literacy rate, 7+ yrs (Urban Males, Per cent)	11970613	88.37
Literacy rate, 7+ yrs (Urban Females, Per cent)	10353889	80.98

Source-Census 2011 Findings

Demographic profile of Scheduled Case and Scheduled Tribe Population

Table-1 (In crores)

Type	**Scheduled Caste**		**Scheduled Tribe**		**All Categories**	
	2001	**2011**	**2001**	**2011**	**2001**	**2011**
Male	8.6	10.3	4.3	5.2	53.2	62.3
Female	8.1	9.8	4.2	5.1	49.6	58.7
All-India	16.7	20.1	8.4	10.4	102.9	121.1

Source – Census 2001 & Census 2011

SC Population in West Bengal

Total SC population	21463270
Total Male population	11003304
Total Female Population	10459966

Source-Census 2011

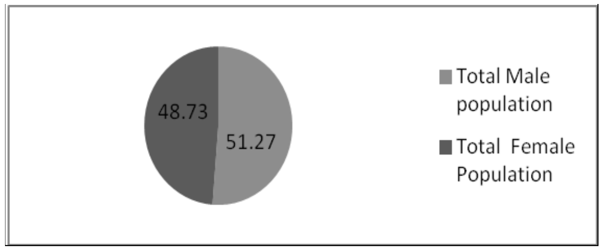

Figure-1

Table-2 ST Population in West Bengal

Total ST population	5296953
ST male population	2649974
ST female population	2646979

Source- Census 2011

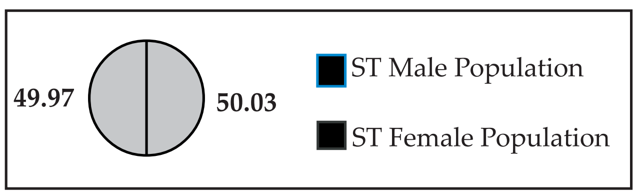

Figure-2

Table -3: Population and Proportion of Eighteen Major SCs, 2011 Census, West Bengal

SL No	Name of the Scheduled Caste	Total population	Proportion to the total SC population
1	SC population	21463270	100
2	Bagdi, Duley	3058265	14.25
3	Bauri	1228635	5.72
4	Chamar, Charmakar, Mochi, Muchi, Rabidas, Ruidas, Rishi	1039591	4.84
5	Dhoba, Dhobi	385280	1.80

6	Dom, Dhangad	352083	1.64
7	Hari, Mehtar, Mehtor, Bhangi, Balmiki	431257	2.01
8	Jalia Kaibartta	569448	2.65
9	Jhalo Malo, Malo	303618	1.41
10	Kaora	272801	1.27
11	Lohar	315093	1.47
12	Mal	306234	1.43
13	Namasudra	3504642	16.33
14	Pod, Poundra	2450260	11.42
15	Rajbanshi	3801677	17.71
16	Sunri (Excluding Saha)	337609	1.57
17	Tiyar	227800	1.06
18	Chain (in Malda, Murshidabad, Nadia and Dakshin Dinajpur districts)	323595	1.51

Namasudra ,Rajbanshi , Pod & Bagdi together constitute 59.71 of the total SC population. Bauri, Charmakar, Muchi, Ruidas, Rishi, Dhoba, Dom, Hari , Mehtar, Sunri(Excluding Saha) have sizable population. The rest of the SCs have a comparatively smaller population.

Table -4 Populations and Proportion of Twelve Major STs, 2011 Census, West Bengal

SL NO	Name of the Scheduled Tribe	Total population	Proportion to the total SC population
1	All Schedule Tribes	5296953	100
2	Bedia, Bediya	88772	1.68
3	Bhumij	376296	7.10
4	Bhutia, Sherpa, Toto, Dukpa, Kagatay, Tibetan, Yolmo	66627	1.26
5	Kisan	98434	1.86

6	Kora	159404	3.01
7	Lodha, Kheria, Kharia	108707	2.05
8	Mahali	81594	1.54
9	Oraon	643510	12.15
10	Santal	2512331	47.43
11	Limbu (Subba)	46847	0.88
12	Tamang	146203	2.76

Santhal , Oraon, Bhumiji constitute 66.68 of the total ST population. Bediya, Kisan, Kora, Lodha, Kheria & Tamang have sizable population. The rest of the STs have a comparatively smaller population.

The STs in the state are predominantly residing in the rural areas (91.66 per cent). Among Baiga, Savar, Bhumij , Chik Baraik, 'Kisan Rabha,and Bedia more than 95 per cent are residing in the rural areas. Contrary to the overall situation among the majority of tribes, Bhutia, Magh,Gond, 'Hajang, have recorded more than 35 per cent urban population.

Educational Status of SC and ST Population in West Bengal

The literacy rate of West Bengal is 77.08, according to 2011 census. The rank of the state is 20th in terms of literacy among all Indian states. The rate is just 3.07% higher than national average. Such figure is not desirable for that state which was the most developed state within the country up to 1961 and has a long history of cultural development since British Colonial period. Picture of female literacy in West Bengal is said to be worse. Presently it is 70.54. The difference of Male and Female literacy is high, 11.15 (2011 Census). Scheduled Caste (S.C) Female literacy of the state is 61.23 for the year 2011 which is far below (9.31%) than the total female literacy, 70.54. The development of S.C Female literacy has jumped 46.90 to 61.23 for the period of 2001 to 2011. Scheduled Tribe (S.T.) Female literacy of West Bengal is very poor condition. Only 47.71 percent S.T females are enumerated as literate in 2011 census. Highest S.T Female literacy is observed in the Metropolitan district of Kolkata (76.57) and lowest is found in Uttar Dinajpur (35.48). The increase of Tribal literacy is high during the last decade (2001-2011). 14.52 percent tribal literacy is increased in the state of West Bengal. Rural (65.51) and Urban (80.98) differentials for female is comparatively high, 15.47 in 2011. Highest Rural female literacy is found in Purba Medinipur district and highest urban female literacy is in North Twenty four parganas. Like other Indian state literacy differentials among different castes is found in this state including each and every district. The picture of S.C. literacy is somewhat better than S.T. literacy but both are far below than general literacy. In 2011 the S.C and S.T literacy are 69.43 and 57.92 but the average total literacy for the state is 77.08%.S.C. literacy as whole, 7.65 percent lower than the average literacy rate of West Bengal. Highest (79.31) S.C. literacy is found in the Kolkata Metropolitan district and lowest figure is observed in Bankura district (54.03). S.T. literacy rate of West Bengal is 57.92 (2011) which is far below from state average general literacy (77.08). District wise variation is also prominent. Highest (82.06) and lowest (43.76) S.T. literacy is observed in Kolkata and Uttar Dinajpur District.

CONCLUSION

Poverty is one of the barriers against literacy and educational development. Poverty also compels the parents to involve their children to works, rather than sending them to schools. So any literacy programme cannot be success without poverty eradication programme. In this regard the policy implementation of Govt. of West Bengal is satisfactory. Recently the „Kannya Sree project is highly successful to reduce drop out of females from the schools. It should not be the task of government only but each and every section of the society should be involved in such programmes.

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Gods Own Country and the Ayurveda Tourism

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ABSTRACT

Kerala is immensely blessed by nature with beautiful beaches, rivers, hills, wildlife sanctuaries, forts and Places; monuments and memorials, shrines and festivals; and a fascinating heritage of art and culture. So this place is called Gods Own Country. Kerala is a narrow, fertile strip of land on the South-west cost of India. Protected by natural barriers in the east, it has evolved largely unaffected by the strife wrought by countless foreign incursions in the rest of India. According to legend, the land was a gift of Parasurama, one of the Avatars of Lord Vishnu. It is believed that Parasurama threw his battle axe into sea, reclaiming the landmass, Kerala. The history of Ayurveda started more than 5000 years ago. Early days in Kerala, usually people are used Ayurveda medicines. But after the arrival of English medicines, Ayurveda treatments becomes shaded and people try to embraced the imported medicines. Ayurveda is a perfect ancient science of life; the word Ayur literally means life and Veda the science or knowledge. Ayurveda briefly explains the knowledge of the do's and don'ts one has to follow, which favors' the wellbeing of each individual to lead a healthy, happy, comfortable and advantageous life physically, mentally and socially. Kerala is a land of various types of herbal specious. In the Ayurveda philosophy all living organisms are made up of five elements. These are called

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Panchamahabhutas and are earth, water, fire, air and vacuum. When these five elements are in harmony, a body is in a state of good health. When the harmony of these elements is disturbed the body is in a state of negative health and requires the intervention of Ayurveda therapy. In 1987 Kerala' Tourism Department try to uplift the age old Ayurveda treatment. They identify that Ayurveda can attract many foreign tourists. From 2000 onwards Ayurveda becomes the part of Kerala tourism products. Recently State Government had nominated Former German Tennis player Steffi Graff as Ambassador of Ayurveda Tourism. Kerala's equable climate, natural abundance of forests (with a wealth of herbs and medicinal plants), and the cool monsoon season (June - November) are best suited for Ayurveda's curative and restorative programs. In fact, today Kerala is the only state in India, which practices this system of medicine with absolute dedication. Rejuvenate your body, mind and soul. Kerala can easily be called the only place that has an unbroken tradition of Ayurveda and earning millions of rupees from Ayurveda Tourism.

INTRODUCTION

Kerala is a state situated on the tropical Malabar Coast of South Western India. It is one of the most popular tourist destinations in the country. Named as one of the ten paradises of the world by the national geographic traveler. Kerala's unique culture and tradition, coupled with its varied demography, has made Kerala as one of the most popular tourist destinations in the world. Growing at a rate of 13.3 per cent, the tourism industry is a major contributor to the state's economy (Government of Kerala (GOK), 2008). Moderate climate, rich art, colorful festivals, diverse natural and cultural attractions with a physical quality of life comparable to developed nations and causing tourism industry to flourish in Kerala. Compared to the other states in India, Kerala is unique for its geographical diversity, and it possesses within the smallest area possible. This diversity often offers tourists a range of attraction and experiences such as beaches, back waters, wild life sanctuaries, evergreen forests, and diverse flora and fauna of Kerala. Those places identified by the Department of Tourism and started various types of Tourism spots in various places (Ram Kumar, 1991, P.96).

The Christianity, Judaism and Islam; all found their way into Kerala. In AD 52, St. Thomas the Apostle is believed to have landed here to spread of Gospel of Christ. After his arrival Portuguese, Dutch and British also arrived here. The state of Kerala formed in 1956 by merging the princely states of Travancore, Cochin and Malabar. In 1957, Kerala became the first democratic state in the world to elect a Communist Government. Present time, the state achieved the highest literacy states in India (Sivan, 1988: 64). The official website of Kerala gives a detailed outlook of geographic features of Kerala. Kerala's 38,863 km2 (1.18 per cent of India's land mass) is wedged between the Arabian sea to the West and the Western Ghats to the East Kerala's coast runs some 580 km in length while the state itself varies between 35 – 120 km in width. Kerala roughly divides into three climatically distinct regions. These include the Eastern high lands (rugged and cool mountainous Ferrari), the Central mid-lands (rolling hills) and the Western lowlands (coastal plains). Located at the extreme southern tip of the Indian subcontinent Kerala lies between North latitudes 8 18 and 12 48 and East longitudes 4 52 and 72 22. Kerala's climate is mainly wet and maintains a tropical climate heavily influenced by the seasonal heavy rains brought by the monsoon (Taken from Year Book 1999: 174).

Ayurveda started more than 5000 years ago. There are glimpses of Ayurveda treatments and medicines in various ancient scripts. The words Ayurveda is derived from two words - Ayu meaning life and Veda meaning knowledge or science. It literally means knowledge about life. Ayurveda does not believe in antidotes and antigens, very rarely those techniques are used, Ayurveda works not to suppress the system of body, but to go to the origin and cure the basic disturbing element. In such treatments there are very low chances of side effect and the benefit of the body is forever. It gives you a complete health treatment, which works on the complete body system so it makes you feel better in your entire body (Swaminatan: 1984, 69).

PURPOSE

The main purpose of the study focused on Kerala's age old tradition Ayurveda how promoting Kerala Tourism Industry. Kerala is called that Gods Own Country. It means Kerala is a land of peace and security. Before 1980, Kerala state of Department of Tourism never think about the glorious tradition of Ayurveda. Latter they identify that Ayurveda can earn crores of foreign money and also it gives a great identity too. Now days Ayurveda became the part of Kerala Tourism and every year so many National and International tourist arriving Kerala only for Ayurveda Treatment. Last year Kerala tourism appointed former Tennis player Steffi Graff as a Ambassador for Ayurveda Tourism. Every Year Tourism department is conducting so much of Ayurveda promotional programs inside and outside the country. Thus Ayurveda carries important role in Kerala's Tourism promotions.

SIGNIFICANCE

Kerala Tourism departments special care and protection leads the quality of Ayurveda treatment. Before so many small shops conducted Ayurveda massages. Now Government gives strict order for stop all illegal Ayurveda Centers. Government appoint a commission to the promotion and special care for patients and Consumers. Every Year Ayurveda Medicines, Oils, various Types of Pastes and other Ayurveda products are Exporting to Europe and USA. But there are some remote places and near the beaches still some illegal centers are working. They are appointing agents and not giving publicity, earning so many forging money and exploiting the virginity of Ayurveda.

LITERATURE

In this section a perusal of works in the field of Historical, Social and Economic issues related with Kerala Ayurveda Industry. The following books discuss the knowledge about Ayurveda and Kerala Tourism.

Government of Kerala Tourism Report, 2008: Kerala Tourism Department 2008 yearly report provide enough data about the relation between Ayurveda and State Tourism Department.

Ram Kumar. Kerala the land of Paradise (1991) contains vital information's about the origin of Ayurveda and how its related with Gods own Country.

Sivan. Kerala Wonders (1988) which gives detailed information about how Ayurveda became the part of Kerala Tourism.

In 1994 Manorama year book explained the merits and demerits of the Ayurveda.

The famous historian Swaminathan. His book History of Malabar analyses the socio-Economic conditions of early Kerala and after the embracement of Ayurveda how Kerala's financial stability had changed.

Some data are collected from state based Magazines and journals.

DATA COLLECTION

Most of the data's are collected from Books, Year reports, Magazines and Journals. Some are collected from authors visit in Ayurveda centers. Some are collected through questionnaire too.

METHODOLOGY

The methodology adopted in this study is mainly Historical. Descriptive. Both primary and secondary source materials have been used. The primary data for the study have been generated through structured formal interview method. The major tool for primary data collection was questionnaire.

The Secondary Sources include data collected from books, year reports related with the title, Magazines and journals.

HYPOTHESES

Ayurveda led the State of Kerala become stable Financial state in India.

Ayurveda provide so many job facilities to the citizens of the state of Kerala.

Ayurveda Create the strong pillar of the Kerala Tourism Industry.

Ayurveda realize the dreams and hopes of the poor Tribal citizens in Kerala.

ANALYSIS AND CONCLUSION

Last sixteen years onwards Kerala Tourism industry providing so much of job for common people through the upliftment of Ayurveda Industry. Most of the places of Kerala, with the help of State Government and Tourism department, they started Ayurveda spas. Every year it's attracting thousands of Domestic and foreign tourists. The Ayurveda physicians of Kerala have evolved various methods of treatment for the rejuvenation of the body and cure of diseases. Classified Ayurveda centers of the Department of Tourism offer a unique combination of Ayurveda treatment programs. A brief description of the procedures followed for different prime treatments are mentioned

1. **Pizhichil** : Pizhichil or Kayaseka is the process by which warm medicated oil is dripped continuously on the body of a person in a prescribed manner. A special medicated oil suited to the condition of the patient is applied on the head and then over the body of the patient sitting in the wooden thoni. It prevents and cures rheumatic diseases like arthritis, paralysis, nervous and sexual weaknesses, and nervous disorders. It is applied to a healthy person as a rejuvenate process.

2. **Dhara** : In this treatment, medicated oil, cow's milk, buttermilk, water or decoction, whichever is prescribed, is poured in a continuous stream on the head especially on the forehead in a specific manner. It is mainly done for mental tension, rheumatic complaints, skin diseases, and diabetics.

3. **Sirodhara** : In Sirodhara, lukewarm medicated oil is poured continuously as an even stream onto the forehead. As per Ayurveda, the head is the root of the human body and hence this procedure has a holistic relaxing effect throughout the body and is ideal for eliminating stress and strain.

4. **Vasthi** : Certain herbal oils and herbal extracts are applied through the rectum, daily for a period of 5 to 25 days. This is done for arthritis, paralysis, numbness, gastric complaints associated with rheumatism, and constant constipation.

5. **Sirovasthi** : This is a process of keeping medicated oils on the head usually up to 45 minutes. Sirovasthi is done for facial paralysis, dryness of nostrils, mouth and throat, severe headache, insomnia, burning sensation of the head, and other vatha created diseases.

6. **Kizhi** : A cloth bundle containing medical leaves and herbal powders is used to massage the body. These are applied to the whole body with hot medicated oils for 45 minutes per day for a period of 7 to 21 days. It is useful in muscular –skeletal disorders, other degenerative disorders, and neurological problems. It is highly effective for osteoarthritis, arthritis with selling, spondylosis, and sports injuries. It boosts blood circulation and infuses brightness and vigor.

7. **Abhyangam** : Through abhyangam, the human body becomes strong and lubricated. Based upon individual body constitution, special oils are used which stimulates the lymphatic system. This assists in the flow of nutrients in the body and removes toxins from the cells. It prevents ageing and has a rejuvenating effect. The body can be able to endure fatigue and physical exertion, induce sleep, improve complexion and strength, and prolong life. It is used for therapeutic and rejuvenate purposes. This treatment is very useful for obesity, especially for diabetics, etc

.8. **Nasyam** : Herbal juices and medicated oils are applied through the nose for 7 to 14 days. This treatment is highly effective for headache, mental disorders, and certain types of skin diseases (Data's are collected from KTDC).

Kerala has inherent uniqueness as regards tourism products such as backwater, eco-tourism, beach tourism, festival tourism, monument tourism, heritage tourism, and health tourism. Among these, health tourism is prominent. In health tourism, But Ayurveda stands unique.Mr. Subhash Goel, the Travel Agent Federation of India (TAFI) president (2005) shares his thoughts about Kerala. On his attributes, the recent successful trends in Kerala tourism; the major delight of Kerala is basically Ayurveda and backwaters. He lauded the manner in which the ancient health care's wisdom of Ayurveda was popularized, which has now become significant. On enhancing the promotion of tourism in Kerala, it has been made a role model for other states in India and can encourage them to revive ancient knowledge systems of India so as to add value to their tourism aspirations. Kerala is not only a beautiful destination in Southern India known for its scenic beaches and scenic backwaters but also, of late, Kerala has gained international attention for medical tourism and is becoming a popular international medical tourism destination. Tourists have also identified that Kerala has a pool of trained doctors and nurses, and an excellent network of hospitals that offer international standards at very affordable prices. Previously Indians working abroad such as residents of Kerala working in the Persian Gulf countries would return to India for medical treatment. Now, other international travelers have also realized the advantages of travelling to Kerala and the medical tourism industry has begun to take off in big way in the state. Kerala is famous for its alternative medical therapies such as Ayurveda which helps to rejuvenate and revitalize the body (Taken from TAFI Magazine: 2005).

OPINIONS FROM TOP OFFICIALS ABOUT KERALA'S AYURVEDA TOURISM

The centuries-old tradition of ancient Indian Ayurveda is fast turning Kerala into a global medical tourism destination, attracting holidays as well as International celebrities to the state.

When British super model Naomi Campbell landed in Kerala last year for an Ayurveda massage session at Leela Kovalam Beach hotel, she was only affirming the efficacy of the Indian healing system with God's Own Country as its torch-bearer in modern times.

According to sources in Kerala Tourism department, those who visited the state in recent times included Italian film director Bernardo Bertolucci, known for his global hits like Last Tango in

Paris and The Last Emperor, who came to the state for Ayurveda treatment for a nagging ailment.

German TV and film actress Ingeborg Schoener (77) has been trooping into the state for the last eight years for Ayurveda treatment. Completely cured of her painful knee problem, she thanked the tourism officials that she had stopped allopathic treatments. "Thanks to Ayurveda, I feel fantastic. I make ghee at home and have stopped using oil to fry food. I do my yoga, drink a glass of hot water first thing in the morning and buy one-year worth of Ayurveda medicines," a spokesperson for the department quoted her as saying.

Pop star Madonna, Hollywood actress Demi Moore and Cherie Blair, wife of former British Prime Minister Tony Blair, have also used Ayurveda for their well-being.

Back home, former Prime Minister A B Vajpayee is an ardent believer in the healing properties of Ayurveda's Panchakarma therapy. After his visit to Kumarakom lake-side resort, from where he famously "mused" on the state of the affair of the nation in 2000, Vajpayee told people around him that he felt very relaxed after Ayurveda therapy in Kerala.

Former President Pratibha Patil, spouses of Vice-President Mohammad Hamid Ansari, Kerala Governor Nikhil Kumar, German soccer legend Gerd Mueller's parents, Union Ministers Shashi Tharoor and A K Antony, Chief Minister Oommen Chandy and Tata Motors MD Karl Slym have all experienced the curative and wellness power of Ayurveda.

"Ayurveda, practiced in Kerala in its traditional and authentic form, has been a major attraction for tourists. We are now planning to leverage its healing and curative aspects, along with its wellness system, to woo tourists during the monsoon season", Kerala Tourism Secretary Suman Billa told PTI.

"It can help Kerala become a 365-day destination and ensure repeat visits by overcoming the element of seasonality," Billa said. "Symptoms of a large number of diseases, like arthritis, nervous system disorders, Parkinson's, asthma and skin ailment, flare up during monsoon but the treatment is also the most effective during this period as the atmosphere becomes dust-free and cool," he elaborates. The list of celebrities from the showbiz world, sports and politics, fascinated by Ayurveda's power to rejuvenate, detoxify and cure, is a never ending one (Data's Are collected from various Journals).

Kerala State Government identify the possibilities of Ayurveda Tourism, nowadays they are doing wonderful promotions in all over the world. While promotion of Ayurveda is done in print and electronic media, it is the travel agents abroad that do better marketing and give more exposure. They have a captive client base and can influence them to visit a particular resort or spa. Another good option to market and promote medical and health tourism including Ayurveda is participation in major travel trade fairs like ITB Berlin, WTM London etc. Apart from this, attractive brochures, CDs and other publicity material to promote Ayurveda in medical tourism is also being prepared. Guidelines for accreditation of Ayurveda and Panchakarma centers have been finalized and issued for implementation. All in the entire ball is rolling to en cash the potential of Ayurveda in medical tourism and even if there is severe competition among Ayurveda hospitals and resorts, the big beneficiary in any case are the Kerala Tourism and Ministry of Tourism and the GODS OWN COUNTRY Kerala.

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Sericulture Industry: Current Status, Problems and Prospects

***Kiran Lata*[*], *Jahangir Ali*[*] & *Jyoti Kachroo*[**]**

ABSTRACT

Sericulture is one of the important potential agro- based rural industry in the world. Asia being the largest producer of silk with China leading in its production as well as supply while India ranks second in silk production in the world after China having a share of about 15.49 per cent in the global production (Anonymous, 2013). It is a labour intensive rural cottage industry that plays a vital role in socio-economic development of rural masses by providing gainful employment opportunities to poor, small, marginal, landless farmers, agricultural labourers, women and weaker sections of the society as it needs low capital investment and provides returns within short gestation period. In the state of J&K it provides employment to 25500 rural families as a subsidiary occupation, by producing about 860 MTs of silk cocoon and generating an income of about 1100 lakh annually by cash. The paper analyzed the current status, pattern of growth in production and employment and also the agribusiness potential of sericulture. The study is based entirely on secondary data gathered from various published sources of government agencies like Department of Sericulture, J&K Government, Economic Survey (various issues) and websites. The paper has highlighted that

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despite fluctuations in growth, the production of silk, employment generated through sericulture activity has improved over the years. The study also explored that the earnings from export and import fluctuated over the years. The Sericulture industry no doubt has occupied a prominent place in the industrial development in Jammu and Kashmir but still its performance and progress is not up to the mark which may be due to many factors such as, non-availability of quality mulberry leaves, unscientific rearing techniques, poor quality of seed, competition from other crops, lack of proper extension activities and also the marketing, financial and other constraints, which act as an obstacle in various fields of sericulture activities.

Keywords: *Employment, Production, Growth, Mulberry and Sericulture.*

INTRODUCTION

Alleviating poverty and proving livelihood has remained the priority goals in a developing economy and sericulture is one of the important sectors of the economy in India that plays an important role in poverty alleviation. The sericulture industry is highly suitable in the context of diversification of farm enterprises and has the capacity to generate attractive income (Vijay Prakash and Dandin, 2005). It does not only offer periodic income, but also utilizes the untapped family labour for various activities. When compared to agricultural crops, it provides more employment round the year and fetches higher income to the rural farm families as the agriculture sector is confronted with a number of factors such as small land holding size, insufficient capital and investment incentives, the inadequate farm infrastructure, limited irrigation facility, limited market and stagnant prices of agriculture products etc that limits its potential for generating new jobs in rural areas. Also the silk sector is vested with some unique features as rural, agro-based, labour intensive, low investment and capital requirement, short gestation period, ecologically and economically sustainable. So establishment of rural based industries like sericulture, in particular, can be very effective in creating new job opportunities and providing supplementary income. Thus keeping in view this background present endeavor has been proposed with the following objectives.

OBJECTIVES OF THE STUDY

i) To analyze the trend in silk production in India and J&K.

ii) To make an assessment of cocoon production, employment and income generated under sericulture in the state.

iii) To examine the growth in export and import of silk and silk goods.

iv) To assess the problems faced by rearers and suggest suitable measures for its improvement.

METHODOLOGY AND ANALYTICAL TOOLS USED

The study is based on secondary sources of information collected from various published sources of government agencies like Department of Sericulture, Government of J&K, Annual reports of Central Silk Board, etc. As the data was not available as per the requirement so the data available was analyzed and the compound growth rate was computed to analyze the trends in silk production, exports and imports, cocoon production, employment and income generated through sericulture using the time series data of different periods using exponential function as follows:

$$Y = a\, b^t$$

and the log linear form

$$\log Y = \log a + t \log b$$

where, Y = Dependent variable

a = Constant term

b = Regression coefficient

t = Time variable in years (1, 2, 3…..., n)

Compound growth rate (r) was estimated as:

$$r = (b - 1) \times 100$$

The standard error of growth rate was computed as

$$SE(r) = \frac{[(100 \times b \times (S.E.\log b)]}{0.43429}$$

The significance of growth rate was tested by 't' test using the formula:

$$t_{cal} = \frac{r}{SE(r)}$$

$t_{cal} > t_{tab}$ (á$_{/2}$, n-2) significant r value at á level of probability

$t_{cal} < t_{tab}$ (á$_{/2}$, n-2) non-significant r value at á level of probability

n = number of years

á = 1 per cent or 5 per cent

RESULTS AND DISCUSSION

1. Production of silk in India and J&K.

   The raw silk production in the state and in country is presented in the Table 1. The table makes it clear that in the country silk production has shown increasing trend over the years and has increased from 17325 metric tonnes in 2000-01 to 28523 metric tonnes in 2015-16 showing a significant growth rate of 3.93 per cent. While the silk production in the state has varied over the years with a significantly high growth rate of 19.70 per cent. The highest production of 138 metric tonnes in the state has been attained in the year 2014-15.

Table 1: Scenario of Raw Silk Production in India and J&K (2000-01 to 2015-16)

Year	Silk Production (MT) India	Silk Production (MT) J&K
2000-01	17325	19
2001-02	17531	22
2002-03	16319	17
2003-04	15742	17
2004-05	16500	19
2005-06	17305	13
2006-07	18475	20
2007-08	18320	89
2008-09	18370	82
2009-10	19690	100
2010-11	20410	110
2011-12	23060	133
2012-13	23679	115
2013-14	26480	136
2014-15	28708	138
2015-16	28523	135
Growth Rate (%)	**3.93* (0.46)**	**19.70* (2.93)**

Source: 1 International Sericulture Commission; 2. Economic Survey (2010-11, 2013-14, 14-15); 3. CSB, 2016; 4. Department of Sericulture, J&K Government, 2015-16

***Significant at 5 per cent level of significance**

PRODUCTION OF COCOON, EMPLOYMENT AND INCOME GENERATED THROUGH SERICULTURE INDUSTRY

The employment pattern under sericulture industry in the country and the state is depicted in Table 2 which indicates that employment provided through sericulture activity has shown increasing trend over the years and has increased from 63 lakh persons in 2008-09 to 80 lakh persons in 2014-15 indicating a significant growth rate of 3.68 per cent and from 0.19 lakh persons to 0.30 lakh persons with a significant high growth rate of 6.71 per cent in the country and the state respectively.

Table 2: Employment Pattern in India and J&K (2008-09 to 2014-15)

Year	Employment (lakh person) India	Employment (lakh person J&K
2008-09	63	0.19
2009-10	68	0.22
2010-11	72	0.25
2011-12	75	0.26
2012-13	76	0.27
2013-14	78	0.29
2014-15	80	0.30
Growth Rate (%)	**3.68* (0.58)**	**6.71* (0.94)**

Source: 1. Sericulture Research and Development Council; 2. Economic Survey (2010-11, 2013-14, 14-15); 3. Department of Sericulture, J&K Government, 2015-16

***Significant at 5 per cent level of significance**

The trends in cocoon production and its productivity are shown in the Table 3 which shows that the cocoon production has increased over the years showing a positive/significant growth rate of 1.98 per cent. As far as cocoon productivity is concerned it has shown fluctuations till 2008-09 after which it attained increasing trend thus registering significant growth of 1.56 per cent.

Table 3: Cocoon production and productivity in J&K (2000-01 to 2014-15)

Year	Cocoon production (000 Qtls)	Cocoon productivity (kgs/100 Dfls)
2000-01	8.90	33
2001-02	7.14	31
2002-03	8.55	34
2003-04	6.80	32
2004-05	7.15	31
2005-06	7.15	33
2006-07	8.34	35
2007-08	8.03	34
2008-09	7.38	32
2009-10	8.10	35
2010-11	8.51	35
2011-12	9.47	37
2012-13	9.01	37
2013-14	10.21	40
2014-15	10.32	41
Growth Rate (%)	**1.98* (0.63)**	**1.56* (0.28)**

Source: 1. Economic Survey (2010-11, 2013-14, 14-15); 2. CSB, 2016; 3. Department of Sericulture, J&K Government, 2015-16

***Significant at 5 per cent level of significance**

The income generated from sericulture activity is depicted in Table 4 which shows that income earned by rearers through sericulture activity has fluctuated over the years and attained a significant high growth rate of 18.03 per cent. So it can be concluded that fluctuations in cocoon production, productivity, employment and income generated may be attributed to poor quality seed, unfavorable climatic conditions, unawareness about rearing techniques, post harvest losses, etc.

Table 4: Income generated under sericulture in Jammu and Kashmir (2006-07 to 2014-15)

Year	Income generated (lakh Rs.)
2006-07	726.00
2007-08	500.00

2008-09	455.67
2009-10	800.00
2010-11	1100.00
2011-12	963.00
2012-13	1193.00
2013-14	2200.00
2014-15	1700.00
Growth Rate (%)	**18.03* (4.11)**

Source: 1. Economic Survey (2010-11, 2013-14, 14-15); 2. CSB, 2016; 3. Department of Sericulture, J&K Government, 2015-16

***Significant at 5 per cent level of significance**

EARNINGS FROM EXPORT AND IMPORT OF SILK AND SILK GOODS

The export earnings from silk and silk goods and its import over the years are presented in Table 5. The highest figure has been attained in the year 2010-11 both in exports as well as in imports after which it has shown fluctuations registering a negative growth rate of -3.22 and -6.12 in case of exports and imports respectively.

Table 5: Exports and imports of silk and silk goods (2010-11 to 2015-16) Crore (Rs.)

Year	Exports	Imports
2010-11	2827.62	1741.67
2011-12	2303.56	1667.18
2012-13	2240.61	1708.56
2013-14	2381.59	1328.26
2014-15	2720.76	1332.04
2015-16	2406.19	1352.33
Growth Rate (%)	**-3.22 (1.02)**	**-6.12 (1.66)**

Source: Kumar 2017

PROBLEMS AND SUGGESTIONS

I. Constraints Faced by the Industry

i) **Supply of mulberry leaves**: The problem of regular and adequate supply of quality mulberry leaves to rearers at proper time and place and also its poor nutritional value affects badly the production of cocoons and makes the task less remunerative.

ii) **Un-scientific rearing techniques:** Silkworm is very delicate and sensitive to natural environmental fluctuations so should be reared under controlled conditions for uniform growth, and development. Being unaware, illiterate and poor the rearers completely ignore the essential management practices, which have significant role on the growth and health of larvae and ultimately the produce.

iii) **Poor quality of seed:** The success and sustenance of sericulture industry depends on the quality of silkworm seed. But unfortunately the silkworm seeds available to reares are of poor quality, as a result of which they get cocoons of poor quality.

iv) **Financial constraints:** There is no provision of loan for the rearers for silkworm rearing. Although some credit linked schemes are there in the department, but are not effective. The rearers associated with sericulture are poorest of the poor of society and has not an easy access to the department, so leave the idea of these credit linked schemes. Besides this there are no insurance schemes for the loss of crop by diseases at the final stage, which would have worked as an incentive to the rearers and thus keep their interests alive in the sericultural activities.

v) **Competition from other Crops and Handicrafts:** The silkworm rearers don't find sericulture more economical and get comparatively lesser returns from it. Also this activity takes place only once in a year so due to this other cash crops prove more attractive for them.

vii) **Other constraints:** Lack of proper extension activities, illiteracy/ ignorance of the rearers, unawareness of benefits of sericultural activities etc. are responsible for the its poor performance.

II. Suggestive Measures

i) Modernization in mulberry cultivation and propagation of quality mulberry varieties to have a quality crop

ii) Providing farmers with adequate and timely supply of disease free eggs and should be made aware and trained about the scientific rearing techniques.

iii) The joint efforts should be made by the researchers, extension specialists, and farmers for testing the sericulture technologies appropriate for local conditions and also popularization of low cost technologies at farmer level.

iv) Awareness about the benefits of sericulture activity among farmers to boost their interest in sericulture.

v) Rationalization of marketing of cocoons and raw silk, and provision of proper and timely marketing facilities

vi) Promoting this enterprise in hilly, border, remote or backward areas.

SUMMARY AND CONCLUSION

Sericulture has been promoted as an agro-based, labour-intensive, rural cottage industry in India. It can provide subsidiary employment to farmers in India that are poor and not employed throughout the year and can augment their incomes. The state of Jammu and Kashmir has tremendous potential to meet the demand of good quality raw silk of international standard as it has suitable agro-climatic conditions for the development of silk industry. The industry has showed a positive trend in cocoon and silk production over time but unfortunately no significant progress has been made due to several constraints. Hence efforts are needed to overcome the problems of this sector not only to increase the employment opportunities but also to promote exports and it is the need of the hour to shift to improved varieties and scientific techniques of rearing for increasing the production of silk of international quality as well as for long term development of the industry.

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Evaluation of Impact of Education Facilities on Social Status of Migrant Families

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ABSTRACT

Education serves as a symbol of social status and a source of white-collar jobs. It is due to such social and economic utilities of education that the desire to achieve it usually entails migration. The incentives in education create a self-motivated desire among the young people to be educated. Education helps in sharpening the abilities, increasing the knowledge, improving the communication skills and brings change in one's behavior to be more participative which in turn helps in attaining respect in the society. The study has been evaluated the level of education change in migrants after migration and impact of migration on social status of migrant families. By use of statistical tool like average mean and chi- square test it has been evaluated that the level of education has increased after migration and showed significant impact of education facilities on social status of migrant families.
Keywords: *Education, social status, migration, level of knowledge and level of confidence.*

INTRODUCTION

Human migration is a universal phenomenon. It is frequent feature of a vibrant population all over the world. Migration is the process through which people move from one area to another area with the purpose of settling in the new area temporary or permanent.

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Tendency or willingness to migrate to a new place takes place when people either find lack of socio-economic opportunities in the place of origin or they get attracted toward new places for leaving a better life. As a result of migration people have to adjust themselves to the societies and cultures of the places to which they migrate. The problem and extent of the adjustment of the migrants to the new cultures is important both from the point of view of the societies and culture of the places to which they migrate. It is also important from the point of view of the preservation of their own values and practices in the new place as well as their contacts with and their adaptation to the new conditions. Hence social scientists in universal and sociologists in general have been taking an intense interest in the problems, dimensions and issues related with migration.

CONCEPT OF RURAL TO URBAN MIGRATION

Rural-urban migration is a form of so-called internal migration which means a movement within a country and which stays in contrast to international or intercontinental migration. It refers to the movement of people from the countryside respectively the rural areas into the cities, often the metropolitan cities of a country. This change of residence is often connected with the migration of labor and a career change from primary to second or third sector - not necessarily, though, as it can refer to the migration of people who are not working in agriculture or farming as well. It is obvious that these developments always show their two sides: one side or the area of destination gains population whereas the other side respectively the area of origin looses people.

REVIEW OF LITERATURE

Following studies have been reviewed which portrayed social and economic issues of migration.

Dineshappa and Sreenivasa (2014), the study focused on the extent and types of internal migration flow in India and also showed huge distresses connected with them. Before 1991 the rate of migration was less but it increased immediate after adaptation of new economic policy. Agriculture acted as the base of Indian economy as a result the type of rural to rural stream dominates in the migration process. Employment among males and marriage among female is the main reasons of migration in the country.

Gogoi and Kumar (2014), in this research it was explained that population problem has become one of the important problems of all human problems. The impact of population growth on economic development and social change in overloaded underdeveloped countries needs a thorough study for policy makers. A study of the casual factors explaining such regional variations. The main source of such investigation is the indirect data on place of birth recorded by the census of India and comparing the place of birth of a person with his place of enumeration at a particular census.

Kumar (2012), in this paper the author tried to make relation between migration, agriculture and weather variability and said that internal migration in India is a composite issue and number of factors affect it. On one side there is a concern that the economic growth in India is not contributing significantly to promote speedy urbanization in-line with the ordinary development arguments. There are also concerns that agricultural distress could be forcing migration of people to other economic sectors and regions in the short to medium term. In the later context, the role of weather variability in reducing agricultural productivity and hence contributing to migration is fast acquiring great importance as such; evidence may provide insights about the scope for migration as an adaptation strategy in the event of climate change.

Masthanaiah et al. (2014), in this study it was concluded that migrant workers engaged in the "Bhiwandi industrial area" are prone towards indulging in high risk behavior for STDs and HIV/AIDS. These risk behaviors are further heightened due to hardship and job stress. Migrant workers tend to get rid of monotony, loneliness and job stress by seeking consolation in different sorts of risk behavior. The study has also found that income, social networking pattern and substance abuse act as crucial determining factors for indulgence into high risk behavior. Availability of disposable income coupled with monotony and job related stress exert pressure for indulging in various risk behaviors. The potential spread of HIV/AIDS to family members of the migrant workers cannot be ruled out if immediate programmatic response is not made.

Niranjan Roy and Avijit Debnath (2011), in this paper, an attempt was made to investigate the impact of a variety of economic and noneconomic factors on net in migration and the impact of net migration on the level of economic development in fifteen major states of India. Using pooled cross section data for fifteen major states, it has been found that net migration is positively influenced by level of Per Capita Income and level of road infrastructure, and negatively influenced by unemployment rate and cost of living. The other variable, crime rate, has been found insignificant as a determinant of migration, indicating that people migrating from one state to other do not concern about risk of life, they are rather concerned about basic needs of life. Further, migration development relationship tested in the present study indicates that level of development is positively associated with net migration. This finding defends the controversial belief that migration is beneficial for development and there is no reason to raise voice against human mobility in the context of Indian economy.

K. Sunny and Hari K.S (2011), this paper tried to study the impact of remittances on various macroeconomic and developmental aspects for the Indian economy. For this, the data regarding remittances and some of the macroeconomic variables like GDP, PFCE, GDFC, savings, FDI, FII, export, import and balance of trade deficit etc have been analyzed for the period 1971-2008. The study showed that remittances has been consistently increasing at very fast rate for the last 15 years and showed significant implications on the above mentioned macroeconomic variables. The impact of remittances has been tremendous for both the household as well as the economy like India which is characterized by persistence of abject poverty and lack of opportunity for the able one in every aspect of their life.

Mohapatra Sanket et al. (2010), this paper was focused to find out the impact of migration and remittances on origin countries and on destination countries in the South. The study also summarizes incipient discussions on the impacts of migration on climate change, democratic values, demographics, national identity and security. In conclusion paper highlighted a few policy recommendations calling for better integration of migration in development policies in the South and the North, improving data collection on migration and remittance flows, leveraging remittances for improving access to finance of recipient households and countries, improving recruitment mechanisms, and facilitating international labor mobility through safe and legal channels.

OBJECTIVES OF THE STUDY

1. To study the change in level of education after migration
2. To study the impact of education facilities on social status of migrant families.

METHODOLOGY

The research has been evaluated the impact of education facilities on the social status of the migrant families. The study covered Udhampur District of Jammu Division as it is the District where people from all regions within or outside the state migrated. Sample has been selected from the number of household who have migrated from all regions within or outside the state to Udhampur. The increase in number of household took as the base for sample selection and data has been identified from 2001 to 2011 census. Convenient sampling has been used to select the sample from number of household migrated to urban area of different teshils of Udhampur District. Sample size of 280 has been used in the study.

ANALYSIS AND INTERPRETATION

So impact of education facilities on social status of the migrant have been evaluated by finding change in level of education after migration and then impact of education on social status.

Change in level of education after migration

The change in level of education has been checked through various factors:

(i) Increase in knowledge
(ii) Increase in skills
(iii) Change in way of talking
(iv) Increase in level of confidence

Table 5.1 (i): Do you Think Your Knowledge Increased After Migration

S.No	Increase	Frequency	Percentage
1.	Yes	272	97
2.	No	8	3
	Total	**280**	**100**

Source: Primary data

Table 5.1 (i) has portrayed the knowledge of migrants after migration. 272 (97 percent) migrant agreed with the statement that the knowledge has increased and only 3 percent are not agreed with the statement.

Table 5.1 (ii): Do you think your skills increased after migration

S.No	Increased	Frequency	Percentage
1.	Yes	269	96
2.	No	11	4
	Total	**280**	**100**

Source: Primary data

When people migrate there may change in the working skills of migrants due to education and other experiences. Table 5.1 (ii) is the representation of enhancement in skills after migration of migrant families in Udhampur District. About 96 percent of the migrant accepted that their skills increased after migration and only 4 percent are not agreed with the statement.

Table 5.1 (iii): Do you think that your way of talking changed after migration

S.No	Increased	Frequency	Percentage
1.	Yes	266	95
2.	No	14	5
	Total	**280**	**100**

Source: Primary data

In order to create good bounding with the people, way of talking play very important role. Table 5.1(iii) has showed the change in way of talking of migrants after migration. 266 migrant out of 280 has believed that their way of talking changed after migration and only 5 percent did not feel any change.

Table 5.1 (iv): Do you think your level of confidence increased after migration

S.No	Increased	Frequency	Percentage
1.	Yes	269	96.07
2.	No	11	3.93
	Total	**280**	**100**

Source: Primary data

Level of confidence play important role in success and this can come through education. Table 5.1 (iv) is the representation of change in level of confidence after migration. Maximum of the migrants (96.07) have agreed that their level of confidence increased after migration and only 3.93 percent says there is hardly any increase in their level of confidence after migration.

Table 5.1: Average change in education level after migration

S.No	Factors	Percent changed after migration	Percent not changed after migration
1.	Increase in knowledge	97	3
2.	Increase in skills	96	4
3.	Change in way of talking	95	5
4.	Increase in level of confidence	96	4
	Averages	**96 (approx.)**	**4**

Source: Primary data

From table 5.1 it was found that out of 280 migrants, about 96 percent were of the view that their level of education has increased because they have availed good education facilities in the Udhampur. Udhampur is the district where there are many good quality of private and public schools available.

Impact of education on social status of migrant families

Education is an important factor that makes change in social status. So impact of education on social status of migrant families has been checked through following ways.

(i) Education of their children before and after migration

(ii) Change in social status through education

Table 5.2 (i): Mcnemar test of children go to school pre-migration and after migration

Do all children's go to school pre migration & Do all children's go to school after migration		
Do all children's go to school pre migration	**Do all children's go to school after migration**	
	Yes	No
yes	103	17
No	157	3

Source: primary data

Chi Square $= \frac{(b - c - 1)^2}{b + c}$

Chi Square $= \frac{(157 - 17 - 1)^2}{157 + 17}$

Chi Square $= \frac{(139)^2}{174}$

Chi Square $= 111.040$

Mcnemar testDo all children's go to school pre migration & Do all children's go to school after migration	
N	280
Chi-Square **Asymp. Sig.**	111.040. 000

Source: primary data

Table 5.2 (i) showed Mcnemar non parametric test of two related samples of before and after migration. Under this method a difference score is calculated for each respondent.

Here in the above table value of p is .000 and it is less than .05. Hence, there is significant increase in numbers of children's go to school after migration.

Table 5.2 (ii): A. Do You Think That Your Social Status in Creased Before Migration Due to Education?

S.No	Increased	Frequency	Percentage
1.	Yes	60	21.4
2.	No	220	78.6
	Total	**280**	**100**

Source: primary data

B. Do you think that your social status increased after migration due to education?

S.No	Increased	Frequency	Percentage
1.	Yes	224	80
2.	No	56	20
	Total	**280**	**100**

Source: Primary data

Table 5.2 (ii) showed that majority of the migrants (80 percent) admitted that education has significant impact on maintaining social status in the receiving society. Though, during initial stage of migration they had experienced strange behavior of the people in the surroundings but education helped them in social interaction, social participation and developing relation with people of higher social status. So they have their own position in the society.

C. Mcnemar Test of Impact of Education on Social Status Pre-Migration and After Migration

Impact of education on social status pre migration & Impact of education on social status after migration			
Impact of education on social status pre migration		**Impact of education on social status after migration**	
		Yes	No
Yes		60	0
No		164	56

Source: primary data

Mcnemar test	Impact of education on social status pre migration & Impact of education on social status after migration
N	280
Chi-Square	162.006
Asymp. Sig.	.000

Table 5.2 (c) portrayed impact of education on social status before and after migration. By use of chi square test the impact of education on social Status has been evaluated. The value of p is .000 so, there is significantly increase in social status of migrant after migration. When people were at source area they are not able to get good

education. By coming at source area there level of education increased. This makes change in the social status of migrant. Education also helps them to get job at different sectors. Income of migrant increased and by these they able to create image in the society.

CONCLUSION

It has been evaluated that the people who are at rural area migrating because of better employment, educational, health and other attractions in the urban areas. An inadequate facility in the source area also has induced them to migrate. After migration there are large changes took place in the behaviour of migrants like earning of the migrant household increased, level of saving increased and Consequently living standard also uplifted. At destination area the access of migrant to better education facilities helped them to avail more quality education which provide them opportunities to get good jobs in different professions with result they get more recognition in the societies. So their participation in social functions increases and they get chance to get their children married in educated and well settled families. Change in level of education facilities has impacted on their social status due to increase in their knowledge, level of confidence and by change in their language after migration.

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Effectiveness of Public Distribution System (PDS): A Case Study of Village Sarore

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ABSTRACT

PDS is primarily a social welfare and antipoverty programme of the Government of India. Essential commodities like rice, wheat, sugar, kerosene and the like are supplied to the people under the PDS at subsidised prices. The Indian public distribution system first evolved 1940 as general entitlement scheme and in 1997 the PDS was revamped as the targeted public distribution system (TPDS) to target large poor households. The Government of India in 2000 launched Antyodaya Anna Yojana scheme in 2000 to provide food to the poorest of the poor so that no can die from hunger and food make available at a very low cost than the market price. In 2013, the Government of India makes right to food as a legal right. Even though, J&K has one of lowest percentage under below poverty line but the state Government running PDS scheme successfully with few shortcomings. The paper is an attempt to study the PDS system in a small village Sarore of Bishnah Tehsil of Jammu district of J&K. The present study is an attempt to study the effectiveness of public distribution at micro level.
Keywords: *Public distribution, Antyodaya, Subsidized, Below Poverty Line*

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INTRODUCTION

The public distribution system is an Indian food security system established by the government of India under the ministry of consumer affairs, food and public distribution. It is a government-sponsored chain of shops entrusted with the work of distributing basic food and non-food commodities to the needy sections of the society at very cheap prices. Commodities distributed include staple food grains, such as wheat, rice, sugar. All through the ups and downs of Indian agriculture, PDS was continued as a deliberate social policy of the government with the objectives of: i) Providing food grains and other essential items to vulnerable sections of the society at reasonable (subsidized) prices; ii) to have a moderating influence on the open market prices of cereals, the distribution of which constitutes a fairly big share of the total marketable surplus; and iii) To attempt socialization in the matter of distribution of essential commodities.

Evolution of Public Distribution System (PDS)

Evolution of PDS	Timeline	Details
PDS	1940	Launched as general entitlement scheme
TPDS	1997	PDS was revamped to large poor households
Antyodaya Anna Yojana	2000	Scheme launched to provide food for poorest of poor
NFSA	2013	Act to provide legal right to food to poor

STRUCTURE OF PDS IN INDIA

India is aiming at self-sufficiency in food grains since independence. Different schemes have been launched time to time to work in this perspective. Rationing in India has been done through various schemes launched by the government. In the 1960s there was an actual shortage of food grains that occurred. In 1970s poverty was analyzed by NSSO and three important systems were launched:-

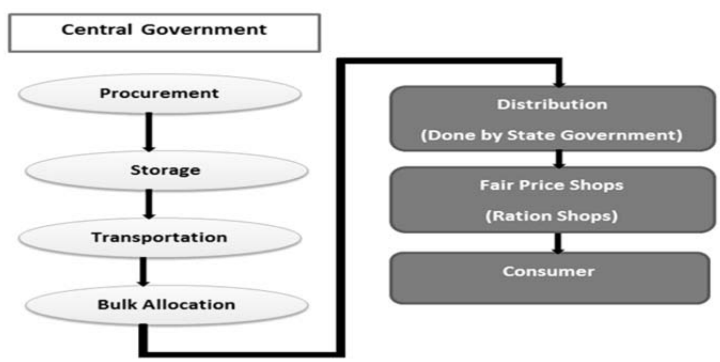
- Public distribution system for food grains
- Integrated child development services (ICDS)-1975
- Food for work(FFW)-introduced in 1977-78
- Besides these, there have been poverty alleviation programmes launched by the government specifically focusing on backward areas.

Under this Public distribution system, there have been three types of ration cards as per NFSA (2013) for categorization of the beneficiary. The new NFSA categorizes households mainly into two: priority and non-priority.

WORKING OF PDS

Public Distribution System is a network whereby accessibility of vital supplies is guaranteed which can be easily accessed by the consumers in every part of the country. This is a transaction system where food grain, sugar, and other needed items such as kerosene oil and edible oil are made available to the people of the state at a fair price to meet their minimum needs. Regular and timely availability of supplies is assured through close monitoring system to make Public Distribution System an effective instrument against various forces in the open market and to keep under check the inflator tendencies. The main commodities are as follows: (a) Wheat, (b) Rice (c) Sugar and (d) kerosene.

Working of PDS



STRUCTURE OF PDS IN J&K

The department of food, civil supplies and consumer affairs is entrusted with the responsibility of distribution of essential commodities namely rice, wheat, sugar, kerosene oil, under PDS. The department implemented the NFSA (2013) in the whole of J&K state w.e.f. 1st of February 2016 with the objective to provide access to adequate quantity of quality food at affordable prices. Currently, food grains are received by the state from the government of India for distribution among (AAY), Priority household (PHH) and non-priority household (NPHH).

SCHEMES

1) NFSA (2013) has been implemented w.e.f. 1st February 2016. As per the act, eligible beneficiaries under priority household are entitled to receive 5 Kg of food grains per soul per month at a highly subsidized price of Rs 3/2 per Kg for rice/wheat. However the existing beneficiary under poorest of poor, continue to receive 35 kg of foodgrains per household per month. Under NPHH category the beneficiaries are provided food grains at a scale of 5kg per person per month at a subsidized price of Rs 12 per kg of wheat and Rs 15 per kg of rice.
2) The government has introduced Mufti Mohd. Food Entitlement Scheme (MMFES) to provide additional food grains to beneficiaries under NFSA which envisages providing of additional 5 Kg of food grains per soul to beneficiaries having a family size from 1-6 over and above NFSA scale from 1st July 2016.

REVIEW OF LITERATURE

Singh (1991) in his study, he analyzed the Public Distribution System in Bihar. He stated a number of serious deficiencies in the system. He prescribed a package of 27 measures to improve the working of the system. He emphasized the important contribution of the Public Distribution System towards poverty alleviation in rural areas. Venugopal (1992) in his study, he indicated the record of food production, the unfair distribution of food grains among the population. He discovered that some States which did not produce enough food grains had a far better record of providing food for the poor than certain states which had a surplus. He also found that the rural poor have not been benefitted to any significant extent by the present Public Distribution System. He stressed the need to involve the community in food management. Finally, he proposed an alternative Public Distribution System more in favour of the poor by dovetailing the Rural Development and Rural Employment Program while at the same time ensuring availability (though not at lower prices) for the urban non-poor. Bhagawati and Srinivasan (1993) have also suggested a shift to a system of food stamps that enables the holders of these stamps to pay for part of the cost of the purchases from the open markets. They suggest that food stamps be issued only to persons belonging to a target group, with the value of food stamps fixed in nominal terms or indexed to some commodity. Madhura (2000) in his study an important feature of the PDS is that the responsibility for implementation, monitoring and for enforcement of legal provisions relating to public delivery rests with the state government. Himanshu and Sen (2011) proposed a scheme, there would be three constituencies entitled to purchase subsidized grains at different prices. Based on projected demand for 45 PDS grains at these prices, the authors estimate the annual outgo subsidy required at Rs 794 billion. The lowest of these pure subsidy estimates could be financed within the current overall food subsidy budget but would leave nothing for other programmes. Moreover, none of the estimates includes the running costs of an enlarged semi-universal PDS. Gairola (2011) in this study, he pointed out that the Public Distribution System in the country facilitates the supply of food grains to the poor at a subsidized price. Essential items such as selected cereals, sugar and kerosene at subsidized prices to holders of ration cards is the objective of efficient Public Distribution System. The PDS also helps to modulate open - market prices for commodities that are distributed through the system. Gundegowda and Nagaraj (2011) in their study, they indicated that Public distribution is essential to the developing countries like India. But this system has been weakened for several reasons for effective and transparent implementation of this needs suggestions. Profit of margin given to FDD is very less. This may lead to malpractices and diversion. The government should enhance the present margin amount. Enforcement may be passed to initiate strict actions against malpractices. Establishing of gowdons in a conspicuous place is one of the reasons for improper implementation of this scheme. Bhat and Bhat Arshad Hussain (2012) in their study, they stated the main objectives of the PDS can be summarized as follows: i. maintaining price stability. ii. Raising the welfare of the poor (by providing access to basic foods at reasonable prices to the vulnerable population). iii. Rationing during situations of scarcity, and iv. Keeping a check on private trade.

STATEMENT OF PROBLEM

Analyses of PDS have revealed several gaps in implementation. These challenges pertain to the inaccurate identification of household and a looking delivery system. Expert studies have shown that PDS suffer from an error of exclusion and misclassification of poor and non-poor. Another challenge is the leakage of food grains during transportation to the ration shop. Therefore our field of study includes proper functioning of the Public distribution system in the concerned village and problems associated.

OBJECTIVES

During September 2013, parliament passed the national food security act (NFSA), 2013 and it has been implemented in J&K w.e.f. 1st Feb, 2016. The NFSA seeks to make the right to food a legal entitlement by providing subsidized food grains to nearly 2/3 of the population. The act relies on the existing targeted public distribution system (TPDS) mechanism to deliver these entitlements. The note describes the functioning of existing PDS mechanism and alternatives to reform the existing mechanism. Keeping in view the importance of food security, the study was conducted which has following objectives:

1. To study the level of food security in the village.
2. To understand the problems related to proper functioning, distribution and leakage of commodities under PDS.

RESULTS

Village Sarore is an average settled village and one-third of have average income is Rs 3000-15000 and the same percentage have income more than Rs 25000. One-fourth of the village has not availed any sort of Govt. scheme like loan or pension's scheme for old age people. Only 7.5 percent of the respondents responded that their family members have been availing old age pension scheme. Nearly about of 18 percent have taken the loan and 8 percent of them have taken a loan for their kid's educations. In the study area, most of the people are engaged in primary sector jobs and either they engaged in agriculture or doing minimal jobs like driving, shopkeeper, factory worker and labouring. More than one-fourth of the residents are engaged in Government jobs. It is interesting to know that the most of the villagers have LPG connections. When asked about when did they start using LPG for cooking? They responded that for the more than five years they are using LPG of cooking and it is very easy to use and good for health especially women. Previously, we were using rudimentary chullahs for cooking which was totally unhealthy. None of the villagers except one responded that they availed the benefit under scheme UJWALA (free LPG connection).

QUANTITY AND QUALITY

Public distribution scheme has been considered as the flagship programme of Government of India. By this programme, Government provides food to a large number of people of India at an affordable cost so that no one can go to bed without an empty stomach. In the study area, ninety percent of the household have above poverty card (APL) while remaining have below poverty card (BPL). In BPL card, the household receives food at the very low cost. None of the households has availed Antyodaya cards in the Sarore village. All of the village households have the old type of cards. Most of the respondents of the Sarore village said that food grains are not available to them in time and they said ration shopkeeper open ration shops according to their convenience and will. Most of the ration shops are nearer to the respondent's house. During the survey, it was also asked about the quantity and quality of the food grains. Twenty-five percent of the respondents responded that they have not received rice or wheat from the ration shop. Twenty percent of the respondents said they received only three and ten kg of rice and wheat and fifty percent received five kg of rice and fifty-five percent of the villagers received twenty kg of wheat from the rations shop. In terms of sugar availability government stopped the distribution. Only priority household is eligible for sugar (500 gm/person). Seventy-five percent of the household responded in positive that they are receiving kerosene oil at the rate of Rs 24/litre. The availability of kerosene is also very erratic and most of the villagers informed that the kerosene dealer sold the kerosene oil in the black-market. In Sarore village, nearly about all of Sarore village said in one voice that is not satisfied with the quantity of food grains they are receiving under public distribution scheme as the quantity of food grains is very minimal as their needs are large because their family size is large. More than fifty percent residents said that they are receiving a very inferior quality of food grains most of the time and when you complained about the quality of the food grains. The shopkeepers shouted at them if you don't like it then leave it. Moreover the ration shopkeeper charge the villagers with the same price whether villagers are BPL or APL card holder.

LEAKAGE IN PDS

Most of the respondents have a firm believe that the ration shopkeeper indulged in hoarding and black marketing. They also reported that they complained about these activities to the superior officer for necessary action but in reality, no actions have been taken till now. They now have a strong belief that there is no need to complain as in reciprocal the shopkeeper will not give the due ration and harass unnecessary from time to time.

CONCLUSION

The public distribution system is the largest distribution system of its kind in the world. We have conducted field survey with an objective to measure the effectiveness of PDS in village Sarore. The study was designed with an objective to explore the effectiveness of PDS in ensuring food and nutritional security to beneficiaries. The system was judged based on the adequacy of supply of commodities in relation to the requirement of consumers and lot of gap was found between supply and demand. The study has provided interesting clues about the impact of PDS on poor. PDS has no doubt benefitted the poor but there are many leakages in its implementation. There is the untimely availability of food grains. People in the village are receiving food grains after three months. The quality of the food grains is also inferior. The charges for APL and BPL card holders are same. There are many people in the village above average procuring ration through BPL cards. There is no check on that. The development in the village can be observed through income structure and basic household amenities which is such that the percentage BPL card holders should be less than 5%. As per the information gathered through the people there are about 11.8% of households who are above average procuring ration through BPL cards. The dealer is engaged in hoarding and black marketing of food grains. Stocks pile up in ration shops while poor go without food. There are many households who deserve to have BPL card are having APL cards. Many people are reluctant to file a complaint against their dealer while some people have file complaint against their dealer but didn’t find an equal response. The mechanism is very slow. The main weakness of the PDS is that it is not benefitting vulnerable sections of the society who actually deserve to the extent for which it is expected to. The main weakness found out in PDS has been its inability to reach the poor effectively. The commodities arrive late and irregularly. Even when people get the ration, it is of poor quality and much less in quantity. The survey revealed that all the customers want a rise in the allotted quota of goods especially rice and sugar.

SUGGESTIONS FOR BETTER FUNCTIONING OF PDS

People in the village have shared their opinions regarding proper functioning of PDS in a way so that it could benefit the beneficiary. People are of the view that food grains should be available timely, quantity should be increased, some are of the view that they should have BPL card and there should be a proper check on the black marketing of commodities.

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Hippophae Salicifolia (Seabuckthorn): Source of Economic Development in Higher Himalayan Region

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ABSTRACT

Hippophae salicifolia D. Don is widely distributed in Indian Himalaya but the species has not gained so much popularity and is used only by the people residing in the vicinity of its natural pockets. It has a strong nutritional potential, fruit juice and pulp are considered rich in Vitamin C, A, E, B, amino acids, minerals, and other phytochemicals. Oil obtained from seeds and pulp has special consideration, both pulp and seed oil is rich in carotenoids, flavonoids, tocopherol and omega fatty acids. It also posses antimicrobial, antioxidant and anti stress properties. The present manuscript reviewed the scientific basis of economic importance of H. salicifolia, *which represented its great commercial value to uplift the rural economy of Indian Himalaya.*

Keywords: *Hippophae sallicifolia, Nutraceuticals, Oil, Antioxidant and Tocopherols*

INTRODUCTION

The Himalayan region has fabulous wealth of flora and fauna, some of them are of great importance. *Hippophae* (Sebuckthorn) is among those genus of plants which is valuable with its multiferous benefits.

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Hippophae species are used in Materia Medica of several traditonal medicinal systems (Suryakumar and Gupta, 2011) with its high nutritional value as well as medicinal importance (Achaarya *et al*., 2010). Genus *Hippophae* belongs to the family Elaeagnaceae and order Daphnales, commonly known as Seabuckthorn and Leh berry in India. Presently six species of the genus *Hippophae* have been reported in all over the world, *viz H. rhamnoides, H. salicifolia, H. tibetana, H. gonicarpa, H. gyantensis*, *H. neurocarpa*. Three species have been from Indian cold desert *i.e. Hippophae rhamnoides* L., *H. salicifolia* D. Don. and *H. tibetana* Schlecht. These species are distributed in higher elevations of Indian Himalayas from Ladhakh (J&K) to Lahul Spiti (HP), Uttarakhand, Sikkim and Arunanchal Pradesh (Chauhan, 1999).

H. salicifolia is a less explored species of Seabuckthorn, preferred to grow in lower altitude (6500-9000 feet) and distributed in north western region of Pakistan, Himachal Pradesh, Uttarakhand and north-eastern India (Rausi, 1971; Singh 1994; Gupta and Ahmed 2010). Due to its high nutritional and medicinal value, the species also gained importance along with other species of *Hippophae. H. salicifola* is a deciduous, dioecious, thorny, small tree or erect shrub with reddish brown bark. Leaves are broad, oblong, lanceolate, stellately pubescent above when young, densely white- tomentose or stellately hairy beneath, usually 5-10 cm long and leaf margins are curved. Flowers in clusters, male flowers are yellow-brown with two scaly leaves and usually with four stamens. Female flowers are short-stalked and two-lobed with exerted stigma. Fruits are yellow to orange in color having black to brown solitary seed with shining surface (Chaurasia *et al*., 2009).

Various studies revealed that *H. salicifolia* is also rich in all valuable biocomponents like *H. rhamnoidies*. All plant parts such as leaves, shoot, bark, fruits etc. are considered rich source of numerous bioactive compounds such as flavonoids (isorhamnetin, quercetin, myricetin, kaempferol and their glycoside compounds), carotenoids (â and ä-carotene, lycopene), vitamins (C, E, K), tannins, triterpenes, glycerides , palmitic, stearic and oleic acids, and some essential amino acids (Xiao, 1980). These properties of *H. salicifolia* provides nutritional securities as well as the many ways of income genration to the rural people of those Himalayan region, which having abundance of *H. salicifolia* growing pockets .

AIM OF THE STUDY

The aim of present study is to access the economic potential of Seabuckthorn (*Happophae salcifolia)*, a well known plant of higher Himalayan region.

OBJECTIVES

The study was aimed with the following objectives:

- To analyze the food, cosmetics and herbal tea potential.
- To analyze the health supplements and nutraceutical potential.

METHODOLOGY

The present study was fully based on secondary sources and the data was collected from various sources such as published research articles and review papers, etc.

FOOD AND FOOD ADDITION POTENTIAL

Complete benefits of *H. salicifolia* are not utilized properly by local people of *H. salicifolia* growing region. Locally it is used for chutney, juice, substitute of tomatoes, fuel wood and fencing, sometimes in veterinary and medicinally in regions of its natural habitat (Dhyani *et al*., 2010). Various studies have highlighted the nutritional and medicinal value of the fruits, seeds, leaves and bark of *H. salicifolia* (Yadav *et al.,* 2006). Yadav *et al.,* 2006 studied the properties of fruit juice of *H. salicifoia* growing in Harshil region of - Uttarakhand and found that, Juice acidity (% citric acid) ranges from 4.89 – 7.93, TSS (ºB) (Juice) from 7.07 - 10.00, TSS: Acidity ratio from 1.24 - 1.76, Juice (%) from 70.70 - 79.23. Juice percentage in the berries of Harshil region was higher than earlier findings of Chauhan, 1999, Heilsher and Lorber, 1996 which reported 65-68 percent juice yield in berries of *H. rhamnoides*. They also concluded that high and wide variability of acidity and total soluble solids indicated the importance of this species used in preparation of value added products such as ready to serve beverages, jam, jellies, candies etc. *Hippophae* spp. is considered important mainly due to the nutritional value of its fruits; Vitamin C (ascorbic acid) is present as a nutrient of primary importance in them and reported highest in *H. salicifolia* (Singh, 2009) among all the species of Seabuckthorn. The juice of this species is also rich in carotenoids (156.7 mg /L), flavonols (350.53 mg /L, Singh and Sawhney, 2005), vitamin E (33.1mg /kg, Singh and Singh, 2001) and minerals like - Zn, Cu, Fe, Ca, Mg, Na and K (Singh *et al*., 2001). Such properties of *H. salicifolia* fruits are providing nutritional securities and opportunities for income generations for local people by preparing value-added products (jam, jellies, squash, and pickles).

HERBAL TEA POTENTIAL

Hippophae spp tea is sold in the market by different brands under different trade names, which is mainly prepared by leaves and dried fruit pulp of *H. rhamnoides*. Chemical profiling of *H. salicifolia* proofed its strong potential as a candidate for herbal tea producing plant. The market of herbal tea is gradually increasing in the global scenario, due to its high antioxidative potential. Sea buckthorn leaves posses various antioxidative nutrients and bioactive substances. Leaves barks and fruits of *H. salicifolia* are rich in polyphenols, flavonoids and other antioxidative compounds (Goyal *et al*., 2011; Wani *et al*., 2013). Besides its antioxidative richness, *Hippophae* tea also provides various health benefits like weight lose antimicrobial, anti inflammatory and anti-arthritis, properties, soothing,energizer,anti-stressand stimulants (www.healwithfood.org).

H. SALICIFOLIA AS HEALTH SUPPLEMENTS AND NUTRACEUTICALS:

Hippophae spp. is rich in flavonoids, polyphenols, vitamin C, vitamin E, dietary fibers, antioxidants and unsaturated fatty acids etc. Fruits juice and pulp are considered rich in Vitamin C, Provitamin A, Vitamin E, Vitamin B, amino acids, minerals, and other phytochemicals, thereof *Hippophae* sp. have the potential for the development of health supplements and nutraceuticals (Dwivedi *et al*., 2009). Most effective health supplement of *Hippophae* in the global market is its oil, for omega 7 fatty acids, obtained from its pulp and seed oil. Palmitoleic acid is an important omega fatty acid present in sufficient amount in all *Hippophae spp.* The species is known for its lower susceptibility to oxidation as compared to other polyunsaturated fatty acids, providing stability during frying and baking (Thakur *et al.,* 2015). Both seed and pulp oil of *Hippophae spp.* is rich in carotenoids, tocopherols and sterols which significantly differ in its chemical characteristics. Fatty acid composition of *H. rhamnoidies* along with *H. salicifolia* studied by Ranjith *et al.,* 2006 and Singh and Gupta, 2015 revealed, the chemical composition of oil of both the species which shares many common features. Various fatty acids studied differ quantitatively but their existences were found in both species**,** pulp and seed oil of *Hippophae spp.* are rich in saturated and unsaturated fatty acids involving the essential fatty acids *viz.* alpha-linolenic acid, linoleic acid and conditionally essential fatty acid like gama-lnolenic acid.

These studies proved that *H. salicifolia* is suitable for human consumption, consists high value of key unsaturated fatty acids (UFAs) such as linoleic acid (15.0, 16.1, 15, 14.3%), á -linolenic acid (1.3%). In *H. salicifolia* ã –Linolenic acid is present in both pulp and seed oil (0.043, 0.056 %) whereas, it is present in traces in *H. rhamnoidies.* Other FAs (Fatty acids) are either in the range of *H. rhamnoides* or slightly in higher or lower concentrations. The fatty acids profile of *H. salcifolia* proves that pulp and seed oil of *H. salicfolia* can also be commercialized as omega fatty acid supplements. Total UFAs are generally higher in pulp oil, and total SFAs (Saturated fatty acids) are higher in seeds oil, so according to needs, plant source should be selected. Ranjith *et al.,* 2006 revealed that, *H. salicifolia* fruit pulp is rich in flavonols, vitamin C and also contain carotenoids and tocopherols and thus can be used for the production of antioxidative products. Carotenoid contents is the basis of commercial trade of sea buckthorn oil (Beveridge, 1999) although *H. salicifolia* contain a lower amount of carotenoids than other *Hippophae* species, still the content is favorable enough. On the basis of these studies, it could be suggested that, *H. salicifolia* can be explored for production and commercialization of various *Hippophae* health supplements and nutraceuticals.

COSMETICS POTENTIAL

Essential fatty acids, long chain alcohols, and sterols in the products are essential nutrients supporting the regeneration of skin cells and restoration of skin barrier structure (Yang *et al*., 2009). Role of Linoleic acid in the skin is significant due to its capacity to strengthens the lipid barrier of the epidermis, protection against transepidermal loss of water and maintaining skin metabolism normal. In oily and acne, prone skin use of Linoleic acid leads to improvement of the work of sebaceous glands, unblocking of pores and decrease in the number of comedos and eczemas (Zieliñska and Nowak, 2014). Flavonoids, carotenoids, and tocopherols not only protect the skin from oxidative damage but also alleviate the effects of sunburn, stimulate healing and soothe irritations (Yang *et al*., 2009). On keeping these benefits in mind various cosmetics are produced with *H. rhamnodies* such as oral beauty supplements, base of creams, emulsions, cosmetic milks and creams, ointments, hair conditioners and shampoos, cosmetic masks, lipstick and lip balms, bath fluids etc. *H. salicifolia* is also rich source of flavonoids, vitamin C, and E, fatty acids, carotenoids and various cosmetically essential fatty acids, proving itself as a strong candidate in cosmetic industry.

FODDER POTENTIAL

The studies on the chemical composition of *Hippophae spp.* found that leaves and fruits are very rich in total crude proteins, digestible nutrients, vitamins and other nutrients, as compared with other feed and fodders fed to animals. Various poultry and cattle feed were prepared by CSK Agricultural University Palampur, Himanchal Pradesh by Seabuckthorn species using leaves, fruits, and cakes. This positively enhanced the overall health of poultry and cattle and increase egg and milk production. In Indian Himalaya where farmers and cattle grazers solely depend on grasses and some higher fodder plants for nourishing their animals, in high altitude areas during dry cold seasons processed leaves and fruit cakes of *H. salicifolia* can be used as a source of animal feed due to the presence of its nutritional component.

Table 1: Physico-chemical properties of oil (% w/w) of H. salicifolia and H. rhamnoies

Parameters	H. salicifolia	H. rhamnoides
Refractive index	1.473	1.473
Butyro- refractometer Reading	71	71
Specific gravity	0.922	0.916
Acid value	4.66	4.01
Peroxide value	18.30	17.50
Iodine value	154.95	150.35
Saponification value	184.32	230.20
Unsaponifiable matter	0.78	0.60
Vitamin E	27.68	30.80

(Source: Kaushal and Sharma, 2011)

Table 2: Comparative Characterstics of H. salicifolia and H. rhamnoides

S. No.	Parameters	H. salicifolia	H. rhamnoidies	References
1	Fruit size (gm/100 seeds)	30-35	8-27	Singh, 2009

2	Seed size (gm/100 seeds)	0.943-1.142	1.103	Singh, 2009
3	Crude protein (Leaves %)	21.6	17.5-20.5	Singh, 2009
4	Total fat content (Leaves %)	4.6	3.5-4.8	Singh, 2009
5	Total oil content (%)	2.0, 10.5	3.2- 4.6, 8.8-14.6	Ranjit *et al.*, 2006Singh *et al*. 2005
6	Vitamin C/100g fruits	29840, 947 mg	4877, 219-642	Singh *et al*. 2005
7	Flavonols (mg/kg fruits)	428 , 350.3	308, 208- 308	Singh and Sawhney, 2005
8	Carotenoids (mg/kgfruits)	163.7 mg/kg	156.7	Singh and Sawhney, 2005
9	Minerals	Zn, Cu, Fe, Mg, Na, K	Zn, Cu, Fe, Mg, Na, K	Gupta and Singh,2005
10	Tocopherols (mg % oil)	248.2 (seed), 134.3 (pulp) 33.1 mg	88.4 mg	Ranjit *et al.*, 2006 Lu, 2005Singh and Sawhney, 2005

CONCLUSIONS AND FUTURE PERSPECTIVES

H. salicifolia is distributed in Himalayan states of India from western to north- eastern Himalaya in subtle form, most of the native people was not aware about its existence and its multifarious purposes. It is traditionally used in these valleys as food, fodder, fencing and medicinal purposes. The biochemical profiling of leaves, fruit and barks of *H. salicifolia* is closely similar to *H. rhamnoides* and proofs its modern approaches for utilization as value added food products, health supplements, nutraceuticals, medicinal agent, and cosmetic uses. Unlike the *H. rhamnoides,* this species has not gained much popularity due to less exploration, thus more studies are needed in all possible beneficial aspects of the species, so that further steps could be taken in commercialization and industrialization of the species. By this local livelihood can be uplifted in remote areas of the Indian Himalayan region, which are situated in highly inaccessible areas where unemployment and migration for employment are the main problems. So it can be concluded that *H. salicifolia* can be used as the alternative of *H. rhamnoides* and have the potential to uplift the economy of the local rural people of high altitude areas of various Indian Himalayan states.

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List of books and chapters in edited volumes published per teacher during the last five years

Sl. No.	Name of the teacher	Title of the book/chapters published	Title of the paper	Year of publication	ISBN/ISSN number of the proceeding	Affiliating Institute at the time of publication	Name of the publisher	Links redirecting to the source website
2017-18								
1.	Dr. D.K. Rana	Innovative Agriculture and Botany	Techniques of Hybrid Seed Production in Cucumber	2018	978-93-87294-14-1	H.N.B. Garhwal University, Srinagar Garhwal	Victorious Publishers (India)	file:///C:/Users/nasee/Downloads/Coverwithcontent.pdf
2.	Dr. D.K. Rana	Innovative Agriculture and Botany	Physiological Disorders of Tomato	2018	978-93-87294-14-1	H.N.B. Garhwal University, Srinagar Garhwal	Victorious Publishers (India)	file:///C:/Users/nasee/Downloads/Coverwithcontent.pdf
2018-19								
	Nil	**Nil**	**Nil**	**Nil**	**Nil**	**Nil**	**Nil**	
2019-20								
	Nil	**Nil**	**Nil**	**Nil**	**Nil**	**Nil**	**Nil**	
2020-21								
	Nil	**Nil**	**Nil**	**Nil**	**Nil**	**Nil**	**Nil**	
2021-22								
1.	Dr. D.K. Rana & Dr. T.S. Bisht	Advances in Environment Engineering and Management	Varietal Evaluation in Okra for Yield and Yield Attributing Traits Under Mid-Hill Conditions of Garhwal Himalayas	2021	978-3-030-79065-3	Department of Horticulture, H.N.B. Garhwal University, Srinagar (Garhwal)	Springer Proceedings in Earth and Environmental Sciences	https://link.springer.com/chapter/10.1007/978-3-030-

								79065-3_32
2.	Dr. T.S. Bisht	Millets and Millet Technology	Minor Millets: Profile and Ethnobotanical Scenario.	2021	978-981-16-0676-2	Department of Horticulture, H.N.B. Garhwal University, Srinagar (Garhwal)	Springer Nature	https://link.springer.com/chapter/10.1007/978-981-16-0676-2_3
3.	Dr. T.S. Bisht	Hi-tech Crop Production and Pest Management	Strategies for doubling farmer's income in hilly terrains by adapting horticulture based integrated farming agri-entrepreneurship model.	2021	978-81-7622	Department of Horticulture, H.N.B. Garhwal University, Srinagar (Garhwal)	Biotech Books	https://www.researchgate.net/publication/353306532_Strategies_for_Doubling_Farmer's_Income_in_Hilly_Terrains_by_Adapting_Horticulture_based_Integrated_Farming_Agri-Entrepreneurship_Model

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Contents

Techniques of Hybrid Seed Production in Cucumber

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Abstract

Cucumber is the most important crop of the cucurbitaceous family. It is used as salad or in pickled form. Heterosis breeding has been a recognized practical tool in providing the breeder with a mean of increasing yield and other economic traits. In cucumber, considerable heterosis has been reported for different traits such as earliness, number of fruit and high yield per plant. However, in hybrid seed production requires development of superior lines for production of superior hybrids. Three major genes Acr/acr, M/m and A/a besides different environmental factors modifying genes mainly control various sex types. Among the various sex forms, gynoecious and monoecious are important from hybrid production point of view.

Keywords: Cucumber, Heterosis, Genes, Gynoecious and Monoecious.

INTRODUCTION

Cucumber (*Cucumis sativus* L.) is one of the most important cucurbitaceous vegetables with a chromosome number 2n = 2x = 14, grown throughout the world in tropical and sub-tropical climatic conditions. It is an ideal summer vegetable crop chiefly grown for its edible tender fruits, preferred as a salad ingredient, pickles, and as a cooked vegetable (Khulakpam *et al.,* 2015 and Shah *et al.,* 2016). The genus *Cucumis* comprised about 30 species distributed over two distinct geographic areas (i) South-East of Himalayas is an important region of the Asiatic group with a basic number of x = 7 to which cucumber belongs (ii) Africa group, comprising large area of Africa, Middle East, Central Asia extending to Pakistan and South Arabia, most species with basic number x = 12 are found in these region with few tetraploids and hexaploids, where muskmelon occur in this region. The cucumber is reported to be indigenous to India (De Candolle, 1886). The chief evidence for this suggestion is the occurrence of *Cucumis hardwickii* Royle, a cucumber like, plant in the foot-hills of Himalayas in India. *Cucumis hardwickii* is similar to *Cucumis sativus* except that the exterior of the fruit is smooth and flesh is extremely bitter. Since, *C. hardwickii* crosses freely with *C. sativus* (Deakin *et al.,* 1971), this has led to the conclusion that *C. hardwickii* is either a feral or progenitor form of the cultivated cucumber (De Candolle, 1886). It fruit contains 83 per cent edible portion. A 100 g fresh cucumber fruit contains 96.3 g moisture, 0.4 g protein, 0.1 g fat, 0.3 g minerals, 0.4 g fiber, 5.7 g carbohydrates, 27 kcal energy, 140 mg calcium, 30 mg phosphorus, 0.6 mg iron, 0.04 mg riboflavin, 0.4 mg niacin and 4 mg vitamin C (Gopalan *et al.,* 1982).

Heterosis breeding has been a recognized practical tool in providing the breeder with a mean of increasing yield and other economic traits. The hybrid vigour or the superiority of the hybrids over parents may be manifested in terms of high productivity, uniformity, improved quality, resistances, environmental adaptations, earliness etc., however, it never happens that each hybridization is accompanied by a

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Physiological Disorders of Tomato

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Abstract

Physiological disorders of tomato are abnormalities in fruit which are caused by abiotic factors not caused by infections of diseases or insects. The abnormality occurs as a result of environmental, genetic factors, nutrition and cultural practices such as watering practices,training and pruning. Physiological disorders encountered in this chapter included blossom end rot (BER), catface, cracking,internal white tissue, irregular ripening, puffiness, pox and fleck, rain check, zippering and sun scald.

Keywords: Physiological, Abiotic, Genetic, Puffiness and Zippering.

INTRODUCTION

Vegetable is the main component of our daily diet. They contain varieties of nutritionally vital compounds such as carbohydrates, protein, vitamins and minerals. Vegetables often attract the consumers for their medicinal properties and also their aesthetic properties, *i.e.* texture, colour, flavor and high water content. Therefore, vegetable showed relatively high metabolic activity when compared to other plant obtained foods as seeds. Compression to other crops like, fruit, cereals, pulses, oil etc the vegetable production increases quickly. This increase of production in vegetable crops is due to use of improved varieties, improved facilities for crop production and also use of improved technology for post harvest management. The morphological and quality of vegetables that we consume is highly influenced by both biotic and abiotic factors, which includes improper pollination or fertilization, hormonal imbalance, deficiency or excess of mineral elements, lack of nutrients, injuries due to high or low temperature, high rainfall, poor light, water logging or water scarcity and phyto-toxic compounds. In vegetable, sometimes more than one factor may be responsible for physiological disorder. Almost all major vegetable crops are prone to various types of physiological disorders that effecting different plant organs thus rendering them unfit for human consumption, therefore control of disorder is essential for profitable production of the crop.

Physiological disorders refer to the breakdown of tissue that is not caused by either invasion by pathogens (disease-causing organisms) or by mechanical damage. They may develop in response to an adverse pre-harvest and/or postharvest environment, especially temperature, or to a nutritional deficiency during growth and development. Physiological disorders are mainly caused by changing environmental conditions such as temperature, moisture, unbalanced soil nutrients, inadequate or excess of certain soil minerals, extremes of soil pH and poor drainage (Jarvis & McKeen, 1991; Nejad *et al*., 2009). This involves the genetic factors also. Thus there is a genetic (G) and an environmental (E) interaction (G × E). This complex interplay of factors is poorly understood for most disorders and in some cases contradictory results have been reported

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Varietal Evaluation in Okra for Yield and Yield Attributing Traits Under Mid-Hill Conditions of Garhwal Himalayas

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Udit Joshi · Deepak Rana · Tejpal Singh Bisht · Vivek Singh

Abstract

Okra is a traditional and one of the most popular crops among various groups of vegetable crops, generally cultivated extensively in summer and rainy season in India. Although at present, a considerable number of commercial cultivars and hybrids of okra are available in the market, yet farmers are facing difficulties in production as the available cultivars are not well adapted to country's specific agro-climatic conditions. Hence, the present investigation was conducted for performance-based evaluation of twenty-six okra cultivars, including a standard check Arka Anamika (C) thus, selecting elite cultivars from the evaluated ones. A Randomized Block Design (RBD) with three replications was employed for aligning all the cultivars under study. The data for 32 quantitative traits were taken using five plants from each treatment corresponding to every replication. A fair amount of variation was observed in all the cultivars in terms of all the yield and its attributing traits under study. The analysis of variance depicted significant differences among genotype for all the traits under investigation where the yield per hectare ranged from 231.87 q/ha (VL Bhindi-2) to 86.95 q/ha (LC-1) with a mean value of 155.55 q/ha. Out of twenty-six cultivars, seventeen genotypes viz., Agri Bahar, Chanda, Hisar Naveen, Hisar Unnat, Kashi Kranti, Kashi Mohini, Kashi Pragati, Kaveri, LC-3, LC-4, LC-6, Lucky-666, Pusa A-4, Pusa Sawni, VL Bhindi-2, Vandana-241, and Varsha Uphar performed better than check cultivar Arka Anamika in terms of yield and its attributing traits. Therefore, these seventeen genotypes can be recommended for further study, future breeding aspects and cultivation in the mid-hill conditions of Garhwal Himalaya.

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Minor Millets: Profile and Ethnobotanical Scenario

3

Laxmi Rawat, A. K. Karnatak, T. S. Bisht, and Akshit Kukreti

Abstract

Minor millets are an agronomic community of genetically diverse species of cereal grasses, well adapted to a range of marginal growing conditions where major cereals are relatively ineffective, such as wheat, rice, and maize. Minor millets are grown in various soils in India, in varying rainfall regimes, and in areas where thermal and photographic cycles vary widely. Seven cultivated species, viz., finger millet, barnyard millet, foxtail millet, proso millet, little millet, kodo millet, and browntop millet represent minor millets. These millets provide millions of households with highly nutritious food and livelihood security, especially small and marginal farmers and residents of rainfed areas, particularly in remote tribal areas. They are now no longer referred to as coarse cereals but as nutricereals or nutraceutical crops, and are considered as a plausible answer to combat malnutrition and secret hunger worldwide. Indian tribal groups have a special link to minor millets as these crops have been an integral component of their agricultural systems and operations. Minor millets are being used by them from time immemorial not only to fight hunger but also for ethnomedical uses. This chapter emphasizes on the potential of minor millets for combating hunger, malnutrition and for ensuring food and nutritional security for tribal communities and discusses the initiatives being taken by the government and civil societies to

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PESTS MANAGEMENT

Chapter 9

Strategies for Doubling Farmer's Income in Hilly Terrains by Adapting Horticulture based Integrated Farming Agri-Entrepreneurship Model

Udit Joshi[1], T.S. Bisht[1], Rajendra Bhatt[2] and Vatsala Tewari[2]

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Uttarakhand being a predominantly hilly state consists of the maximum area under wastelands and forests that leave only 14 per cent under cultivation. In hilly regions of Uttarakhand, people are not able to follow large scale farming as 89 per cent out of total farmers of the state come under the small and marginal category. The objective of the present study is to provide a Horti-based Agri-entrepreneurship model for the villages of the Garhwal region for doubling farmer's income in these regions through agricultural development. The present model was formulated based on the studies conducted at 3 villages of Garhwal region i.e., two villages from district Pauri Garhwal and one village from district Tehri Garhwal. Almost every family in every village has considerable cultivable land hence, all are dependent upon agricultural and other allied activities for livelihood sustainment. Major problems observed were damage to the crops by wild animals, prevalence of migration among

Chapter 13
Plant Growth-Promoting Bacteria: Effective Tools for Increasing Nutrient Use Efficiency and Yield of Crops

Chitra Pandey, Shrivardhan Dheeman, Deepti Prabha, Yogesh Kumar Negi, and Dinesh Kumar Maheshwari

Abstract Agrochemicals or fertilizers are essential to optimize crop production but their excessive and unwanted application is posing a myriad of adverse effects such as declining soil fertility besides contaminating surface and groundwater. These synthetic chemicals mismanage the soil ecology leading to disturbed ecosystem and loss of beneficial bacteria inhabiting in soil. Traces of such chemicals have also been deposited in agricultural products that cause serious illnesses in human beings. Considering such facts, the use of plant growth-promoting bacteria (PGPB) renamed as plant beneficial bacteria being promoted to enhance nutrient availability, plant growth, and yield promotion to maintain sustainable agriculture. These bacteria have been in use for a long time for increasing plant growth and development and to reduce the subsistence farmer's dependence on agrochemicals. The scientific community observed that beneficial effects are now befitting for the sustainable growth promotion and crop yield enhancement due to the influence of PGPR in order to augment nutrient uptake capacity and nutrient use efficiency. The aim of the present study is focusing on the PGPRs which work as a tool to enhance nutrient use efficiency of various crops. Long-term application of such bacteria could act as a newer alternative to

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chemical fertilizer and able to cope its adverse effects on both soil and ecology and reverse plant–soil ecosystem.

Keywords PGPR · Crop yield · Rhizosphere · Nutrient management

13.1 Introduction

Agriculture has been and will continue to be the backbone of food availability and food security. It directly sustains the livelihood of about two-third of the global population, and is the lifeline of agro-industries. However, over time, the sustainability of agricultural growth has emerged as a central issue confronting many countries in the world. This issue has become even more important as the pressure on land and other natural resources has increased manifold with an increase in population and per capita consumption of food grains (Negi 2005). As the world population is dwelling, food availability has to be increased corresponding to meet out the increasing food demand. The current world population of 7.6 billion and is expected to reach 8.6 billion in the year 2030 and 9.8 billion in 2050 (UNDESA 2017). Therefore, the use of agrochemicals has become important to sustain agriculture production and fulfill the food requirement of all human beings worldwide. Initially, the use of these chemicals was much promoted among the farmers to grow the crops at their best. However, their long-term headforemost application results in low soil fertility and increases the dependency of farmers on these agrochemicals.

Farmers use a variety of agrochemicals and depend on them for the successful production of their crops. Another constraint of agriculture production is decreasing land availability for farming. This will further lead to the enhancement of nutrient load per unit area in soil. The depletion of nutrients in the soil is, therefore resulting in poor plant growth and productivity. Plants require 16 essential nutrients or elements for adequate growth and production. Three of these, carbon (C), oxygen (O), and hydrogen (H) are drawn from water and the air. The remaining elements are taken up from the soil (Gellings and Parmenter 2016). These nutrients have been divided into three categories viz. macronutrients, micronutrients, and trace elements (Table 13.1).

Crop health and productivity depend on the availability of these nutrients and their uptake as well. However, this is well known that most of the nutrients in the soil are present in complex or unavailable forms. Inorganic fertilizers are thus manufactured in plant-available forms. Therefore, as these fertilizers are amended in soil, the nutrients get quickly released and become available for plant uptake. Fertilizers undoubtedly increase productivity and fulfill the food demand but, at the same time, their adverse effects on soil, environment, and human beings increase many-fold. Unfortunately, residual accumulation of these harmful chemicals in grains, fruits, and other edible parts has been reported in recent years by many researchers (Bhanti and Taneja 2007; Gurusubramanian et al. 2008; Singh et al. 2008). Consumption of such contaminated produces may cause serious health problems (e.g., allergic reactions, intestinal disorders, hormonal imbalance, and even cancer) in human beings

Table 13.1 Plant nutrients and their role

S. no.	Nutrient types	Element	Role in plant growth
1.	**Macronutrients** (Required in large quantities and their deficiency or unavailability affect plant survival)	Nitrogen (N)	The basic component of proteins and chlorophyll. Plays an essential role in plant growth
		Phosphorous (P)	Plays an important role in root growth and promotes the establishment of young plants, flowering, fruiting and ripening, photosynthesis, respiration, and overall plant growth
		Potassium (K)	Promotes the movement of sugars, turgor, and stem rigidity. It also increases the plant's overall resistance to cold, diseases, insect pests, etc. Promotes the formation of flower buds, the hardening off of woody plants, and fruiting
2.	**Micronutrients** (Required in fewer amounts and their deficiency or unavailability may result in poor plant health and low productivity)	Calcium (Ca)	It plays a vital role in plant structure because it is part of cell walls and holds them together. Promotes the development of the root system and the ripening of fruit and seeds. Also, found in the growing parts of plants (apex and buds)
		Magnesium (Mg)	An important part of chlorophyll. Helps in fruit ripening and seed germination. Reinforces cell walls and promotes the absorption of phosphorous, nitrogen, and sulfur by plants
		Sulfur (S)	A component of several proteins, enzymes, and vitamins. Contributes to chlorophyll production. It helps plants absorb potassium, calcium, and magnesium
3.	**Trace elements** (Required in very fewer amounts and their deficiency or unavailability may result in poor metabolic functions, health, and low productivity)	Iron (Fe)	Essential for chlorophyll production. It also contributes to the formation of some enzymes and amino acids
		Boron (B)	Essential to overall plant health and tissue growth. Promotes the formation of fruit and the absorption of water

(continued)

Table 13.1 (continued)

S. no.	Nutrient types	Element	Role in plant growth
		Manganese (Mn)	Promotes seed germination and speed-up plant maturity. Plays an important role in photosynthesis by contributing to chlorophyll production. Essential for nitrogen assimilation and protein formation
		Molybdenum (Mo)	Essential for nitrogen assimilation by plants and nitrogen fixation by bacteria. This means that it is needed for the production of nitrogen-based proteins
		Chlorine (Cl)	Stimulates photosynthesis
		Copper (Cu)	Activates various enzymes. It also plays a role in chlorophyll production
		Zinc (Zn)	Plays an important role in the synthesis of proteins, enzymes, and growth hormones

(Bhanti and Taneja 2007; Singh et al. 2008). Another side of the coin is that the fertility of the soil has decreased over time resulting in decreased productivity due to deprived soil nutrients. So many chemicals are there in use to control pests, insects, and pathogens with an instant effect. However, irrelevant and indiscriminative use of these chemicals is leading to a very harmful effect on human health (Lawrence et al. 2004; Chaturvedi et al. 2013), soil environment (Aktar et al. 2009; Lin et al. 2019; Tiryaki and Temur 2010), and animals (Dalvie et al. 2011; Odukkathil and Vasudevan 2013).

It is well known that (i) these chemicals are recalcitrant and not fully degradable, and (ii) their degradation depends on their half-life, the amount applied, chemical reaction, etc. (Pandey et al. 2017). All these factors have arisen questions among the scientific community, environmentalists, and social organizations regarding food security, soil, water, and air pollution, crop nutrition, soil fertility, etc. These problems provoked the scientific community to search for environment-friendly commercial alternatives that could act as good as chemicals to increase soil fertility and crop productivity to ensure food security. A large number of publications have appeared during the last decade on the use of plant growth-promoting bacteria (PGPR), organic manures, botanicals, etc., and come up as a vivacious and viable alternative to agro-chemicals. Such biological alternatives not only enhance the nutrient availability but also increase their uptake by host plants. Besides this, PGPRs secrete plant growth hormones, antibacterial and antifungal metabolites, induce systemic resistance against many diseases and thereby ensure higher crop production and another advantage of these microbes is that they can be applied with other biological inputs.

13.1.1 Organic Manures: An Alternative Source of Plant Nutrients

Generally, plant and animal residues or by-products come under this category such as compost, manure, and animal residues. Being organic, these fertilizers have a good amount of different nutrients and therefore increase soil fertility (Li et al. 2018). Unlike inorganic chemicals, these fertilizers do not show any harmful effects on plants or human beings. Also, they are biodegradable, renewable, and sustainable. However, beneficial microorganisms help in the adequate release of nutrients in the soil from these fertilizers. Their strategic use may not only enhance the crop production but also improves the soil quality and fertility.

Organic manures viz., FYM, vermicompost, poultry compost, cattle dung, etc., improve the physical properties of soil (water hold-ing capacity, soil aeration, soil aggregation, etc.), prevent soil degradation and increase the population of beneficial soil microorganisms. These organic amendments contain most of the nutrients in a plant-available form such as nitrates, phosphates, exchangeable calcium, zinc, and soluble potassium (Orozco et al. 1996). Similarly, forest litter also plays a fundamental role in nutrient turnover and the transfer of energy between plants and soil. This is also a good source of the nutrients that are accumulated in the upper layers of the soil. FYM is used in between 10 and 30 t ha^{-1} in different crops including cereals, pulses, vegetables, etc. Vermicompost and Forest litter are used 6–10 t ha^{-1}. However, the rate of application of organic manures can be reduced if applied along with microbial inoculants biofertilizers. Several reports suggest a 25–50% reduction in organic manure requirements if beneficial microbes are combined with them (Yildrim et al. 2011; Singh et al. 2015; Rahman et al. 2018).

13.2 Plant Growth-Promoting Bacteria

Although, much has been said about PGP bacteria (Maheshwari 2011; Maheshwari et al. 2015, 2017) it is pertinent to give a brief description about their role and efficacy. Plant growth-promoting rhizobacteria (PGPR) are the beneficial bacteria closely associated with plant rhizosphere and possess plant growth-promoting abilities (Kloepper and Schroth 1978). These are used to improve soil fertility and crop productivity and also as biocontrol agents to reduce crop losses. To commemorate their spectrum of action, they are designated with several terms including plant growth-promoting bacteria, plant health-promoting bacteria, bioinoculant, biofertilizers, biocontrol agents, etc. PGPRs generally represent a wide range of root colonizing bacteria belonging to *Azotobacter, Azospirillum, Bacillus*, *Burkholderia, Rhizobium, Pseudomonas, Serratia,* etc. Along with plant growth promotion, they reforest eroded areas, restore the contaminated sites, and thereby render a positive effect on the degraded soil ecosystem (Gupta et al. 2015). It seems inevitable that fewer agrochemicals with their low dosages will be used in the coming time and more emphasis would be put on the use of environmentally and biologically safe alternatives including the use of beneficial microbes. PGPRs have been found successful in getting established in the soil ecosystem due to their high adaptability in a wide variety of environments, faster growth rate, and biochemical versatility to metabolize a wide range of natural and xenobiotic compounds. Successful studies using PGPRs including genera *Acinetobacter, Alcaligenes, Arthrobacter, Azospirillum, Azotobacter, Bacillus, Burkholderia, Caulobacter, Chromobacterium, Enterobacter, Erwinia, Flavobacterium, Micrococcus, Rhizobium, Serratia, Xanthomonas, Proteus*, and *Pseudomonas* on the growth enhancement of various crops have been achieved in laboratory and field conditions (Glick 1995; Gray and Smith 2005; Verma et al. 2010; Negi et al. 2011; Maheshwari et al. 2015; Agarwal et al. 2017b) in Table 13.2.

PGPRs produce growth hormones, enzymes, and other metabolites that facilitate solubilization of soil nutrients (phosphate, nitrogen, potassium, etc.) and thereby enhance nutrient uptake with subsequent augmentation of the plant growth (Baligar et al. 2001; Mishra et al. 2009). The interaction between plant, soil, and microbes is influenced by abiotic (physical, chemical) and biotic (soil biota) factors (Jackson and Prat 1996; Putten et al. 2013). Abiotic factors such as temperature (low and high), high salt, pH, soil fertility, moisture content have been reported to influence enzyme activities nutrient, concentration (Chapin 1980), and nutrient uptake (Gavito et al. 2001) which have shown to affect plant growth directly or indirectly (Heinze et al. 2017). Plant growth-promoting bacteria secrete various phytohormones such as GA (Bottini et al. 2004; Hayat et al. 2010), IAA (Spaepen et al. 2007), Cytokinin, Salicylic acid (Jochum et al. 2019), abscisic acid (Cohen et al. 2015). Phytohormones like auxins, cytokinins, and gibberellin production have been observed for the significant enhancement of seedling parameters (Melnykova et al. 2013; Talboys et al. 2014). The broad spectrum antagonistic activities of PGPRs are executed by secretion of several metabolites including antibiotics (Guo et al. 2014; Lee et al. 2016), volatile compound HCN (Khabbaz et al. 2015), siderophores (Kesaulya et al. 2018), enzymes chitinase and β-1, 3-glucanase, etc. (Huang et al. 2005). These beneficial microbes can easily be applied in different crops by seed, root treatments, foliar sprays, mixing in soil or organic manure, etc., to various crop plants (Fig. 13.1). The demerits include (i) requirements for long-term storage, and (ii) generally crop-specific or site-specific.

Table 13.2 Different PGPR strains found effective to increase plant growth of various crops

S. no.	Bacterial strains used	Crop	References
1.	*Pseudomonas fluorescence* (ATCC13525)	*Vigna radiata*	Katiyar and Goel (2004)
2.	*Pseudomonas putida* (B0)	*Zea mays* var. QPM-1	Pandey et al. (2006)
3.	*Serratia marcescens* SRM (MTCC 8708)	*Curcurbita pepo*	Selvakumar et al. (2007)
4.	*Serratia marcescens* SRM	*Triticum* sp. cv. VL 802	Selvakumar et al. (2008)
5.	*Acinetobacter rhizosphaerae* BIHB 723	*Pisum sativum* var. Palam priya, *Zea mays* var. Girija, *Hordeum vulgare* var. Dolma	Gulati et al. (2009)
6.	*Pseudomonas* spp.	*Triticum aestivum* L.	Mishra et al. (2011)
7.	*Pseudomonas fluorescence*	*Phseolus vulgaris* var Pusa contendor	Negi et al. (2011)
8.	*Rhizobium, Pseudomonas, Serratia, Bradyrhizobium japonicum*-SB1, *Bacillus thuringiensis* KR1	*Lens culinaris* Medikus	Kaur et al. (2015)
9.	*Pseudomonas* sp. JJS2, *Enterobacter* sp. AAB8	*Cajanus cajan* (L.) and *Eleusine coracana*	Shukla et al. (2015)
10.	*Rhizobium* sp.	Lentil (*Lens culinaris* Medikus)	Singh et al. (2018)
11.	*Bacillus subtilis* and *B. pumilus*	*Amaranthus hypochondriacus*	Pandey et al. (2018a, b)

13.2.1 Potential Role of Microbes in Nutrient Availability

Plant growth-promoting bacteria are known for their ability to increase nutrients concentration in rhizospheric and non-rhizospheric soil. PGPR can increase phosphorus, nitrogen, potassium, and other micronutrients concentration in the soil (Vejan et al. 2016). These nutrients are in unavailable form in the soil and PGPR achieve availability of these by solubilization, due to siderophore production and oxidation of sulfur, etc. A significant amount of nitrogen (from 20 to 22 TgN per year up to 40 Tg N per year) has been contributed to the agriculture system due to N-fixation (Galloway et al. 2008; Herridge et al. 2008). Other nutrients such as Fe and Zn are also required to increase plant growth, and PGPR increases the availability by using different mechanisms. Zn mobilizing bacteria have been observed to increase Zn uptake along with the crop yield (Ramesh et al. 2014; Shakeel et al. 2015). The isolation, identification, and characterization of Zn and K solubilizing bacteria

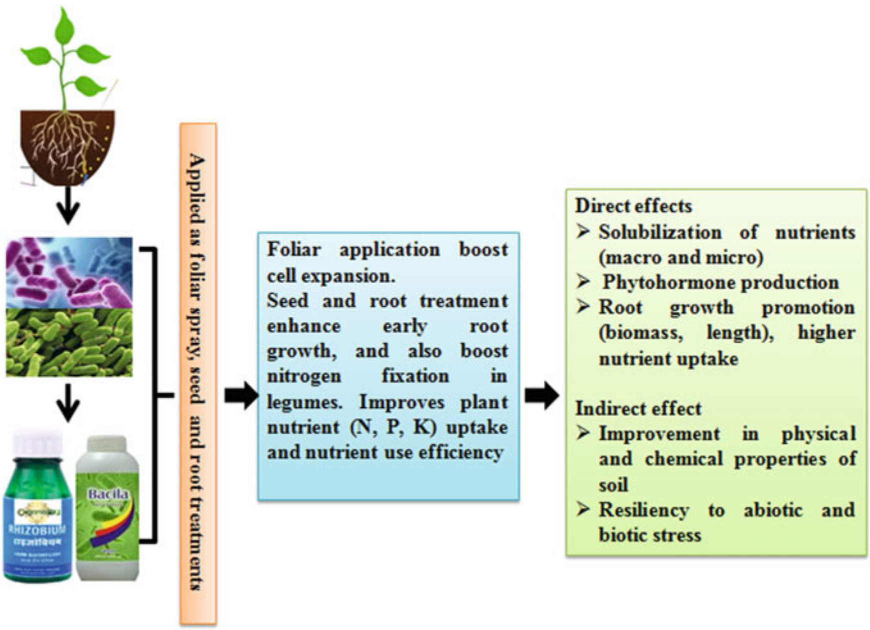

Fig. 13.1 Effects of PGPR applications on plants

have been reported. Along with that PGPR (*Microbacterium oxydans* JYC17, *Pseudomonas thivervalensis* Y1-3-9, and *Burkholderia cepacia* J62) having metal resistance increased Cu uptake (maximum 113.38%) by Rape plant and improved copper remediation capacity and also increased antioxidant content in leaves, the biomass of remediation plant (Ren et al. 2019). Canbolat et al. (2006) reported a significant effect of *Bacillus* M-13 and *Bacillus* RC01 on nitrogen fixation and phosphate solubilization and increased availability promotes the uptake of these nutrients by barley (*Hordeum vulgare*). In another case, Maize plant grew on nutrient-deficient calcisol soil when treated with the *Pseudomonas alkaligenes* PSA15, *Bacillus polymyxa* BcP26, and *Mycobacterium phlei* MbP18, improved soil nutrients and uptake of the nutrients (N, P, K), was observed. Bacterial inoculants have been observed as a better plant growth promoter in nutrient-deficient soil (Egamberdiyeva 2007). Strains of *Pseudomonas fluorescens, Pseudomonas putida,* and *Pseudomonas fluorescens* were found effective to increase nutrient uptake and field in paddy (Lavakush et al. 2014). Recently, Pandey et al. (2018a) reported that biopriming of amaranth seeds by the selected *Bacillus* isolates exhibited a significant increase in all three macronutrients (N: 36.18%, P: 32.45%, K: 17.11%) in soil. Authors also reported that the higher solubilization and availability of these nutrients significantly increased the grain yield in *Amaranthus hypochondriacus*.

13.2.2 Nutrient Use Efficiency (NUE)

Nutrient use efficiency reflects the ability of a plant to use the available nutrients at its maximum potential. It can be defined as yield (biomass) per unit input of fertilizer/nutrient content). NUE, therefore, depends on the plant's ability to take up nutrients efficiently from the soil but also depends on internal transport, storage, and remobilization of nutrients. NUE is a critically important concept for evaluating crop production systems and can be greatly impacted by fertilizer management (Baligar et al. 2001). It is classified into four different subtypes (i) Agronomic efficiency, (ii) Physiological efficiency, (iii) Apparent recovery efficiency, (iv) Utilization efficiency as described in Table 13.3 (Baligar et al. 2001). Nutrient use efficiency of chemical fertilizers is very low which ultimately leads to increased fertilizer amount in the field and subsequently, that remaining fertilizer vanished in the environment. Even if fertilizer could apply in an adequate amount, plants use only 50% and the remaining 50% leached out in the environment, for instance, plant uptake 50% of nitrogen fertilizer and remaining polluting water (Chandini et al. 2019).

Since plants primarily depend on soil for all their nutrients, it is important to make them available in a utilizable form. Different nutrients have their specific role in plant growth and development and therefore, must be available at the required concentration. By the application of agrochemicals, farmers try to amend the soil with sufficient nutrients. Therefore, it is necessary to manage the nutrient application

Table 13.3 Types of Nutrient use efficiency

S. no.	Type of nutrient use efficiency	Definition and description
1.	Physiological efficiency (PE)	Physiological efficiency is defined as the $\dfrac{\textbf{Yield F (kg)} - \textbf{Yield C (kg)}}{\textbf{Nutrient uptake F (kg)} - \textbf{Nutrient uptake C (kg)}}$ Where Yield F is the biological yield of a fertilized plot (kg), Yield C is the biological yield of an unfertilized plot (kg), Nutrient uptake F is nutrient uptake of a fertilized plot (kg), Nutrient uptake C is nutrient uptake of an unfertilized plot (kg)
2.	Agronomic efficiency (AE)	$\dfrac{\textbf{Grain Yield F (kg)} - \textbf{Grain Yield C (kg)}}{\textbf{Quantity of nutrient applied (kg)}}$ Agronomic efficiency expressed as the additional amount of economic yield per unit nutrient applied
3.	Apparent recovery efficiency (ARE)	$\dfrac{\textbf{Nutrient uptake F (kg)} - \textbf{Nutrient uptake C (kg)}}{\textbf{Quantity of nutrient applied (kg)}}$ ARE has been used to reflect the plant's ability to acquire applied nutrients from the soil
4.	Utilization efficiency (EU)	Nutrient utilization efficiency was calculated by formula: **EU (kg/kg) = PE X ARE**

Source Baligar et al. (2001)

and also to increase the plant potential to produce more with the recommended dose of fertilizers. This is quite possible by increasing the "Nutrient use efficiency" (NUE) of the plants. It is the key component to enhance crop productivity. Generally, the NUE is crop or variety-specific but, there are reports, which suggest that PGPRs can effectively increase the NUE in different plants, result in higher crop productivity and nutrient quality. Recent research on plant–microbe interaction has revealed that PGPRs affect the ability of host plants to efficiently utilize the absorbed nutrients and increase yield and nutritive quality of the produce (Pandey et al. 2018a, b; Rahman et al. 2018).

13.2.3 PGPRs in NUE Enhancement

High crop yield is the result of adequate availability of nutrients in the soil and their optimum uptake and accumulation in the plant systems. This, in turn, may enhance the NUE of the plant. It has been reported that PGPR provides the optimum level of nutrients to the plants and thereby increasing plant growth and yield (Pandey et al. 2018b; Rahman et al. 2018). Usually, nutrients are present in the soil but, generally, they remain in plant unavailable form and PGPRs can convert them into the available form (Adesemoye and Kloepper 2009).

PGPR group of bacteria are soluble in nature. Some of the bacterial genera increase soil N, P, and K availability by solubilization and fixation reaction. PGPRs possess different mechanisms for higher nitrogen availability which include ammonification, nitrification, denitrification, mineralization, etc. (Ogunseitan 2005). A diverse range of PGPRs are known to enhance nitrogen use efficiency, for instance, *Acetobacter, Azoarcus, Arthrobacter, Azotobacter, Azospirillum*, *Bacillus*, *Burkholderia, Enterobacter, Pseudomonas, Nitrobacter, Nitrosomonas, Rhizobium,* etc. (Table 13.4). Nitrogen use efficiency is the plants' ability to utilize available nitrogen in the field to enhance plant growth and productivity. To achieve the best NUE scientific researches were based on 4R principle, i.e., right source, right rate, right time, and right placement. NUE depends on the transport, storage, recycling, remobilization, and plant growth stage along with the nutrient uptake. The synchronization of nitrogen availability with nitrogen demand can increase nitrogen use efficiency significantly.

Spolaor and coworkers (2016) suggested consortium of *A. brasilense* Ab-V5 + V6 and consortium of *A. brasilense* Ab-V5 and *Rhizobium* sp 53GRM1 to be effective to enhance the NUE of popcorn and enhanced the grain yield. Zeffa et al. (2019) applied *A. brasilense* Ab-V5 to improve maize growth and concluded that it increased NUE in N limiting conditions along with the improved root architecture, N assimilation, uptake, and increased biomass. Authors concluded that the morphological and structural changes in the plant occured because of the production of phytohormones by *A. brasilense* Ab-V5. Ahmad et al. (2017) reported that the PGPR impregnation with the DAP and urea enhanced nitrogen and phosphorus use efficiency of wheat and thereby increased photosynthetic rate, growth, and yield.

Table 13.4 Plant growth-promoting bacteria reported to enhance nutrient use efficiency and nutrient uptake

PGPR	NUE/nutrient uptake	Crop	Reference
Pseudomonas sp.	Nutrient uptake	Wheat (*Triticum aestivum*)	Shaharooma et al. (2008)
Burkholderia cepacia RRE25	Enhancement in nutrient use efficiency.	Rice (*Oryza sativa*)	Singh et al. (2013)
Pseudomonas aeruginosa QS-40	Enhancement in nitrogen use efficiency.	Sunflower (*Helianthus annuus*)	Arif et al. (2017)
Bacillus amyloliquifaciens IN937a, *Bacillus pumilus* T4	Increased N, P uptake and nutrient use efficiency	Tomato (*Solanum lycopersicum*)	Fan et al. (2017)
Pseudomonas fluorescens, Bacillus megaterium, Azospirillum brasilense	High nutrient uptake and nutrient use efficiency.	Maize (Zea maizae)	Gulnaz et al. (2017)
Pantoea agglomerans, Rahnella aquatilis and *Pseudomonas orientalis*	High nitrogen, phosphorus and potassium uptake, increased nutrient use efficiency.	Rice (*Oryza sativa*)	Khanghahi et al. (2018)
Bacillus subtilis and *B. pumilus*	High nitrogen, phosphorus and potassium uptake, increased nutrient use efficiency. Also, high residual availability of nutrients after crop harvest	Amaranth (*Amaranthus hypochondriacus*)	Pandey et al. (2018b)

Wu et al. (2005) evaluated the effect of biofertilizers (AMF, *A. chroococcum*, *B. megaterium*, *B. mucilaginous*) on the maize growth and its nutritional properties and reported enhanced growth, soil properties, and nutritional value (total N, P and K). Increased N and P use efficiency was reported when the wheat plant was treated with *P. fluorescens* ACC50 and *P. fluorescens* biotype F (ACC73) (Shaharooma et al. 2008). Arif et al. (2017) observed that the combination of N-enriched compost and *P. aeruginosa* increased uptake efficiency of a sunflower plant, and a significant difference was observed in seed and quality of oil. Study also revealed that the inoculation of wheat by A*zospirillum spp.* effectively enhanced P and N use efficiency of wheat along with increased grain yield (Kivi et al. 2014). Ahmad et al. (2017) reported that the combination of PGPRs with a decreased amount of urea and DAP increases plant growth, yield (20%) along with nitrogen, and phosphorus use efficiency of wheat. This can be helpful to heel decreased soil fertility slowly and can add beneficial microbes in the soil.

Bacteria in agrobiology have multifarious role including nutrient efficiency in crop plants (Maheshwari et al. 2013). Phosphate solubilizing microbes were found as an effective tool for providing applied nutrients to the rice, few genera, and bean. They increased nutrient uptake (N, P, K) and NUE (Duarah et al. 2011). Those PGPRs having phosphate solubilizing, IAA producing, and disease suppressing ability are known to enhance nutrient uptake and nutrient use efficiency as reported by various workers. According to their study N, P, K uptake, and use efficiency of rice plants increased due to application of hyperproducing IAA mutants of *Burkholderia cepacia* (RRE25), *Bacillus cereus, Brevibacillus reuszeri,* and *Rhizobium rubi* have been reported to increase growth and organic manure use efficiency of strawberry (Karlidag et al. 2009). A concurrent increase in wheat productivity and uptake of N and P was observed by the application of consortium of *P. striata, A. chroococcum*, and *Glomus fasciculatum.* Moreover, increased uptake leads to augmented nutrient use efficiency (Khan and Zaidi 2007).

PGPRs also influence the micronutrient availability for the plants by using different mechanisms: Root exudates alteration by the symbiotic and non-symbiotic association with their respective host plants; enhancement of soil nutrient availability by increasing the solubility (Adesemoye and Kloepper 2009; Fitter et al. 2011). The plant growth significantly influenced by the micronutrients along with the macronutrients supported metabolic and enzymatic activities in the plant. The effects of PGPRs on nutrient availability and their use efficiency are depicted in Fig. 13.2. In this context, Shabayev (2012) studied the effect of PGPRs and reported increased iron and zinc contents in wheat while Sharma et al. (2015) demonstrated that *P. putida* and *Bacillus* sp. BN30 treatment enhanced zinc content rice. Increased Zn content was observed in Jaya and Pusa basmati-1 varieties of rice when treated with *Bacillus* sp. BN30. Recently, Adak et al. (2016) studied the effect of PGPRs on micronutrient enhancement and reported an increase in iron and zinc content in rice. On the other hand, Pandey et al. (2018b) observed a positive correlation between different treatments and NUE on amaranth using PGP bacilli. The study depicts that NUE of amaranth for N, P, and K were increased with different treatments that would

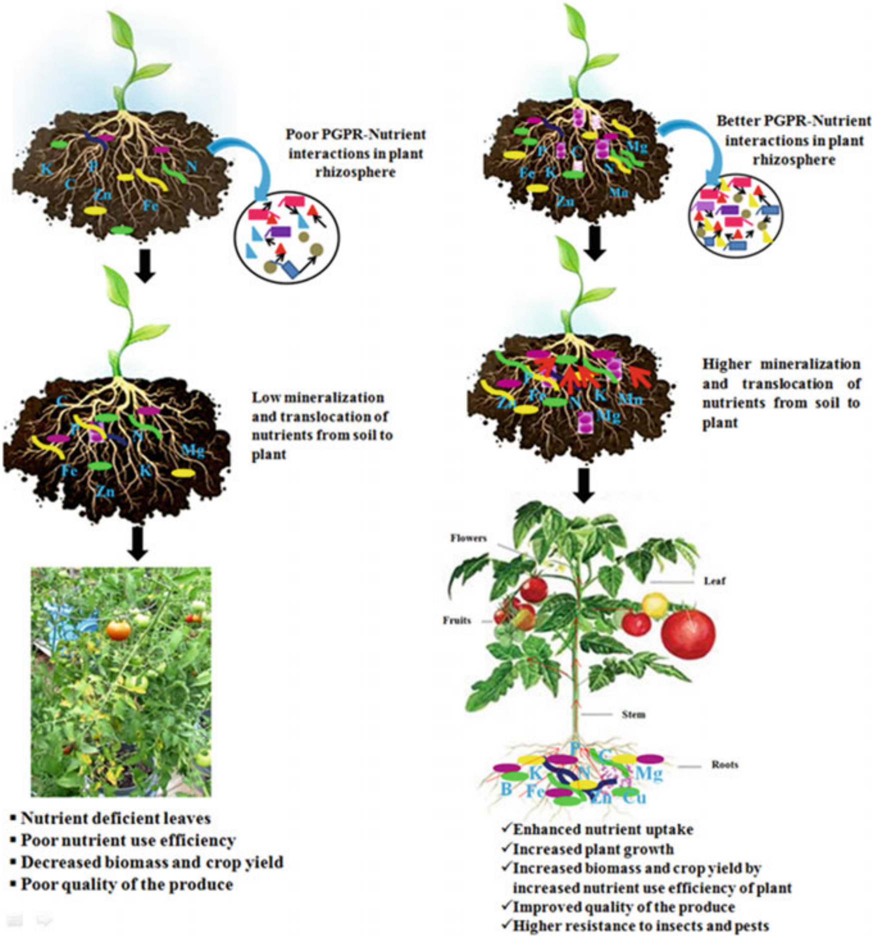

Fig. 13.2 Effects of PGPR treatments on nutrient availability, plant growth, and yield

have facilitated their better utilization through different biochemical and metabolic processes to produce higher crop yield.

13.3 Impact on Crop Yield Enhancement

PGPRs ameliorate plant health and productivity by enhancing the nutrient status of soil and host plants (Dey et al. 2004). The bioavailability of nutrients and their increased uptake may significantly enhance the nutrient use efficiency of plants. Increased solubilization of nutrients (macro and micro) by PGPRs enhanced their uptake and accumulation (Parmar and Patel 2009; Dhiman et al. 2019; Bhatt and

Maheshwari 2019). Nutrient availability has been influenced by solubilization, chelation, and oxidation-reduction reaction in soil (de Santiago et al. 2011). Several workers (Puente et al. 2004; Sharma et al. 2012; Prasanna et al. 2013) studied the nutrient enhancement and nutrient availability in the soil as well as in plants that resulted in the bacterial inoculation. Goteti et al. (2013) observed a significant enhancement in nitrogen and phosphorus contents of the maize when inoculated with *Bacillus* sp. in comparison to that of plants treated with *Pseudomonas* spp. This implies that PGPRs competence strongly enhanced crop growth with nutrients as well. Han et al. (2006) and Supanjani et al. (2006) applied two species of bacilli, i.e., *Bacillus megaterium* var. *phosphaticum* and *Bacillus mucilaginosus* in nutrient-limited stressed soil where the strains increased bioavailability of minerals, their uptake and thereby enhanced growth of pepper and cucumber. In the same year, Hafeez et al. (2006) suggested the use of *Bacillus pumilus* as a bioinoculant to promote the crop yield in wheat. Beneduzi et al. (2008) reported *Bacillus* isolate SVPR30 as an efficient bioinoculant for growth enhancement of the rice.

On the other hand, Zongzheng et al. (2010) also evaluated the growth promoter effect of *Bacillus subtilis* SY1. Their study revealed a significant increase in seedling parameters such as sprout tendency, germination percentage, sprout index, and vigor index. *Bacillus* isolates exhibited good PGP activities and significantly influenced seedling length, fresh weight, and dry weight of cowpea (Thomas et al. 2010). *Bacillus* sp. RM-2 was reported to enhance the seedling value parameters of cowpea with an increase in the number of seeds, the weight of seeds, and total grain weight (Minaxi et al. 2011). Agrawal and Agrawal (2013) reported the growth promotion of tomato by *Bacillus* sp. showing PGP traits. In the same year, Mehta et al. (2015) supported the fact of planting value parameter enhancement by the treatment of bioinoculants. Significant increase in seed germination, shoot length, root length, shoot dry weight, root dry weight, along with an increase in nitrogen, potassium, and phosphorus was observed after the application of *Bacillus circulans* CB7. Dubey et al. (2014) suggested that the combination of a half dose of chemical fertilizers with the *Bacillus* BSK17 was effective for the growth promotion of *Cicer aerietinum* and reported a significant increase in germination, yield.

Recently, Refish et al. (2016) accounted for the role of *Bacillus subtilis* BS87 in the growth promotion of *Anoectochilus roxburghii* and *A. formosanus*. Similarly, multifarious bacilli influence was reported to influence the growth promotion of different crops such as *Curcuma longa* (Chauhan et al. 2016), *Fagopyrum esculentum* (Agarwal et al. 2017b). Awasthi et al. (2011) recorded enhanced growth and biomass yield of *Artemisia annua* L. (Asteraceae) when treated with the consortium of *Glomus mosseae* and *B. subtilis*. Biocoenotic consortium of *P. aeruginosa* KRP1 and *B. licheniformis* was suggested for bioformulation to enhance the productivity of *Brassica campestris* by Maheshwari et al. (2015). Recently, Vurukonda et al. (2016) evaluated the effect of a consortium of *B. cereus*, *B. subtilis,* and *Serratia* spp. on cucumber plants that exhibited darker green leaves, fewer wilt symptoms increased chlorophyll content and drought resistance. Kumar et al. (2016) suggested consortium of *Bacillus* spp., *Pseudomonas* spp., and *R. leguminosarum* in enhancement for the growth and grain yield of *Phaseolus vulgaris.* These PGPRs have not only been found effective to promote plant growth but also reported to increase soil fertility by solubilizing nutrients in the soil and thereby suggested as an ecofriendly approach toward sustainable agriculture (Bishnoi 2015; Romao-Dumaresq et al. 2017; Singh et al. 2018).

13.4 Conclusion

Given the above, it can be concluded that plant growth-promoting bacteria are useful to enhance nutrient availability in soil and nutrient uptake by host plants. If these are used in the long run, they can, therefore, sustain the soil fertility and higher crop yield. The use of potential strains can effectively trigger and enhance the nutrient use efficiency of host plants. The enhanced nutrient use efficiency will not only increase the crop yield but also ensure the sustainable availability of nutrients in the soil even after crop harvest. Such residual amounts may reduce the nutrients quantity required in subsequent crop and thereby will reduce the input cost of the crop. Such strategies can be very effective for the sustainability of crop production and yield essential for food security.

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Chapter 6
Mycoremediation of Common Agricultural Pesticides

Chitra Pandey, Deepti Prabha, and Yogesh Kumar Negi

6.1 Introduction

Pesticides are bewildering variety of organic compounds that either by design or by accident eventually winds up in the environment. Since the ancient time, pesticides are being used either to kill unwanted insects, pathogens, plants, etc. or otherwise reduce their adverse impact on agriculture crops and their production. The sulfurous rock, salt, tobacco extract, red pepper, wooden ash, etc. were the common pesticides of choices in the ancient time. Chemical pesticides predominately replaced these all authentic versions of pesticides in the world's agricultural system due to their instant effect on crop protection from pest infestation, thereby minimizing crop losses. Agro-pesticides are classified as insecticides, fungicides, and herbicides or weedicides. A total of 1175 pesticides including 335 insecticides, 410 fungicides, and 425 herbicides were registered for use in the United States till 1975. Whereas, in India 261 pesticides are registered for use under section 9(3) of the Insecticide Act, 1968. According to a survey, approximately 50,000 species of plant pathogens, 8000 species of weeds, and 9000 species of insects and mites are known to smash up crops and reduce crop productivity which at the end results in reduced food availability. After the introduction of benzene hexachloride (BHC), dieldrin, 2, 4-dichlorophenoxyacetic acid (2, 4-D), and dichlorodiphenyltrichloroethane (DDT), a new advancement was achieved in pesticide application.

Being more efficient and feasible to use, these chemicals got admired in all agricultural systems, and over the time, they became indispensable in agricultural production. With the continuous use of the pesticides, crop protection and production

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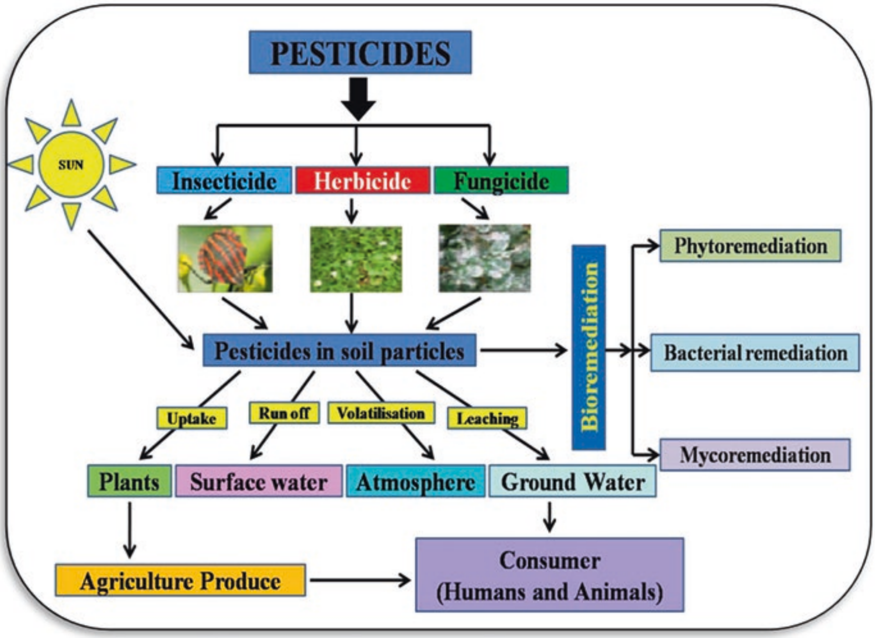

Fig. 6.1 Fate of increased use of pesticides on environment

became dependent on these chemicals. It was found that in their absence, fruit, vegetable, and cereal productions were reduced and around 78%, 54%, and 32% losses, respectively, were recorded by the attack of different pests (Pimentel 2009). Though they are reported harmful to human beings and animals, their abrupt discontinuation would surely cause depletion in crop productivity. At the same time, their anarchic, frequent inexpedient use has developed resistance in some pests, and their increasing concentration started causing harm to nontarget organisms too. Their residues remain in arable land and other unexpected places as well (Damalas 2009). In all over the world, Europe is the prevalent consumer of pesticides followed by Asia, while the United States, France, China, Brazil, and Japan are among the largest manufacturers and traders of pesticides (Zhang et al. 2011). Around 4 million tons of pesticides are consumed by global agricultural sector to reduce food losses and to enhance food production substantially. However when high doses of pesticides and other harmful chemicals are used, they get accumulated in the ecosystem raising their residual effect in soil and consequently enter in the food chain (Bartha 1980). Once the pesticides are exposed in the environment, their fates vary according to their half-life, amounts of pesticide applied, physicochemical reactions in the soil, and climatic factors. Pesticides are exposed in the environment by volatilization, leaching, and absorption in soil particles and then contaminate the groundwater too. They also get accumulated in plants and thereby in agriculture produce and finally reach to consumer (Fig. 6.1).

In all over world including India, pesticide consumption has increased over the time. This increase in pesticide use is either because of resistance in pests or otherwise infestation of new pests. Since residues of these pesticides get accumulated in the agriculture produce, they may pose adverse effect on consumer's health. Pesticide residues have been detected from various leafy vegetables including spinach, fenugreek, mustard and cabbage (~21.5 ppm), tomato (~17.5 ppm), and cauliflower (~1.70 ppm) which unfortunately are above the maximum acceptable daily intake (ADI) as prescribed by WHO in India (Bakore et al. 2002). The subsequent investigation revealed the presence of significant amounts of pesticide residues in the groundwater resources and tropic levels at a magnitude (Maloney 2001). These residues may induce carcinogenic, teratogenic, and other serious health hazards to the humans and animals because of their bioaccumulation and fat-soluble nature (Agrawal et al. 2010). Several hypersensitive reactions like eczema, dermatitis, allergic respiratory diseases, etc. are also caused by pesticides. They have been examined as mutagens and reported to cause mutations in chromosomes of humans and animals, thereby inducing carcinoma of the lung and liver (Chauhan and Singhal 2006). From the point of view of environmental sustainability and public health, pesticide degradation is an indispensable prerequisite.

Due to all aforementioned dilemmas, techniques are required for their degradation into nontoxic and ecologically safe products, which is beneficial for the environment as well as for the human health. Different methods have been developed for the degradation of pesticides in contaminated soil and water, e.g., heterogeneous photocatalysis with TiO_2, physical treatment (adsorption and percolator filters), high-temperature incineration, etc. According to FAO assessment, 3000–4000 USD/ton is the cost of these maneuvers (Ortiz-Hernandez et al. 2013). These methods are not only expensive but may also have serious disadvantages such as toxic emissions, hazardous ash formation, and production of dioxin which is carcinogenic (Vidali 2001). An alternative method for the treatment of pesticides is use of biological methods in which pesticides can be degraded with the help of microbes and plants without causing any harmful effect to the environment (Atlas and Pramer 1990). In a variety of organic and inorganic chemicals, pollutants are naturally transformed into their simpler non-harmful or less harmful forms by different microorganisms and certain plant species which is termed as "bioremediation." Various parameters such as soil moisture, temperature, and physicochemical properties of the soil persuade the rate of bioremediation of harmful chemicals in soil.

Most of the pesticides are synthetic and are similar to naturally occurring compounds to be subjected to microbial degradation. The degradation of chemical compounds depends on their structure and chemical bonds. Biochemical processes occurring in the environment are responsible to abate pesticides. Synthetic pesticides have a bewildering variety of chemical structure enclosing aliphatic and aromatic chains (Fig. 6.2). Aliphatic carbon chain containing pesticides are generally degraded by β-oxidation process, and the resulting carbon fragments are further metabolized by tricarboxylic acid cycle. Pesticides having aromatic chains can be degraded by dihydroxylation and ring cleavage. Bioremediation is therefore should be promoted as an effective alternative approach to remove or otherwise minimize the adverse effects of such hazardous chemicals.

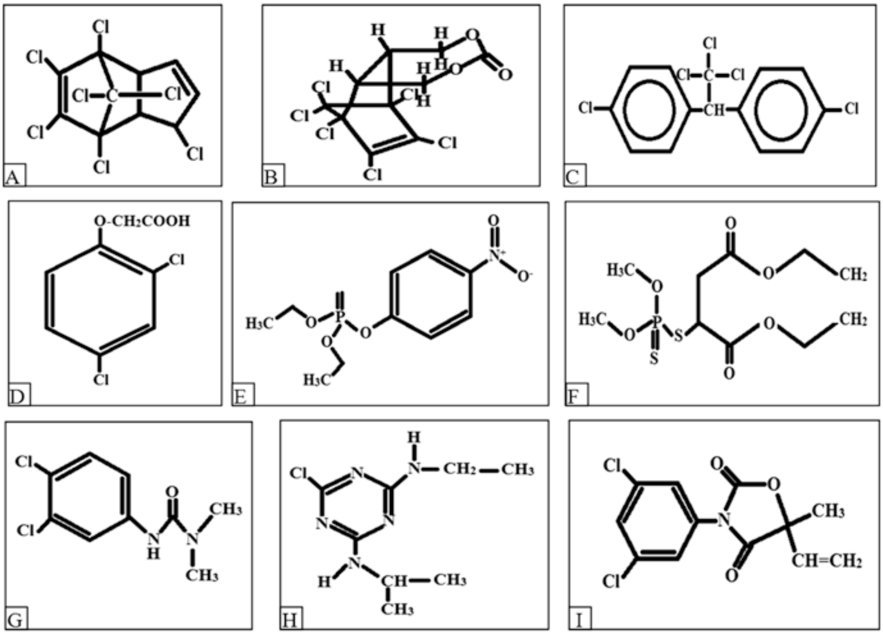

Fig. 6.2 Structures of some common agricultural pesticides. (**a**) Heptachlor, (**b**) Endosulfan, (**c**) DDT (Dichlorodiphenyltrichloroethane), (**d**) 2,4-D (2,4-Dichlorophenoxy acetic acid), (**e**) Parathion, (**f**) Malathion, (**g**) Diuron, (**h**) Atrazine, (**i**) Vinclozolin.

6.2 Bioremediation

Bioremediation is a process of degradation of biological wastes, chemical fertilizers, pesticides, etc. into nontoxic or less toxic form using certain microbes or plants. In some of the plants, bacteria and fungi have been identified to detoxify the substances which are perilous to the environment and human health. Plants and microorganisms used for bioremediation must enzymatically attack the pollutants and convert them into non-harmful end products. Similar to other biological processes, bioremediation requires suitable environmental conditions which permit the growth of the candidate microbe or plant to achieve effective degradation of pollutants at a higher rate. It often involves modification in environmental conditions to promote the growth of the candidate organism which simultaneously enhances degradation of the pollutants which is known as bioaugmentation. Bioremediation is safe, feasible to use, and more economical than traditional methods. However, some chlorinated organic or high aromatic hydrocarbons cannot be degraded using bioremediation and showed resistance particularly toward microbial actions. Since bioremediation process takes place in soil, therefore, use of plants (phytoremediation) and microbes (microbial remediation) for the purpose is more feasible than any other technique (Vidali 2001).

6.2.1 Phytoremediation

Phytoremediation is the process in which plants are used to degrade or transform the pollutants. Plants perform this reaction by different mechanisms including phytoextraction, phytodegradation, and rhizofiltration. The completion time of this process depends on the length of time taken by the plant to grow and type of the pollutant. Phytoremediation involves implantation of trees and grasses so it is environment-friendly and sometimes cost-effective too. It is a good technique for remediation of the pollutants with minimal maintenance, but it has its limitations that the pollutant should be in the reachable zone of plant roots (Trapp and Karlson 2001). In addition, if the pollutant is too water soluble, it will not be accessible to the root system, and no degradation will take place (Ghosh and Singh 2005). Other than these, high concentration of pesticides can be toxic to plants.

6.2.2 Microbial Remediation

Microbes are employed in this process for safe and effective remediation of environmental pollutants, pesticides, and other hazardous chemicals. Both bacteria and fungi are involved in different processes. Among the different bacterial genera, *Pseudomonas*, *Bacillus*, *Alcaligenes*, *Sphingomonas*, *Rhodococcus*, and *Mycobacterium* have been found promising to degrade pesticides and hydrocarbons (Sahinkaya and Dilek 2007; Caliz et al. 2011). Some of the anaerobic bacteria (*Dehalobium chlorocoercia* DF1 and *Dehalococcoides mccartyi*) are used in the bioremediation of polychlorinated biphenyls (PCBs) in river sediments (He and Bedard 2016; Payne et al. 2013). On the other hand, different fungi are also involved in remediation of pollutants in waste water, soil, organic wastes, etc. It has been reported that many filamentous fungi including *Penicillium* spp., *Fusarium* spp., white-rot fungi, mushrooms, etc. are entangled in the remediation of various chemical fertilizers and pesticides, and the process is known as “mycoremediation.” Since a large number of fungi produce resting bodies, they can survive longer in adverse conditions and induce their beneficial impact. Therefore, use of fungi is more common in remediation processes of different chemicals and organic waste.

6.2.3 Mycoremediation

Fungi play important role in human welfare because they are used by humans in various aspects like edible fungi which are being used to fulfill food requirements, waste decomposition, and production of industrially important products (enzymes, organic acids, alcohol, etc.). On the other hand, certain fungi are also used for the remediation of hazardous chemicals including pesticides (Prasad 2017). Numerous fungi including white-rot fungi have been reported to degrade various chemical compounds such as DDT, endosulfan, heptachlor, etc. (Kullman and Matsumura 1996; Singh and Kuhad 1999; Nwachukwu and Osuji 2007). *Pleurotus ostreatus*, *Trametes versicolor*, *Lentinula edodes*, *Bjerkandera adusta*, etc. also play a vital role in the process of bioremediation (Singh 2006). Similarly, *Aspergillus flavus*, *A. niger*, and *Trichoderma harzianum* have been found responsible for the degradation of chlorpyrifos and endosulfan (Katayama and Matsumura 1993; George et al. 2014). *Rhizoctonia solani*, *Sporothrix cyanescens*, *Mortierella*, etc. can degrade chloroneb fungicides and other pesticides (Hock and Sisler 1969). Fungi have good potential to degrade pesticides including different insecticides, fungicides, and herbicides. Major classes of pesticides with their representative compounds and different fungi involved in their remediation are elaborated in Table 6.1.

6.3 Insecticide Degradation

Insects such as beetles, butterflies, moths, and grasshoppers widely destroy the crops and thereby decrease the crop productivity resulting in economic losses. *Phyllophaga* spp., *Aphis* spp., *Prostephanus truncatus*, *Callosobruchus maculatus*, *Helicoverpa armigera*, *Pyrilla perpusilla*, and *Spodoptera litura* are among the major pests of the major crops such as wheat, maize, sugarcane, etc. and are reported to cause heavy losses in their respective host crop. Therefore, to prevent crop losses and productivity, their control is necessary. A number of insecticides is therefore applied in different crops to eradicate these pests. Combination of copper arsenite and copper acetate (Paris green) was firstly used to control Colorado potato beetle. Different types of insecticides are recommended for different insects. Among them chlorinated insecticides are broad spectrums, less toxic with large residual effect on soil. From soil, these residues either get accumulated in agricultural produce or leach down and contaminate the groundwater. Consumption of such contaminated water by human and other animals induce health hazards in them. Major examples of chlorinated insecticides include aldrin, dieldrin, DDT, endosulfan, endrin, heptachlor, and lindane. The role of fungi in the remediation of some hazardous insecticides is discussed briefly in the following section of this chapter.

6.3.1 Heptachlor (1,4,5,6,7,8,8-heptachloro-3a,4,7,7a-tetrahydro-4,7-methano-1H-indene)

This is a compound with pure white crystals and was first introduced in 1948 to kill termites. Later on it was also introduced in the agricultural system to protect the crops (e.g., maize, small grains, and sorghums) from ants, termites, wireworms,

Table 6.1 Classes of pesticides with representative examples and fungi involved in their mycoremediation

Class	Group	Major representative	Fungus involved in degradation	References
Insecticides	Organochlorine	Aldrin, lindane, DDT, endosulfan, heptachlor, dieldrin	*Aspergillus terreus*, *Trichoderma*, *Phlebia lindtneri*, *Fusarium ventricosum*, *Cladosporium*, *Phanerochaete chrysosporium*	Purnomo (2017), Kamei et al. (2011), Mougin et al. (1996) Siddique et al. (2003), Xiao et al. (2011c)
	Organophosphates	Chlorpyrifos, malathion, parathion, ethion	*Aspergillus oryzae*,	Rao and Sethunathan (1974), George et al. (2014)
			A. niger, *A. flavus*, *Penicillium waksmanii*, *Acremonium* sp.	
	Pyrrole	Fipronil	*Trametes versicolor*	Wolfandqa et al. (2016)
	Pyrethroids	Bifenthrin, cypermethrin, fenvalerate	*Cladosporium* spp., *T. versicolor*	Chen et al. (2011), Mir-Tutusaus et al. (2014)
Herbicides	Bipyridyl derivatives	Diquat, paraquat	*Mucor hiemalis*, *Zygorhynchus heterogamous*, *A. niger*, *Penicillium frequentans*	Smith et al. (1976)
	Amides	S-metolachlor and all chloro and propanol	*Aspergillus flavus*	Sanyal and Kulshrestha (2002)
	Urea	Diuron, isoproturon	*Rhizoctonia solani*, *Pestalotiopsis versicolor*, *Cunninghamella echinulata*, *Mortierella*	Ronhede et al. (2005), Ellegaard-Jensen et al. (2013)
	Triazines	Atrazine, propazine	*Aspergillus*, *Rhizopus*, *Fusarium*, *Penicillium*, *Phanerochaete chrysosporium*	Mougin et al. (1994)
	Cholorophenoxy compounds	2, 4-D, glyphosate	*P. chrysosporium*	Ferreira-Guedes et al. (2011), Bastos and Magan (2009), Ronhede et al. (2005)
			Trichoderma, *Trametes versicolor*, *Penicillium*, *Aspergillus*, *Rhizopus*, *Fusarium*	

(continued)

Table 6.1 (continued)

Class	Group	Major representative	Fungus involved in degradation	References
Fungicides	Phenyl amide	Tetraconazole, mefenoxam, metalaxyl	*Rhizopus stolonifer*, *Gongronella* sp.	Martin et al. (2013)
	Morpholine	Piperalin,	*Bjerkandera adusta*	Ermakova et al. (2008)
	Phthalimides	captafol, folpet, captan	*R. stolonifer*, *Gongronella* sp.	Martin et al. (2013)
	Dicarboximide	Vinclozolin, iprodione	*Cunninghamella elegans*, *Stereum hirsutum*	Pothuluri et al. (2000), Bending et al. (2002)
	Ethylenebisdithiocarbamates	Mancozeb, azithiram, thiram	Button mushroom, *Rhizoctonia solani*	Ahlawat and Singh. (2011), Chatrath and Raju (1986)

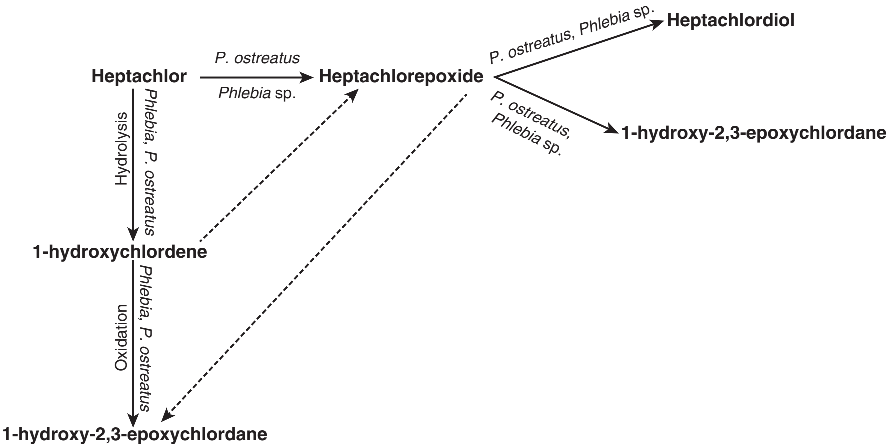

Fig. 6.3 Heptachlor degradation pathway. (Adapted and modified from Leon-Santiesteban and Rodriguez-Vazquez (2017))

cutworms, maggots, etc. Due to its carcinogenic effect on human beings, it has been banned in some countries including India. However, some countries like Algeria, Brazil, etc. are still using heptachlor. The half-life of heptachlor has been reported 2 years to several years (Maloney 2001). Because of its long persistence, several adverse effects including liver damage, carcinogenicity, irritability, muscle tremors, and convulsions have been reported in humans and animals (Dadey and Kammer 1953). Different, fungal species found in soil have been isolated and evaluated to degrade this molecule. Some of these fungi include *A. niger*, *Lentinus subnudus*, and *P. chrysosporium* and are found effective to degrade this pesticide (Nwachukwu and Osuji 2007). Heptachlor is transformed in heptachlor epoxide by *Penicillium*, *Fusarium*, *Rhizopus*, and *Trichoderma* spp. (Miles et al. 1969; Nwachukwu and Osuji 2007) which is however more toxic than its parent compound. *Pleurotus ostreatus* has been reported as a potential transformer of heptachlor into heptachlor epoxide along with two metabolites in nitrogen-deficient and nitrogen-rich medium which have been identified as 1-hydroxychlordene and 1-hydroxy-2,3-epoxychlordane (Purnomo et al. 2013). Xiao et al. (2011b) have reported that heptachlor can be degraded in heptachlor epoxide by the fungus *Phlebia* sp. and also hydrolyzed into 1-hydroxychlordene and was subsequently oxidized into 1-hydroxy-2,3-epoxychlordane (Fig. 6.3).

Phlebia aurea, *Phlebia brevispora* (Xiao et al. 2011b), and *Pleurotus ostreatus I* (Purnomo et al. 2013) use heptachlor epoxide as a substrate and further transform into 1-hydroxy-2, 3-epoxychlordane and heptachlor diol (2,3-dihydroxyheptachlor) by oxidative dechlorination and hydrolysis of the epoxide ring. These metabolites were found less toxic than the parent compound (Xiao et al. 2011b; Leon-Santiesteban and Rodriguez-Vazquez 2017). Among the different fungi involved in the remediation of heptachlor, *Phlebia aurea* and *Pleurotus ostreatus* were found most effective for the transformation of heptachlor epoxide and degrade heptachlor into the less toxic metabolite heptachlor diol (Fig. 6.3). Therefore, such degaradative fungi can be useful to reduce the harmful effects of heptachlor on environment, animals, and human beings as well.

6.3.2 Endosulfan (6,7,8,9,10,10-hexachloro-1,5,5a,6,9,9ahexahydro-6,9-methano-2,4,3-benzodioxa-thiepin-3-oxide)

The world is using endosulfan since its introduction in 1950s. It is used to control a wide variety of insects such as flea beetle, cabbageworm, peach tree borer, and leafhopper that attack on a wide range of food crops including vegetables, cereals, pulses, and fruits. This is also used in wood industries for the preservation of wood. It is recommended to control pests like *H. armigera* and *S. litura* in India (Vendan 2011). This is a chlorinated hydrocarbon insecticide of the cyclodiene subgroup and has been categorized under the category of persistent organic pollutant (POP). Endosulfan is a mixture of two stereoisomers alpha and beta-endosulfan in a ratio of 7:3. This has been reported that the endosulfan is rapidly degraded in water within 3–7 days but persists in soil for a longer period (Zhulidov et al. 2000). The residues of endosulfan have been detected in mammals, fishes, soil, and other food stuffs and even in human breast milk (Golfinopoulos et al. 2003). Consumption of contaminated food and water has been considered as major mode of transportation of this molecule to humans and other animals. Higher residual effects have been reported to induce adverse effects on human health such as cancer and infertility.

Due to its lots of side effects, it has been banned in many countries of the world. However, in some countries like Australia, Thailand, Canada, the United States, and India, its restricted use is permitted. Among the different countries, India is the largest producer and consumer of endosulfan. Since several adverse effects on human and animals are reported, complete degradation of this pesticide is needed. Many microorganisms have been investigated for this purpose, among which some fungi such as *A. niger* (Mukherjee and Gopal 1994), *T. harzianum* (Katayama and Matsumura 1993), *P. chrysosporium* (Kullman and Matsumura 1996), and *Mucor thermohyalospora* MTCC 1384 (Shetty et al. 2000) have been found effective for its mycoremediation. *Fusarium ventricosum* and *F. oxysporum* have been effective for the complete degradation of α and β-endosulfan (Siddique et al. 2003, Mukherjee and Mittal 2005). Singh (2006) reported *Phanerochaete chrysosporium* BU-1 as very effective fungus for the remediation of endosulfan (Fig. 6.4).

Mycoremediation of endosulfan by *P. chrysosporium* is catalyzed by the oxidation of endosulfan to endosulfan sulfate and then to endosulfan diol. Endosulfan sulfate formed by fungal oxidative metabolism is as much toxic as endosulfan is, whereas endosulfan diol is less toxic than the endosulfan. Further endosulfan diol is converted into less toxic endosulfan ether, endosulfan monoaldehyde, endosulfan dialdehyde, endosulfan hydroxyether, or endosulfan lactone (Awasthi et al. 2003;

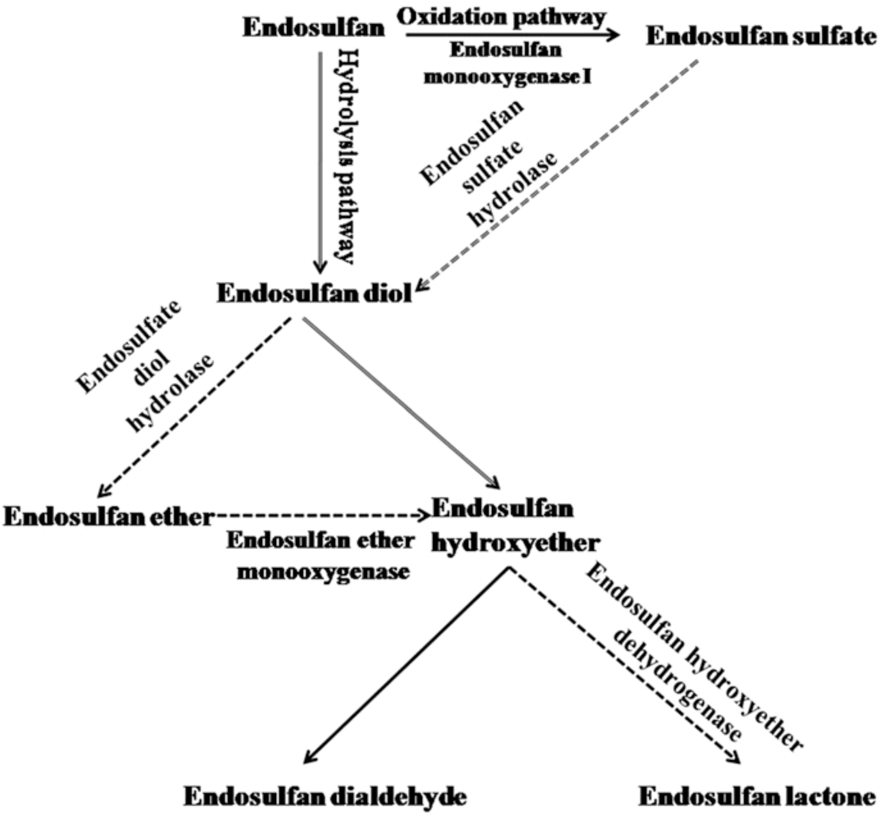

Fig. 6.4 Flow chart showing metabolism of endosulfan by *Phanerochaete chrysosporium* BU-1. (Adapted and modified from Singh (2006)). Dashed arrows indicate minor metabolic pathway; solid arrows indicate major metabolic pathway

Goswami et al. 2009). Therefore, these fungi could be effective in significant removal of endosulfan from the environment to reduce their effects on human and animal health.

6.3.3 DDT (Dichlorodiphenyltrichloroethane)

In 1939, a Swiss entomologist Paul Muller discovered DDT which was effective against the pests resistant to arsenic insecticides. In 1949, DDT was recommended to control pests such as Indian meal moth, European corn borer, potato leafhopper, and caterpillars (Yu 2008). DDT is however now banned in various countries such as China, the United States, and other developed countries due to a vast array of side effects, but still this is being used to control mosquitoes in many countries. In Africa and some developing countries, this is still in use due to its low cost. It has been widely reported that DDT exposure causes liver damage, endocrine disruption, sex hormone obstruction, and even cancer (Persson et al. 2012). Moreover, this is a pesticide with slow rate of degradation in environment. A vast array of bacteria and fungi degrade DDT into DDE (1,1-dichloro-2,2-bis (4-chlorophenyl) ethylene), DDD (1,1-dichloro-2,2-bis (4-chlorophenyl) ethane) (less toxic to humans), and DBP which have one or two benzene ring present and toxic to human beings and animals. The degradation of DDT has been reported by several mechanisms in deferent fungi. Some fungi transform DDT via reductive dechlorination, whereas others initiate degradation through hydroxylation prior to dechlorination. White-rot fungus, *Phanerochaete chrysosporium* has been reported widely for the degradation of DDT and its metabolites (Bumpus et al. 1985) into carbon dioxide; along with that some brown-rot fungi able to degrade DDT by the hydroxyl radicals produced via the Fenton reaction.

The common degradation pathway of DDT is known as Fenton reaction after the name of H.J.H. Fenton who gave the basic pathway in 1894. In this reaction, DDT is first dehydrochlorinated into DDE (1,1-dichloro-2,2-bis(p-chlorophenyl ethylene) by *Gloeophyllum trabeum* and then hydrogenated into DDD, followed by oxidative dechlorination to form DBP (4,4 dichlorobenzophenone). A fungus *Daedalea dickinsii* transforms DDT into DDE by dehydrochlorination and then transformed into DDD by hydrogenation. DDD is further dechlorinated and is converted to DDMU (di-1,1-chlorophenyl-2-chloroethene). However in case of *Fomitopsis pinicola*, the end product of the degradation of DDT is DDD (Purnomo et al. 2010). Some fungi degrade DDT into DDE by dehydrochlorination reaction and further into DDD by reductive dechlorination. DDD is further degraded into DDA (bis (4-chlorophenyl) acetic acid), DBP, DBH (4,4-dichlorobenzhydrol), and DDM (di-1,1-chlorophenyl-2-chloroethane). DBP is further transformed into 4-chlorobenzophenone (CBP) and 4-chloromethylbenzophenone by *Aspergillus niger*. Another pathway of DDT degradation was proposed by Bumpus and Aust (1987) and reported *P. chrysosporium* to be the most preferable organism to yield different metabolites after degradation of DDT. *P. chrysosporium* is able to renovate DDT into different by-products and afterward oxidize them to end-product carbon dioxide (CO_2) (Fig. 6.5). In this pathway, first of all, a reductive dechlorination of DDT to DDD was carried out. After that dicofol [1,1-bis(4-chlorophenyl)-2,2,2-trichloroethanol] and FW-152 [2,2-dichloro-1,1-bis(4-chlorophenyl) ethanol] were produced by hydroxylation of DDT and DDD. Another product of the transformation of FW-152 to DBP may be the results of reductive dechlorination, oxidation, decarboxylation, and the ring cleavage of DBP which however has not been fully described by them. These aforementioned fungi can be used to reduce the residual effects of DDT which still is causing harm in some countries.

Another group of insecticides is organophosphate; the insecticidal property of this group was firstly described by Gerhard Schrader in 1989. A total of 100 types of organophosphorus insecticides are used in agricultural system, and many of them have been banned now due to their toxic effects on animals, birds, and mammals. Major side effect of these insecticides is the damage to the nervous system by

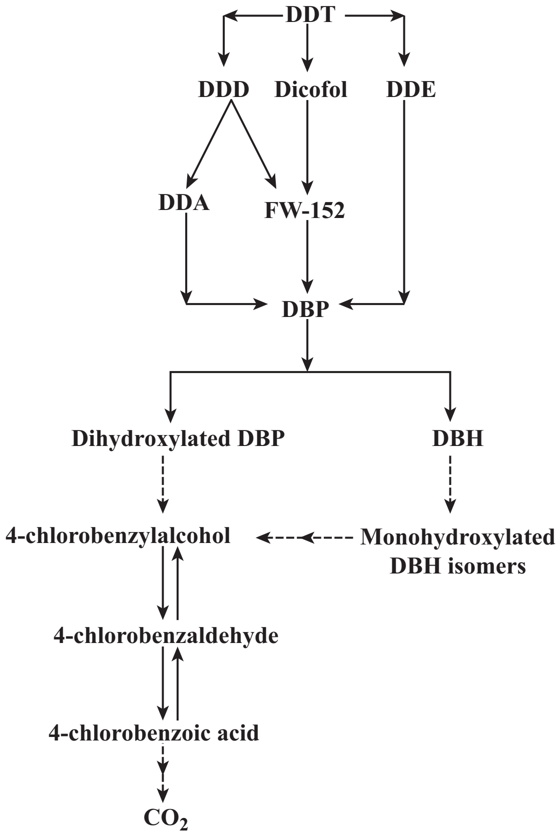

Fig. 6.5 DDT degradation pathway by basidiomycetes. (Adapted and modified from (Bumpus et al. 1985; Bumpus and Aust 1987; Xiao et al. 2011c))

phosphorylation of acetylcholine esterase enzyme (Ach E) resulting in the excess of acetylcholine in the system. This was found responsible to induce impairment of diaphragm, respiratory depression, etc. Among them, malathion and parathion have long been used widely in past.

6.3.4 Malathion

Malathion is used to protect agricultural crops, stored products, and home garden and also to kill mosquitoes in surroundings. A maximum of eight parts per million (ppm) of malathion as residue in food crops are permissible as per the food and drug administration (FDA) standards. Usually malathion is broken down from few weeks to several months after application in field by soil bacteria and fungi, but its extensive use has caused contamination of food and water reservoirs. From these resources it enters in human body and reaches to many organs and tissues through blood stream. In the liver, malathion is broken down in various metabolites, which are unfortunately more harmful than malathion. It causes vomiting, cramps, diarrhea, watery eyes, headache, loss of consciousness, and even death. Therefore, scientists started working toward its effective removal from the environment. It is transformed into β-monoacid and dicarboxylic acid by carboxylesterase activity of *Aspergillus oryzae* and is subsequently converted into inorganic phosphate. According to Massoud et al. (2008), malathion degradation by fungi is faster than the bacteria. He suggested that this may be due to the fungal chitinases which act faster than bacterial esterases. Other fungi such as *F. oxysporum* and *Candida cylindracea* are also reported to degrade malathion. Ester hydrolysis of malathion by cutinase of *F. oxysporum* results in the degradation of malathion monoacid (MMA) and malathion diacid (MDA). *Candida cylindracea*, however, degrade malathion into MMA by detoxification (Kim et al. 2005).

6.3.5 Parathion

It is another insecticide of this group that was firstly described by Schroder in 1944. This is generally used to control bollworms, armyworms, and aphids in a large variety of crops. Similar to such other compounds, its exposure to humans is associated with cancer and adrenal cortical adenoma, malignant pancreatic tumors, etc. In addition, parathion induces toxicity in nervous system and also affects adversely the synthesis of macromolecules like DNA, RNA, and proteins (Eaton et al. 2008). Therefore, proper degradation of this pesticide molecule is quite necessary. *Penicillium waksmanii* has been found effective to degrade parathion into amino-parathion (Rao and Sethunathan 1974). Amino-parathion is less toxic as compared to its original form. It has been reported by scientific community that reductive transformation of parathion reduces its toxicity.

6.4 Herbicide Degradation

Weeds are the undesirable plants which grow in association with the main crops and share foremost part of nutrients, light, place, water, and CO_2 from the main crop. Major weeds of the agricultural fields in India are fine leaf fumitory (*Fumaria parviflora*), yellow pea (*Lathyrus aphaca*), Mexican prickly poppy (*Argemone mexicana*), small-seeded canary grass (*Phalaris minor*), wild oats (*Avena fatua*), wild onion (*Asphodelus tenuifolius*), wild green amaranth (*Amaranthus viridis*), and beggarweed (*Desmodium triflorum*). These weeds reduce the crop stand and productivity. Some weeds such as *Agropyron repens*, *Lantana camara*, *Sorghum halepense*, etc. have shown allelopathic effects on different crops. To control such unwanted plants, a vast array of chemicals known as herbicides are being used. The use of synthetic herbicides has begun at the time of World War II, and 2, 4-D was the first herbicide that was introduced. In India, first attempt to control weeds by using synthetic chemicals was carried out in the year of 1937. Just like other chemicals, herbicides have also been found effective for weed management. But, their extensive and many a time indiscriminate use has developed resistance in many weed varieties.

This increasing resistance has led to an increase in resilience of weeds which ultimately increased the use of such chemicals. Market value of herbicides has been increased by 39% during 2002–2011 (Gianessi 2013). However, their excessive use has also induced harmful effects on environment and simultaneously on human health. The toxicity and perseverance of herbicides in environment depend on its chemical properties and quantity used. Herbicides that are used commonly include atrazine, metolachlor, clodinafop propargyl (CF), 2, 4-dichlorophenoxyacetic acid (2, 4-D), diuron, paraquat, and glyphosate (GP). They are harmful to birds, animals, and humans even at very low concentrations (in μg). Therefore, their proper degradation is required, and the microbes have shown a great hope to degrade them. Many fungi are involved in their degradation in simple non-harmful compounds.

6.4.1 2, 4-D (2, 4-Dichlorophenoxyacetic Acid)

This is a selective chlorinated acidic phenoxy herbicide and has been widely used to control broadleaf weeds of different crops such as wheat, oats, barley, rye, and corn. This herbicide was introduced in India in 1946. In most of the environmental conditions, 2, 4-D amine salts and esters convert to the 2, 4-D acid (pKa = 3.11) which is highly water soluble and therefore contaminate rivers, streams, and lakes (Muller and Babel 2004). It is classified as a hormonal herbicide with level II toxicity according to WHO and gets absorbed easily into the human and animal organs. Due to its toxicity, it exerts teratogenic, neurotoxic, carcinogenic, immunosuppressive, and hepatotoxic effects on humans (Singh and Singh 2016). In addition, 2, 4-D is responsible to interrupted energy (ATP) production in mammals and also related to the soft tissue sarcoma and Hodgkin's and non-Hodgkin's disease. Moreover, it is reported to induce lung toxicity in humans (Ganguli et al. 2014). Higher concentration/dose of 2, 4-D also causes toxicity to plants and increases multipolar cells with chromosomal aberration and decreases mitotic index (Gui et al. 2011). Due to its high consumption and very high toxicity, researchers are working toward effective degradation of such chemicals. This is a well-known herbicide, which mimics the effect of plant growth-regulating hormone and ultimately increases plant growth and results in plant death. According to one study, 2, 4-D at a higher concentration (100 mg/L) transforms into 2,4-dichlorophenol, which has been reported more toxic than the 2, 4-D.

Numerous studies have reported that *Mucor genevensis*, *Phoma glomerata*, *Chrysosporium pannorum*, *Aspergillus penicillioides*, *Aspergillus niger*, and *Fusarium oxysporum* are useful to degrade 2, 4-D and its other derivates (Fournier and Catroux 1980; Vroumsia et al. 2005). However, 2, 4-dichlorophenol degradation rate is higher than that of 2, 4-D. *Mortierella* sp. and *P. chrysosporium* are involved

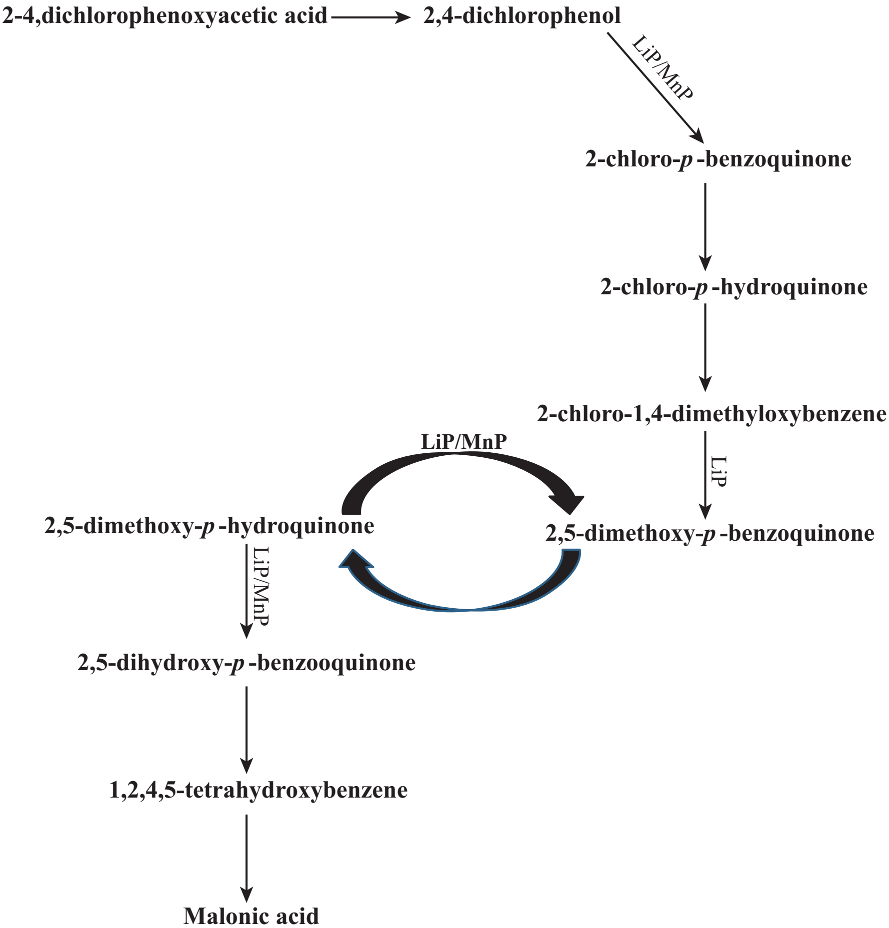

Fig. 6.6 Degradation pathway of 2,4-D and 2,4-dichlorophenol. (Adapted and modified from Buswell (2001)). LiP, Lignin peroxidase; MnP, Manganese peroxidase.

in the degradation of dichlorophenol (DCP) (Nakagawa et al. 2005). 2, 4-D is first converted into 2, 4-dichlorophenol which is further transformed in other metabolites by several reactions such as peroxidative dechlorination, quinone reduction, methylation, etc. (Fig. 6.6). These are the extracellular and cell-associated reaction of *P. chrysosporium*. 2, 4-dichlorophenol is oxidized either by LiP (Lignin peroxidase) or MnP (Manganese peroxidase) into 2-chloro-*p*-benzoquinone in which 4-chlorine atoms are removed to yield *p*-quinone. 2-chloro-*p*-benzoquinone is further reduced into 2-chloro-*p*-hydroquinone (Buswell 2001). After reduction of 2-chloro-*p*-benzoquinone, methylation reaction takes place in which 2-chloro-1,4-dimethoxybenzene is yielded. 2-chloro-1,4-dimethoxybenzene serves as a substrate for LiP-catalyzed oxidative dechlorination and yields 2,5-dimethoxy-*p*-hydroquinone and then to 2,5-dihydroxy-*p*-benzoquinone by subsequent oxidative dechlorination and reduction reaction which ultimately yields 1,2,4,5-tetrahydroxybenzene, and further oxidation and aromatic ring cleavage of 1,2,4,5-tetrahydroxybenzene yields to malonic acid which is the end product of this reaction.

6.4.2 Diuron [N-(3, 4-dichlorophenyl)-N, N-dimethylurea]

Diuron is one of the phenylurea herbicides and is most commonly used in cotton crop. Surprisingly, diuron has been recovered from groundwater resources in the limits exceeding threshold levels (Ruberu et al. 2000). A slow degradation of phenylurea herbicides are reported in various laboratory studies (Bozarth and Funderburk 1971; Zablotowicz et al. 2000). According to various studies on diuron, it is reported to leach down deeper in soil easily and pollutes the water bodies (Tworkoski et al. 2000). Diuron containing antifouling paint has also been reported as a pollutant of aquatic environment of Japanese and Dutch coastal areas (Okamura et al. 2003). Thus, appropriate degradation of this chemical is required. Some fungi are involved in its degradation such as *Rhizoctonia solani*, *Pestalotiopsis versicolor*, *Sporothrix cyanescens*, *Cunninghamella echinulata*, *Mortierella*, etc. Ellegaard-Jensen et al. (2013) reported the pathway for the degradation of diuron (Fig. 6.7). Diuron is first converted into DCPMU (1–3,4-dichlorophenyl-3-methylurea) that is further transformed into DCPMDU (1-3,4-dichlorophenyl-3-methylideneurea) and DCPU (1-3,4-dichlorophenyl urea). The DCPU is further converted into 3,4- DCA (3,4 dichloroaniline) that is comparatively much safer.

6.4.3 Atrazine (2-Chloro-4-ethylamino-6-isopropylamino-S-triazine)

Atrazine (2-chloro-4-ethylamino-6-isopropylamino-s-triazine) is a selective herbicide which kills only target weeds. It is frequently used to protect crops such as pineapple, sugarcane, pearl millet, sorghum, maize, etc. Its average life in water and

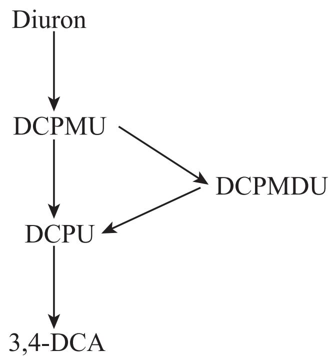

Fig. 6.7 Diuron degradation. (Adapted and modified from Ellegaard-Jensen et al. (2013))

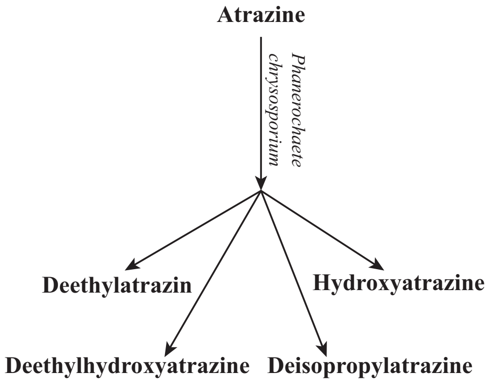

Fig. 6.8 Degradation of Atrazine given by Mougin et al. (1994)

soil is about 13–261 days (Abigail and Das 2012). Atrazine has benzene-like aromatic structure and high water solubility (Garcinuno et al. 2003). High persistence of atrazine has been detected in groundwater and also in drinking water that causes many hazardous effects on human health and ecosystem. It has been reported to be responsible for inhibition of testosterone production (Friedmann 2002) and is also responsible for the removal of MHC-I molecules from the dendritic cell surface (Pinchuk et al. 2007). This was also found responsible for various birth defects in human beings. Use of soil microorganisms has been found an inevitable approach to degrade atrazine into carbon dioxide and ammonia (Rousseaux et al. 2001). Many fungi such as *Aspergillus*, *Rhizopus*, *Fusarium*, *Penicillium*, *Trichoderma*, and *Phanerochaete* are proficient to degrade atrazine (Mougin et al. 1994). Among these, *Phanerochaete chrysosporium* efficiently degraded atrazine into deethylatrazine, deethylhydroxyatrazine, hydroxyatrazine, and deisopropylatrazine (Fig. 6.8). Another fungus, *P. pulmonarius*, is involved in the dealkylation and hydroxylation of the side chain of the atrazine, and the enzymes P-450 monooxygenases and chloroperoxidases somehow affect the dealkylation process (Abigail and Das 2012).

6.5 Fungicide Degradation

Numerous fungi have been reported to induce a variety of diseases in different crops and subsequently are responsible for heavy crop losses worldwide. *F. oxysporum* (fusarium wilt), *Claviceps fusiformis* (ergot), *Rhizoctonia solani* (root rots), *Puccinia graminis tritici* (black rust of wheat), *Ustilago tritici* (loose smut), *Sclerospora sorghi* (downy mildew), etc. are some common deadly fungal pathogens. Fungicides are the chemicals which are frequently used to protect crops from the infectious fungal diseases. Vast array of fungicides is being used in agricultural system to protect crops and thereby to enhance their productivity. Fungicides such as benomyl, vinclozolin, mefenoxam, metalaxyl, azoxystrobin, etc. are frequently used to protect crops.

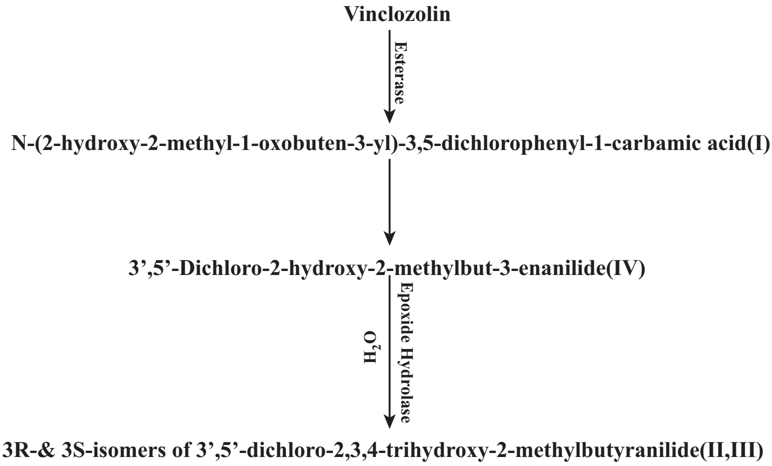

Fig. 6.9 Biotransformation of vinclozolin by *Cunninghamella elegans*. (Adapted and modified from Pothuluri et al. (2000))

6.5.1 Vinclozolin

It is a dicarboximide fungicide that is widely used in various fruit and vegetable crops. Excessive use of vinclozolin has shown residual effects on ecosystem and has been found in groundwater near to threshold concentration (Cova et al. 1990). This has been listed as endocrine disrupter and causes reproductive defects such as reduced prostate weight and vaginal pouching in rats (Gray et al. 2001). Pothuluri et al. (2000) have reported that *Cunninghamella elegans* can transform vinclozolin into four different metabolites (Fig. 6.9). Vinclozolin is transformed into metabolite I (*N*-(2-hydroxy-2-methyl-1-oxobuten-3-yl)-3, 5-dichlorophenyl-1-carbamic acid (I) by esterase enzyme; around 50% of the total metabolism is accounted by this metabolite. Metabolite IV (3′, 5′-dichloro-2-hydroxy-2-methylbut-3-enanilide) is formed by the decarboxylation of the oxazolidine portion of vinclozolin. Epoxide hydrolase reaction via ethylene dihydroxylation of metabolite IV results in the formation of metabolite II and III (3R- and 3S- isomers of 3′, 5′-dichloro-2, 3, 4-trihydroxy-2-methylbutyranilide). Though vinclozolin is degraded in simpler molecule by fungi, their toxicity is still unknown and needs further research on these compounds.

6.5.2 Chloroneb (1,4-dichloro-2,5-dimethoxybenzene)

Chloroneb (1,4-dichloro-2,5-dimethoxybenzene) is generally insoluble in water and stable at temperature up to 267.78° C. It efficiently controls soilborne fungal diseases in plants including food crops and ornamental plants (Hock and Sisler 1969). It is also used to treat seeds of sugar beets, soybeans, cotton, and beans to control fungal attacks. Exposure of this fungicide causes vomiting, tremors, and convulsions in human beings. *R. solani* has been reported to transform chloroneb into a nontoxic metabolite 2,5-dichloro-4-methoxyphenol (Hock and Sisler 1969). In addition to *R. solani*, complete degradation of chloroneb can be achieved by using *P. chrysosporium*.

6.5.3 Metalaxyl [Methyl N-(2, 6-dimethylphenyl)-N-(methoxyacetyl)-D, L-alaninate]

Another fungicide metalaxyl is a phenylamide and was introduced in 1977 for the first time for seed treatment and foliar sprays. This is a photostable compound and soluble in water at 20 °C (Sukul and Spiteller 2001). This fungicide is commonly used to control plant diseases such as late blight, downy mildew, damping off, etc. This has a broad-spectrum activity and is used on a wide range of agricultural crops and ornamental plants. Due to its high mobility and low absorption, it exists in soil for a long time and thereby contaminates groundwater (Martin et al. 2013). Metalaxyl adversely affects the environment by suppressing soil fungi and actinomycetes (Penttila and Siivinen 1996). This has also been reported as a mutagen (Hrelia et al. 1996). Therefore, methods for its proper degradation are required. Some fungi such as *R. stolonifer* and *Gongronella* sp. have been identified for the bioremediation of metalaxyl though the degradation pathway is still unknown (Martin et al. 2013). As only few organisms of choice are found so far, extensive research to find more organisms for its safer removal should be given a priority.

6.6 Conclusion

Pesticides being very effective to control a variety of insects, pathogens, and weeds have become an important component of agricultural system worldwide. But, unfortunately, their extensive and many a times irrelevant use has resulted in resistance among the target pest populations. Also, the persistence of these pesticides in the environment has been reported detrimental in the long run. Remediation of these pesticides by microbes is economically and environmentally feasible. Mycoremediation is proven to be an effective approach for the remediation of harmful chemicals and thereby to shield the environment against the hazardous effects. Numerous fungi including *P. chrysosporium*, *Phlebia aurea*, *A. niger*, *Phoma glomerata*, *Chrysosporium pannorum*, etc. have shown potential to transform or degrade harmful pesticides to non-harmful or less harmful compounds. These remediation processes are extremely advantageous to safeguard not only environment but the living organisms including humans as well.

6.7 Future Prospects

Mycoremediation has emerged as the best technique for the removal of pesticides. Although various fungi involved in remediation of pesticides have been identified and being used but for some of the pesticides only. However the complete degradation pathway for few pesticides is not available yet. Also in some cases, the toxicity of end product is not validated. Therefore there is a need to make efforts and comprehensive research to define the appropriate remediation pathway and the properties of the end product(s). Being natural inhabitants of diverse agroecosystems, fungi have an added advantage to transform or degrade the hazardous pesticides wherever they have been applied. No extra efforts or cost of transportation and processing of the sample is required, henceforth, if a suitable organism is identified and applied in agroecosystem that can make it safe for all living beings.

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Chapter - 1

Molecular Breeding: Need of Current and Future Plant Science

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Abstract

In the past two decades, genomic and molecular tools had been used as vital part of modern plant breeding to accelerate selection and development of parents and progeny of desired characteristics. In this review, the fruitful discussion of fundamental components of plant molecular breeding had been summarized i.e. the development of molecular marker, construction of genetic and physical map, identification of molecular markers associated with genes/QTLs (qualitative trait loci), mapping of quantitative trait loci and finally utilization of molecular markers in modern plant breeding approaches. Moreover, previous scientific reports on qualitative and quantitative trait mapping, current progress of markers assisted breeding, applications, achievements and future perspectives of molecular assisted breeding are discussed.

Keywords: molecular breeding, markers, crop improvement, Biotechnology, plant science

Introduction

According to present and future requirements superior crop varieties with combination of higher yield potential having excellent grain quality, resistant to abiotic and biotic stresses, and input use efficiency are needed. For durable resistance breeding various strategies are available such as pyramiding, lineage exclusion, mixtures and multilines on the basis of complete and specific resistance genes uses. Usually three major strategies are used for improvement of disease resistance of crops in current agriculture; first approach is improvement of cultural practices, second strategy involves crop improvement through conventional/marker-assisted breeding, third approach is transformation genes directly into elite cultivars (Baulcombe, 2004). Conventional breeding have been carried out for the last

50 years and resulted with release of number of resistant varieties along with high yield and quality. Despite of it, progress of conventional breeding is slow due to several obstacles, such as laborious and time-consuming selection process, low efficiency of appropriate genotype selection because of the quantitative nature of agronomic traits, crossing/selfing of several generations and often negatively affected by linkage drag.

Recent advances of molecular genetics have introduced novel tools for developing superior crop varieties for the future need which is known as molecular breeding. Only a decade ago, the status of crop genetics was far behind but with the completion of various genomes sequencing projects crop improvements research is greatly accelerated. With advance in molecular biology the researches are now focused on functional annotation of genes, revealing the underlying mechanisms involved in major agro-economical traits such as high yield, grain quality, biotic and abiotic stress tolerance and finally translation of genomic knowledge via molecular breeding into agricultural productivity (Helliwell and Yang, 2013).

In a broad sense, PMB may be defined as the utilization of genetic manipulation done at the molecular level to improve interested traits of plants. The PMB includes marker assisted selection (MAS) approaches, genome wide selection (GWS) approaches, genomic selection (GS) approaches, gene manipulation through transgenic (transgenic breeding) approaches, etc. PMB usually refers to use molecular markers combined with genetic or physical maps based trait analysis, to assist in improvement of phenotypic traits. This definition has been employed to explore molecular breeding strategies, i.e. marker-assisted selection (MAS), marker-assisted backcrossing selection (MABS), marker-assisted gene pyramiding (MAGP), marker-assisted recurrent selection (MARS), genome wide selection (GWS), and genomic selection (GS). In this review, a complete package and practice of progress in research and applications of plant molecular breeding aspects had been covered smoothly under following main outlines: molecular markers; genetic and physical map; qualitative trait analysis; quantitative trait analysis; plant molecular breeding (PMB) strategies, application, achievements and future perspectives.

Molecular markers

The development of DNA markers to detect and exploit DNA polymorphism within and among individuals is most significant discovery in the era of molecular biology. A genetic marker is a piece of DNA or polypeptide with easily identifiable phenotype i.e. cells or individuals having different distinguishable alleles. It can be a isozyme, protein or DNA sequence whose inheritance can be monitored. It may be as short as sequence surrounding a single base-pair (bp) difference (i.e. single nucleotide polymorphism, SNP), or as long one, i.e. minisatellites. Molecular markers may be defined in various ways i.e.:

i) Chromosomal landmarks or alleles that allow to trace a specific region of DNA molecules

ii) Specific pieces of DNA with known positions on the genome (http://en.wikipedia.org/wiki/Genetic_marker)

iii) Genes with discerned phenotypic expression can be used to identify individuals/cells that carry it, or as probe to mark loci, chromosomes or nucleus (King and Stansfield, 1990)

In simple words, molecular markers represent genetic differences among individual cells, organisms or species. They are identifiable DNA sequences found at specific locations of the genome, transmitted from one generation to the next by the standard laws of inheritance (Semagn *et al*. 2006). They may be the part of target genes/alleles themselves as 'signs', or may not be the part of target genes/alleles and can act as 'flags'. Molecular marker occupies specific genomic position in the chromosome (like genes) called 'locus' (plural 'locus'). When they are located in close proximity to genes i.e. tightly linked to target genes, may be referred as gene 'tags'.

Types of molecular markers

Genetic marker mainly includes two types of markers; DNA markers and non-DNA markers. Non DNA marker consists of morphological, biochemical and cytological markers but employed very few to tag traits of interest due to limited numbers and inherent drawbacks, i.e. occasional changes by environmental factors. Thus, molecular plant breeding is exclusively limited to using DNA markers. A DNA marker is a short region of DNA sequence representing polymorphism between different cells, individuals or species. In molecular plant breeding, DNA markers which are ideal, should be genome-specific, abundantly distributed throughout the genome, highly polymorphic, codominant, less costly and easier to detect. Moreover, analysis can be automated for high throughput application in practical breeding.

A number of DNA markers have been described in scientific publications, which are listed according their discovery year in chronological order as following: restriction fragment length polymorphism (RFLP; Botstein *et al*., 1980), short tandem repeats (STR; Hamada *et al*., 1982), variable number tandem repeat (VNTR; Nakamura *et al*., 1987), allele specific oligo (ASO; Beckmann, 1988), allele specific polymerase chain reaction (AS-PCR; Land-egren *et al*., 1988), inverse PCR (IPCR; Triglia *et al*., 1988), sequence tagged site (STS; Olsen *et al*., 1989), single stranded conformational polymorphism (SSCP; Orita *et al*., 1989), arbitrarily primed polymerase chain reaction (AP-PCR; Welsh and McClelland, 1990), random amplified polymorphic DNA (RAPD; Williams *et al*., 1990), sequence tagged microsatellite site (STMS; Beckmann and Soller, 1990), DNA amplification fingerprinting (DAF; Caetano-Anolles *et al*., 1991), expressed sequence tags (EST; Adams *et al*., (1991), degenerate oligonucleotide primed PCR (DOP-PCR; Telenius *et al*., 1992), simple sequence length polymorphism (SSLP; Dietrich *et al*., 1992), simple sequence repeats (SSR; Akkaya *et al*., 1992), strand displacement amplification (SDA; Walker *et al*., 1992), cleaved amplified polymorphic sequence (CAPS; Konieczny and Ausubel, 1993), microsatellite primed PCR (MP-PCR; Meyer *et al*., 1993), sequence characterized amplified regions (SCAR; Paran and Michelmore, 1993), anchored microsatellite primed PCR (AMP-PCR; Zietkiewicz *et al*., 1994), inter-simple sequence repeat (ISSR; Zietkiewicz *et al*., 1994), selective amplification of microsatellite polymorphic loci (SAMPL; Morgante and Vogel, 1994), random amplified microsatellite polymorphisms (RAMP; Wu *et al*., 1994), single nucleotide polymorphism (SNP; Jordan and Humphries 1994), single primer amplification reactions (SPAR; Gupta *et al*., 1994), site-selected insertion PCR (SSI; Koes *et al*., 1995), allele specific associated primers (ASAP; Gu *et al*., 1995), amplified fragment length polymorphism (AFLP; Vos *et al*., 1995), inverse sequence-tagged repeats (ISTR; Rohde, 1996), random amplified microsatellites (RAM; Hantula *et al*., 1996), multiplexed allele-specific diagnostic assay (MASDA; Shuber *et al*., 1997), sequence specific amplification polymorphisms (S-SAP; Waugh *et al*., 1997), anchored simple sequence repeats (ASSR; Wang *et al*., 1998), and diversity arrays technology (DArT; Jaccoud *et al*., 2001). A large type of DNA markers provides opportunity for researchers to associate the purpose(s) of a specific project with number of available molecular marker types. Out of these marker types some markers have very much similarity (i.e., ASO, ASAP, and AS-PCR), some are synonymous (i.e., RAMP, ISSR, RAM, AMP-PCR, SPAR, ASSR, and MP-PCR; Reddy *et al*., 2002), and some are identical (i.e., STMS, SSLP, SSR and STR).

Broadly, DNA markers can be classified into two categories: hybridization based DNA markers; in which visualization of DNA profiles is performed by hybridization of the restriction endonuclease digested DNA, to a labelled probe (DNA fragment of known origin or sequence). PCR-based

DNA markers; particular DNA sequences or loci are amplified *in vitro* with the help of primers (specifically or arbitrarily chosen oligonucleotide sequences) and a DNA polymerase enzyme (thermostable).

Hybridization-based DNA markers

RFLP is the most frequently used hybridization-based DNA marker. Firstly they were used for genetic mapping of a mutation of adeno-virus serotypes (Grodzicker *et al*., 1975), later in human genome (Botstein *et al*., 1980), and in plant genomes (Weber and Helentjaris, 1989). The technique reveals pattern differences between sizes of DNA fragments in individual organism on the basis of restriction enzymes cleavages. Generally, two organisms differ for cleavage site patterns of a restriction enzyme due to DNA rearrangements in their origin because of point mutations within recognition sites, deletions or insertions within the DNA fragments, irregular crossing over and evolutionary processes. This difference of cleavage site patterns for particular restriction enzyme produces different length of the digested DNA-fragments during digestion with particular restriction enzyme.

The procedures of RFLP markers can be summarized in following steps; genomic DNA digestion by one or more restriction endonuclease(s), agarose gel electrophoresis to separate restriction fragments, southern blotting to transfer separated fragments from gel to filter, southern hybridization with labeled probe(s) to detect individual fragments, and autoradiography (Landry, 1994). These markers are co dominant, highly reproducible and widely used in molecular research i.e. to construct the genetic map; high-density genetic maps and to tag agronomic traits. RFLP markers require high quality and quantity of DNA also demand radioisotopes for detection, which limited its use in genetic analysis.

PCR-based markers

PCR is a molecular biology technique to replicate (amplify) small quantities of DNA (usually up to 10 kb) enzymatically, without using a living organism. It is used to amplify a short, well-defined part of a DNA strand of a single gene or just part of gene. Basic protocol used for PCR is simply can be summarized in following steps; denaturation of double-stranded DNA at higher temperature (at 92-95 ^{o}C) for single strand templates formation, binding of short single strands of DNA primers at specific annealing temperature (at 45-65 ^{o}C) to the templates at ends flanking the target complementary sequences and catalyzation of the template-directed syntheses of new identical double-stranded DNA molecules to the template (at 72 ^{o}C). PCR technique represents various advantages over hybridization-based methods including; requirement of small amount of DNA, high polymorphism, elimination of demand of radioisotopes, requirements of small labs in terms of cost, equipment and facilities, no requirement of prior sequence knowledge in many applications i.e. AP-PCR, RAPD, DAF, AFLP and ISSR, amplification of DNA sequences from preserved tissues, screening of many genes simultaneously (Wolfe and Liston, 1998). Depending on the prior knowledge of sequences of primers used for amplification, PCR-based techniques can be classified into two following categories; arbitrary or semi-arbitrary primed PCR techniques that do not require prior sequence information (e.g., RAPD, AFLP, ISSR, DAF and AP-PCR), site-targeted PCR techniques that require prior DNA sequences (e.g., SSR, SNPs, STS, EST, SCAR and CAPS). A overview of five major DNA markers which are mostly used in plant molecular breeding are given following:

RAPD, AP-PCR and DAF have been collectively termed as multiple arbitrary amplicon profiling (MAAP). In the RAPD system, the total genomic DNA of individuals is amplified by PCR using a single, short (usually about 10 bases) random primer (Williams *et al.*, 1990). Polymorphisms results from rearrangements either at or between the primer-binding sites, base insertions, substitutions or deletions are visible in gel electrophoresis as absence or presence of a particular DNA fragment. This technique had been widely used in many organisms for genetic studies and germplasm characterization, to construct genetic maps, distinguish various elite cultivars and tag useful agronomic traits. RAPD markers analysis is simple and easy, but its low polymorphism, low reproducibility and dominant nature make RAPD less applicable for molecular analysis. Number of variation of the RAPD markers system is available which are shortly modified according the need of specific project i.e. arbitrarily primed polymerase chain reaction (APPCR); uses longer arbitrary primers than RAPDs, and DNA amplification fingerprinting (DAF); uses shorter (5-8 bp) primers for generation of a large number of DNA fragments.

Table 1: Characteristics of most frequently used molecular markers

Characteristics	RFLP	RAPD	AFLP	ISSR	SSR	SNP	DArT
Co-dominant/Dominant	Co-dominant	Dominant	Dominant	Dominant	Co-dominant	Co-dominant	Dominant
Reproducibility	High	High	Intermediate	Medium-High	High	High	High
Polymorphism level	Medium	very high	High	High	High	High	High
Required DNA quality	High	High	High	Low	Low	High	High
Required DNA quantity	High	Medium	Low	Low	Low	Low	Low
Marker index	Low	High	Medium	Medium	Medium	High	High
Genome abundance	High	Very high	Very high	Medium	Medium	Very high	Very high
Cost	High	Less	High	High	High	Variable	Cheapest
Sequencing	Yes	No	No	No	Yes	Yes	Yes
Status	Past	Past	Past	Present	Present	Present	Present
PCR requirement	No	Yes	Yes	Yes	Yes	Yes	No
Visualization	Radioactive	Agarose gel	Agarose gel	Agarose gel	Agarose gel	SNP-VISTA	Microarray
Required DNA (ng)	10000	20	500-1000	50	50	50	50-100

Optimized from Nadeem *et al*. 2018

AFLP marker technique combines the reliability of RFLP markers with the convenience of PCR (Vos *et al*., 1995). It involves genomic DNA restriction, followed by ligation of complementary adaptors to the restriction sites and amplification of a subset of the adapted restriction fragments by selective PCR. AFLP analysis mainly comprises with three following steps; genomic DNA digestion with usually a frequent cutter (recognition site 4-bp i.e. TaqI or MseI) and a rare cutter (recognition site 6-bp i.e. Hind III or EcoRI) restriction enzymes; adaptors ligation to the both ends of the restricted fragments; then PCR and poly acrylamide gel electrophoresis (PAGE) of fragments. Its key feature is simultaneous screening of representative DNA regions distributed randomly throughout the genome which is known as genome representation. It is used for constructing genetic maps; tagging agronomic traits, and characterizing cultivars. AFLP markers are high reliable and irreproducible but dominant nature and complex banding pattern makes AFLP markers difficult for utilization in high throughput automation.

SSR markers or microsatellites are random tandem repeats of short (usually 2-6 bp long) nucleotide motifs. SSRs can be characterized as randomly distributed throughout genome locus specific, codominant, hypervariable and highly reproducible. Since, SSRs have ability to be multiplexed and automated for high throughput genotyping, gradually replaced RFLP, RAPD, and AFLP markers and become the present easiest marker of choice. Mainly two genomic sources; microsatellite enriched DNA libraries and have contributed for development of SSRs. Recent availability of more genome sequences has contributed for developing SSRs directly from genome sequences. Currently, Gramene database (www.gramene.org) contains more than 24,00,000 SSR markers. SSRs have been extensively used in QTL mapping, linkage mapping, germplasm characterization and marker-assisted selection.

A single nucleotide difference between two DNA sequences or individuals constitutes an SNP Marker. Generally, a few base insertions or deletions (indels) come under SNPs, but more specifically nucleotide substitutions i.e. either transitions (G/A or C/T) or transversions (A/T, C/G, T/G or C/A) are considered as SNPs. SNPs are simplest form of DNA marker which provides the maximum number of markers among all DNA markers. SNP markers are often present in genes, highly abundant in living organisms, codominant and its genotyping can be easily automated which makes it’s a very attractive DNA marker type which have rapidly replaced the former DNA markers and become the choice for genetic studies and molecular breeding of plants. Realizing the potential importance of SNPs in plant molecular breeding, corporations, such as Monsanto, Bayer, Crop Science, Delta and Pine Land Company started large-scale SNP research and used SNPs for tagging disease-resistance genes and other important traits.

Genetic and physical maps

Genetic or physical map assists to identify molecular markers associated with economically important traits, clone genes of interest and dissect agronomic traits. Researchers have constructed number of genetic maps with different populations using multiple types of molecular markers (Reinisch *et al*., 1994).

Quantitative trait analysis

Major agronomically important traits, i.e. yield are controlled by polygenes or QTLs, interaction of QTLs × environment (E) and epistasis. Each gene of this polygene has a small influence on the phenotype, which is also effected by environmental conditions. Usually, the efficiency of MAS is reduced by QTL × E interaction and epistasis (interactions with other genes) which results as skewed QTL effect. Consequently, phenotyping and genotyping of quantitative traits is complex undertaking, therefore repeated field test is needed for accurate characterization and stability test of the QTL effect. The analysis and mapping of QTLs are performed mainly for yield, yield associated components, biotic and abiotic stress resistance/tolerance.

QTLs mapping

Bi-parental mapping uses two parents to develop a population for QTL identification. It is similar to major genes mapping, however it is more complicated due to existing following differences; usually larger population size, repeatedly evaluation of segregating populations in multiple environments (locations or years), genotyping of all progenies with all polymorphic markers for constructing linkage map, analysis of the phenotypic data with appropriate statistics tool such as ASReml or SAS, an appropriate mapping method for identification of QTLs, such as composite interval mapping. Later step can be conducted with statistical softwares such as Map QTLs and QTL Cartographer (Van Ooijen, 2009).

Multiple-parent mapping uses more than two parents to develop a population for QTL identification. Obtaining of a high-resolution genetic map with a biparental population is very difficult or impossible due to low genetic diversity present within germplasms. Multiple-parent mapping ensures greater genetic diversity with increased polymorphism frequency to improve the possibility of QTL identification.

The utilization of the QTL mapping has been limited due to various constraints in plant breeding; lack of universally valid QTL-marker associations because new QTL mapping is required to identify QTL markers of a new Germplasm, strong QTL × E interaction, which varies phenotype between different locations or years, deficiencies of statistical analysis of QTLs, leading either underestimation or overestimation of the number of QTLs, lack of frequent QTLs with major effects on trait.

Association mapping

Association mapping uses all alleles present in a data panel of phenotype and variety obtained through various experiments or variety tests on the basis of linkage disequilibrium. It has become a powerful tool for the identification of markers-associated with QTLs in plants (Hamblin *et al*., 2011).

Allele mining

Allele mining is an approach for identification of novel alleles or allelic variants of a candidate gene of interest on the basis of the information available about the genes, from a wide range of germplasm. Allele mining success mainly depends on the diversity of genetic materials and availability of gene and genome sequence information of crop species. Usually local landraces and wild relatives are used for efficient allele mining, because they serve as reservoirs of useful hidden alleles. Sequence based allele mining and EcoTilling are widely used approaches in the allele mining. Sequence based allele mining strategy is simpler and less costly approach than EcoTilling. Allele mining have wide range of applicability in crop improvement such as identification of alleles, characterization of allelic variation, identification of haplotypes, analysis of haplotypes diversity, evolutionary relationship and molecular markers development. Allele mining approaches have been used for identification of novel alleles of many blast resistance genes.

Application of plant molecular breeding in practice

Molecular markers with other genomic tools have been extensively used in practical plant breeding by both public institutions and private companies. Great success has been achieved in transferring of a number of agro-economical traits into elite cultivars. We are giving an overview of few successful attempts of the utilization of molecular markers and other genomic tools in plant breeding.

Marker-assisted backcross breeding (MABC)

MABC used for the introgression of genes (one or a few) from donar parent into the susceptible or adapted or elite cultivars. During backcrossing, MABC selects target loci with the help of molecular markers, minimizes linkage drag and accelerates the recovery of genome of the recurrent parent (RP) (Charcosset, 1997). The main objective of MABC is introgression of the targeted trait along with maximum recovery of the recurrent parent genome. Tightly linked markers with important traits are used in MABC for detection of the presence of desire gene in backcrossing thus greatly increases selection efficiency.

MABC is superior to conventional backcross breeding in terms of efficiency, precision and time saving so playing important role in the development of improved cultivars. Recently many blast resistance genes of rice have been successfully introgressed into the genetic background through MABC and improved the blast resistance.

Marker-assisted backcross selection (MABS)

MABS is simplest form of marker-assisted selection which has been successfully applied in assisting transfer of genes/transgenes from a donor parent to recipient elite cultivars. Currently, 90% of Indian cotton contains one or more transgenes for tolerance to insecticidal toxin and more than 90% of USA cotton primarily tolerant to herbicides insecticidal toxin. Delta and Pine Land Companies widely used MABS for introgression of the transgenes into many elite cultivars.

The general principle and procedure of MABS is as following (Figure 0):

1. Selection of donor parent (DP) containing the transgene(s) to make cross with an elite cultivar as the recurrent parent (RP)
2. Identification of at least ten polymorphic markers distributed throughout per chromosome between the DP and RP markers
3. Growing of F_1 population, validation of presence of the transgene at early stages for elimination of false hybrids finally crossing of the true F1 plants to the RP
4. Growing the BC_1F_1 population, screening of individuals for presence of the transgene at early growth stages, crossing true hybrids back to the RP
5. Growing the BC_2F_1 plants, screening of individual plants for validation of the transgene and genotyping of true hybrids with maximum polymorphic markers

6. Planting of the progenies having greatest RP genome recovery, backcrossing it to RP for obtaining the BC_3F_1population, screening of individual plants for the presence of transgene and genotyping of each progeny with polymorphic markers
7. Planting of the progenies having maximum RP genome recovery, backcrossing it to RP for obtaining the BC_4F_1 plants, screening of individual plants for validation of the transgene. Self-pollinate BC_4F_1 plants for obtaining the BC_4F_2 plants and harvest homozygous individuals for the transgene locus to evaluate and release further. MABS can expedite the cultivar development that is essential for a seed company to stay competitive

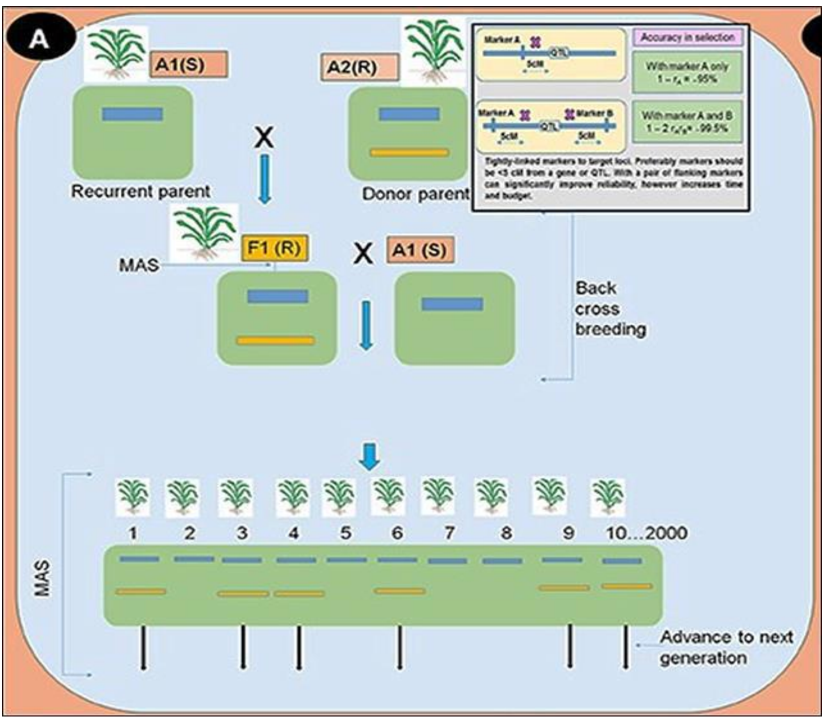

Fig 1: Simple Procedure of Marker Assisted Backcross Breeding

Gene pyramiding

Often plant breeders are needed to combine number of desirable traits from multiple parental lines, for development of superior breeding lines and varieties particularly in the case of disease resistance. Accumulation of more than two genes into a single line or cultivar is known as gene pyramiding. The strategy of a gene pyramiding program is accumulation of genes identified in multiple parents into a single genotype to create genotype with all of the targeted genes (Joshi and Nayak, 2010). Technically gene pyramiding broadly used to combine multiple pest and disease resistance genes for specific pathogen races or insect for development of durable resistance because different R-genes often provide resistance to different races, isolates or biotypes (Figure 2). Gene pyramiding is greatly accelerated through utilization of molecular markers for identification and selection of plants having desired allele combination in early growth stage. Utilization of markers facilitates to access, transfer and combine genes faster rate with precision, saves resources including field space, greenhouse, water and fertilizer. Gene pyramiding is one of the most effective strategy to achieve durable resistance against biotic stresses and have been successfully used for accumulation of different blast resistance genes in elite cultivars rice.

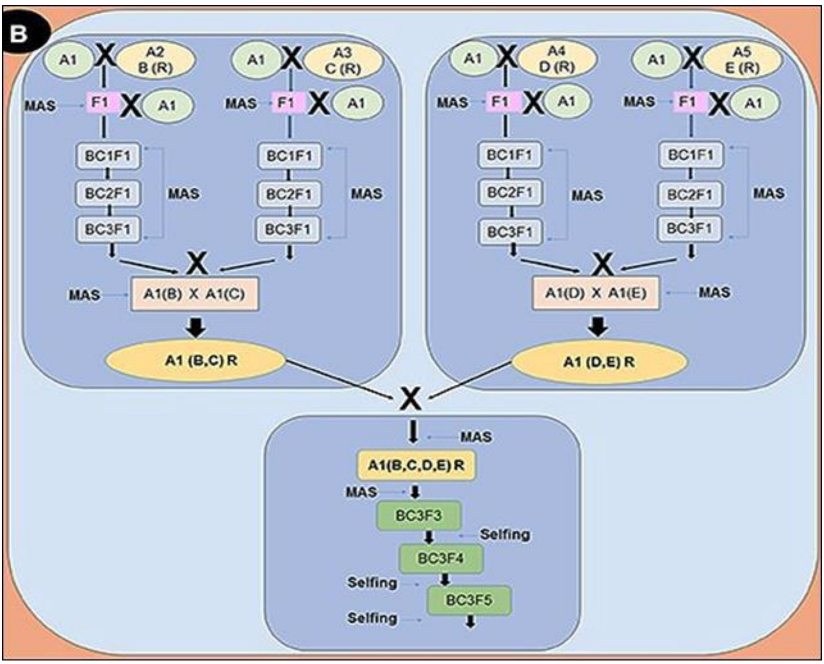

Fig 2: Simple Procedure of Molecular Assisted Gene Pyramiding

Achievements

Scientists have used various molecular markers for genetic mapping in recent year to identify candidate genes or QTLs. Molecular marker technique provides us a rapid protocol for selection of multiple resistance genes without requirement of testing progeny or phenotypic disease screening. Several genes of agronomic importance such as blast resistance, brown planthopper, bacterial leaf blight, grassy stunt and tungro virus have been transferred into the elite breeding lines from the wild species, in addition the QTLs for abiotic and biotic stress resistance genes are also have been explored through molecular assisted selection (Brar and Khush, 1997).

Marker-assisted breeding in rice: Dr. A.K. Singh, Head, Division of Genetics, Indian Agricultural Research Institute (IARI) developed Improved Basmati rice varieties having resistance to bacterial blight under the project "Development of biotic stress resistant rice through marker assisted breeding". Financial support for this project has been granted by the Department of Biotechnology (DBT), Ministry of Science & Technology (MOST), Government of India (GOI).

Combination of molecular marker-assisted selection with phenotypic selection has been effectively used in to develop these Basmati rice varieties. The bacterial blight resistant genes namely, xa13 and Xa21 were transferred in the genetic background of Pusa Basmati 1, Pusa Basmati 6 and Pusa Basmati 1121 for development of Improved Pusa Basmati 1, Pusa Basmati 1728 and Pusa Basmati 1718, respectively. Likewise, blast resistance gene Pi9 incorporated into the genetic background of Pusa Basmati 1 to develop Pusa Basmati 1637. Pusa Basmati 1728 and Pusa Basmati 1718 are released by the Central Variety Release Committee (CVRI) after testing in All India Coordinated Research Project (AICRP).

Table 2: Improved Basmati rice varieties developed through molecular marker-assisted breeding having resistant to biotic stresses

Variety	Year of release	Deployed Pedigree	Duration (days)	Yield (t/ha)	Areas recommended	Special characteristics
Improved Pusa Basmati 1 (IET 18990)	2007	PB 1/IRBB 55/PB1*1	135-140	5.0-5.5	Punjab, Haryana, Delhi, Western UP, Uttarakhand, Jammu and Kashmir	Possesses bacterial blight resistance genes *xa13* and *Xa21* in the background of PB 1
Pusa Basmati	2014	Pusa	120-125	6.0-	Punjab, Delhi,	Possesses two genes
1609		1602/Pusa		6.5	and Uttarakhand	for blast resistance
(IET 22778)		1603				(*Pi2* and *Pi54*)
Pusa Basmati	2016	PB 1/	130-135	5.0-	Punjab, Haryana,	Possesses a
1637		IRBL		5.3	Delhi, Jammu	broad-spectrum blast
(IET 24570)		9-W/PB			and Kashmir,	resistance gene, *Pi9*
		1*3			Uttarakhand, and	in PB 1 background
					western Uttar	
					Pradesh	
Pusa Basmati	2017	PB 1121/	140-145	5.0-	Punjab, Haryana,	Possesses two genes
1718		SPS 97/		5.3	and Delhi	for bacterial blight
(IET 24573)		PB				resistance (*xa13* and
		1121*3				*Xa21*) in PB 1121
Pusa Basmati	2017	PB 6/Pusa	140-145	4.5-	Punjab, Haryana,	Possesses two genes
1728		1460/PB 6		5.0	Delhi, Jammu	for bacterial blight
(IET 24573)		*3			and Kashmir,	resistance (*xa13* and
					Uttarakhand, and	*Xa21*) in PB six

					western Uttar	background
					Pradesh	
Pusa Basmati	2018	Pusa	135-140	5.5-	Punjab, Haryana,	Possesses two genes
1884[a]		1726/Pusa		6.0	Delhi, Jammu	for blast resistance
		1727			and Kashmir,	(*Pi2* and *Pi54*) in PB
					Uttarakhand, and	six background
					western Uttar	
					Pradesh	

Adopted from Singh A.K. *et al*. 2018, Genetic Improvement of Basmati Rice: Transcendence through Molecular Breeding

MABB is also deployed successfully for development of rice varieties having tolerance to abiotic stresses. Saltol, a major QTL for salinity tolerance at seedling stage (Gregorio *et al.* 1997) has been incorporated into the genetic background of PB 1509 (Yadav *et al.* 2017), PB 1121 (Babu *et al.* 2017) and PB1 (Singh *et al.* 2018c) to develop near isogenic lines having Saltol QTL. Under salt stress, these varieties will ensure improvement of Basmati rice yield. In 2017, Grover *et al.* deployed MABB for transfer of "imazethapyr" herbicide tolerance from an EMS-induced mutant of Als gene HTM-N22 which was identified in the rice variety Nagina 22 to PB 1121. and a set of advanced backcross PB 1121 progenies with resistance to imazethapyr are in advanced stages of testing. In 2017, S.G. Krishnan *et al.* adopted MABB for transfer of a major QTL, qDTY1.1, governing reproductive stage drought tolerance, from drought-tolerant variety "Nagina 22" to Pusa Basmati 1. This led identification of backcross-derived superior progenies with yield advantage under reproductive stage drought stress.

The high-yielding Basmati rice varieties developed through MABB brought paradigm move in Basmati rice cultivation, consumption and export (more than the worth of Rs. 25,000 crores annually). In the Indo-Gangetic Plains (IGP), it is bringing prosperity to billions of Basmati rice farmers; this success story can be termed as Basmati revolution.

Marker-assisted breeding in wheat: Punjab Agricultural University, Ludhiana developed Unnat PBW343 through MABB by pyramiding two stripe rust and two leaf rust resistance genes Lr37-Yr17/Lr76-Yr70 in the wheat wide hybridization programme. In which, linked pair of genes Lr37-Yr17 along with a stem rust resistance gene Sr38 have been introgressed on wheat chromosome 2AL from Aegilops ventricosa while Lr76-Yr70 were introgressed on wheat chromosome 5DS from Aegilops umbellulata. Unnat PBW343 is first commercial product of PAU, Ludhiana wide hybridization programme. Unnat PBW343 variety is an improvement of mega variety PBW343 having resistant to stripe and leaf rust. Chaudhary Charan Singh Haryana Agricultural University, Hisar deployed MABB to transfer two major QTLs Nax1 and Nax2 responsible for tolerance to early growth stage salt tolerance in wheat from salt tolerant wheat variety Kharchia 65 to salt sensitive elite wheat cultivars WH 1105 and HD 2967. Near isogenic lines having potential degree of early growth stage salt tolerance will become available soon for using in wheat improvement programs.

Marker-assisted breeding in maize: The MABB identified hybrids with enhanced protein quality, pro-vitamin A, Zn and Fe would give better micronutrients content which can play a major role in micronutrient deficiency reduction. During 2017, Vivek QPM9 as a rich version of Pro-vitamin A was identified through targeted breeding approaches by AICRP for Northern Hill Zone. This is Indias first pro-vitamin A rich hybrid, also rich in tryptophan and lysine amino acids and earns the distinction of country's first multi-nutrient rich maize.

Marker-assisted breeding in cotton: Cotton blue disease (CBD) is caused by a virus belongs to the family Luteoviridae. Resistance to CBD is found in Upland cotton cultivar 'Delta Opal' which is controlled by a dominant gene, CBD, mapped to chromosome 10 flanking by the DC20027 SSR marker and the NG0204310 SNP marker.

Bacterial blight, caused by *Xanthomonas axonopodis pv. malvacearum*, is a major cotton disease managed by planting resistant cultivars. There are many isolates, but race 18 is the most prevalent. The resistance to race 18 is controlled by a dominant gene, B12 which was mapped to chromosome 14 flanking by NG0207069 and NG0207155 SNP markers.

In Brazil, the Deltapine breeder screened all F2 plants with markers associated with the CBD and B12 genes upto F4 or F5 stage. Further in field tests of these potential lines in the nursery or inoculation with bacterial blight by spraying in a field demonstrated that almost all cotton selected lines were resistant to both diseases.

For root-knot nematode a recessive root-knot nematode resistance gene, rkn1, in Acala Nem X identified, mapped to chromosome 11 and tagged with CIR316 SSR marker. Fang, 2007 screened lines derived from crosses having LA887 as one parent using the SSR marker CIR316. One resistant line out of these became, the first root-knot nematode resistant commercial cultivar DP174RF.

For improving fiber quality Shen *et al*. (2011) used markers to assist transfer of the fiber length QTL on chromosome 1 (qFL-chr1) into other cotton lines. A single near-isogenic introgression line, R0140-08, selected with 94.3% of recurrent genome and significantly longer fibers. Four chromosome-segment introgression lines (CSILs) IL040-A4-1, IL088-A7-3, IL080-D6-1, and IL019-A2-6 associated with superior fiber qualities QTL, were selected and transferred through backcrossing into three commercial Upland cotton cultivars to develop five improved lines (3389-2, 3262-4, 3326-3, 3426-5 and 3380-4).

Molecular markers are applied to improve traits of interest such as root-knot nematode resistance has been successfully implemented in both private and public breeding programs. In 2014, a new root-knot resistant variety, DP1454NRB2RF, which was bred has been released through MAS (http://southeastfarmpress.com/cotton/cotton-resistant-root-knot-nematodes-unveiled, accessed 18 Jan. 2015).

Conclusion

Disease management is one of the most important needs to feed growing world population. The availability of number of molecular tools gives opportunity to characterize genes of interest and to identify plants with target genes for improving the efficiency of conventional breeding. Molecular dissection accelerates identification of resistance genes and QTLs or multiple loci with major and minor effects. The development of molecular markers from these genes or QTLs can be used in MAS to select resistance without confounding environmental factors effect. DNA markers co-segregate with the gene are very powerful to use in crop protection and routinely used in plant genome analysis such as molecular genetics and plant breeding. Recently developed molecular breeding strategy such as allele mining and gene pyramiding holds greater potential for attaining long durable resistance against abiotic and biotic stresses in plants. Identification of superior and novel resistance alleles of the blast resistance genes is a vital task in the molecular breeding program. These novel alleles are extremely useful in crop breeding programs and can be used for development of superior and productive plants. Rice blast is the most severe disease of rice limiting the production of rice by causing 157 million tons yield loss per annum worldwide (Kaundal *et al*., 2006). Resistant varieties development by incorporation of new genes into improved germplasm has been established as effective, economical and environmentally friendly for controlling of rice blast disease (Skamnioti and Gurr, 2009).

Future perspectives

In Basmati rice improvement program breeding strategies come with a long way from collection of germplasm, selection of superior plant then transformation of pedigree breeding into MABB for rectification of specific weaknesses of good varieties. High yielding dwarf varieties of crops have revolutionized production and quality attributes but there is still urgent need to further improve aroma and taste of Basmati rice. The understanding of molecular basis of Basmati quality traits would require whole-genome sequencing of the elite Basmati rice varieties such as Taraori Basmati, Basmati 370, PB1, PB1509 and PB1121 in respect to yield and quality traits. Whole-genome sequencing would also facilitate to develop new generation varieties of crops combining yield, improved grain and nutritional quality, adaptation to climate change, resistance to abiotic and biotic stresses, and according to consumers, farmers and market needs.

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Chapter - 2
Perspectives of Nano Technology in Agriculture

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Chapter - 2

Perspectives of Nano Technology in Agriculture

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Abstract

Agriculture is Indian backbone of economy and Agriculture is essential for human survival and social sustainability. Agriculture is root to solve the issues of food crises with sustainable techniques implement in farming that protect ecosystems, environment and human health, and in the same time produce adequate amount of grains, meat, plants. Here we review Nanotechnology is a rapidly evolving field with the potential to take forward the agriculture and food industry with new tools which promise to increase food production in a sustainable manner and to protect crops from pests. Nanotechnology had been its unique characters like-Biological, physical and chemical properties that is large scale model for the same material and through Nonmaterial were many application in fields of agriculture and food including crop productions, preservation of forest, water conservation, water resource management, waste water treatment, soil conservation, soil resource management, drug delivery, breeding of farm animals, aquaculture, fishery development, poultry farming. Nowadays agrochemical like Nano-fertilizers are increasingly been used as alternates to bulk fertilizers and reduce pollution of soil and water by different agrochemicals. Nano-fertilizers facilitate the slow and steady release of nutrients and thereby reduce the loss of nutrients and enhance the nutrient use efficiency, and agricultural diagnostics of disease, reestablishment of agricultural resources from natural disaster, organic agriculture, and food processing. Simplification of land ownership, correction of land maps and infrastructures development is necessary for application of nanotechnology efficiently for sustainable agriculture in India.

Keywords: nano technology, agriculture, nano application, nano fertilizers, plant diagnosis

Introduction

Agriculture is considered the backbone of India, with more than 60% of the population dependent on it for their livelihood. In the same times there are many challenges facing agriculture sector, like climate change, non-reasonable use of resources and usage too much chemical fertilizer agriculture means cultivation of plants to produce food grains for survival purposes. Over the time, definition of agriculture changes, at present agriculture means cultivation of plants, trees, animals, fishes, other living materials in earth for food, medicine, clothes, shelter, environment and good quality of human life. Agriculture practices vary in each part of earth based on the quality of soil, environment and needs of local people. Continuous efforts of research scientists to improve agricultural and food security seek joint efforts from different technologies to alleviate appropriate strategies for defeating food crises and malnutrition. Sustainable agricultural development plays a central role to overcome global food crisis. Nanotechnology is a field that applies nanoscale principles and techniques to understand and transform living or nonliving systems and uses this principle on the biological and non-biological area to create new devices and systems integrated from the nanoscale. The basic processes of life at the molecular subcellular mechanisms, formation of the tissue's primary structures, molecular organelles of cell constructions are occur at the nanoscale Nanotechnology is the science and technology of tiny things, the materials that are less than 100nm in size. One nanometer is 10-9 meters; Nanotechnology combines solid state physics, chemistry, chemical engineering, biochemistry, biophysics, and materials science. The ability to control and manipulate that emerge at this nano scale, including increased conductivity, optical properties, and reactivity (Paradise *et al*. 2009). For this reason, understanding the design of biological systems can shape the development of life sciences and medicine, as well as of highly efficient and versatile new devices and systems. Since the physical and chemical infrastructure of non-biological systems also constructed at subatomic particles; the understanding the design architecture. particles is a main challenge in the interdisciplinary where sustainable agriculture looks to form bridge among the nanotechnology technicians, agriculturist, engineers, medics and scientists (Roco 2003). 40% to 60% of the total world food production depends on the application of fertilizers. Nanotechnology is working with the smallest possible particles which increase hopes for improving agricultural productivity through encountering problems unsolved conventionally, the nanotechnology applications have the potential to change agricultural production by allowing better management and conservation of inputs of plant and animal production. Nanotechnology provide a great scope of novel applications in the plant nutrition fields to achieve the future request of the rising population because nanoparticles have exclusive physicochemical characters i.e. high surface area, high reactivity, and tunable pore size.

Nanoparticle

Nano particle is defined based on the size at which fundamental characters different from those of the corresponding bulk material Nanoparticles overlap in size with colloids, which ranges from 1 nm to 1 mm in diameter. Also, the physical properties of nanoparticles are different from the properties of the bulk material. Nanoparticles have the ability for biodegradation of these chemicals and converted it to harmless components. Studies have shown that this method is more efficient and lower costs in ground water treatment than methods which require pumping the water out of the ground for treatment. Can be used as sensors to detect very small amounts of chemical vapors. Various types of nanomaterials, such as carbon nanotubes, zinc oxide nanowires or palladium nanoparticles can be used as sensors. Because of the small size of nanotubes, nanowires, or nanoparticles, a few gas molecules are enough to change the electrical properties of the sensing elements. This allows detecting a very low concentration of chemical vapors. Making composite fabric with nano-sized particles or fibers allows improvement of fabric properties without a significant increase in weight, thickness, or stiffness as might have been the case with previously-used techniques.

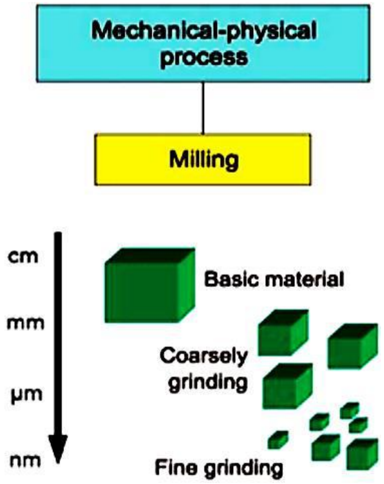

Fig 1: Schematic diagram for preparing nanoparticles by mechanical process

Nanoparticle process

The Nanomaterial prepared through two basic methods (Top Down depending on size reduction from bulk materials) and Bottom-up system where materials are synthesis from atomic level (according to Royal Society and Royal Academy of Engineering). "Top-down" systems: where tiny manipulations of little number of atoms or molecules fashion elegant patterns, through mechanical-physical methods like grinding, milling and crushing for producing nanoparticles, this method use for producing Nano composites and Nano-grained bulk materials like metallic and ceramic nanomaterial in extensive size distribution (10-1000nm) as shown in figure 1.

Bottom-up system: In 'Bottom-up' building up, numerous molecules self-assemble in parallel steps, as a function of their molecular recognition characters, this processing produces more complex structures from atoms or molecules, also, this method produce a uniform controlling sizes, shapes and size ranges of nano materials.

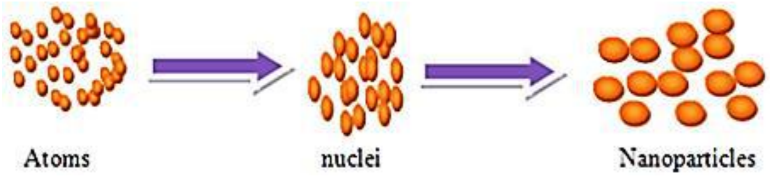

Fig 2: Structures of Nano particles are fabricated by chemical procedures

There are various positive effects of nanomaterials in agriculture like

In nano-world, materials less than 100-nanometer size behave completely different, the rules that manage the behavior of the elements of our known world start to give way to the rules of quantum mechanics, and everything changes. There are various advantages that nanotechnologies offer due to the unique functional properties of nanoparticles and materials like:

- The higher solubility of nanoparticles in suspension
- The higher surface area and particle size of the nanoparticles, which facilitates penetration of seed coats and subsequently emerging roots
- Better bioavailability of molecules to the seed radicals

Various application of nanotechnology in agriculture fields

Plant germination and growth

The effects of nanomaterials on plant germination and growth with the goal to promote its use for agricultural applications have been studied during recent years. Zheng *et al*. (2005) studied the application of nano and traditional TiO_2 on the yield of naturally-aged spinach seeds. The results revealed that seeds treated with nano TiO_2 increased dry weight (73%), Photosynthetic rate (three times) and chlorophyll-A formation (45%) than control over germination period of 30 days. Nanomaterial was achieved better growth rate of spinach seeds than traditional TiO_2 indicating that nanomaterials have beneficial properties for plant germination. This might be attributed to the photo-sterilization and photo-generation of "active oxygen like superoxide and hydroxide anions" by nano-TiO_2 that can enhance the seed stress resistance and support capsule penetration for water absorption and oxygen for fast germination Lin and Xing (2007) assessed phytotoxicity of nanomaterials (MWCNTs, Aluminum oxide-Al_2O_3, ZnO, Al and Zn) and its effect on germination rates in radish, rape canola, ryegrass, lettuce, corn, and the phototoxicity of the powdered Ag nanoparticles was inhibited by coating them with biocompatible polyvinyl pyrrole.

Plant protection and production

Nanopesticides could be summarized as very small particles of pesticidal active components or other small engineered structures with useful pesticidal characteristics (Bergeson, 2010b). Nanopesticides can enhance the dispersion and wettability of agricultural formulations (i.e., decrease in organic solvent runoff), and harmful pesticide movement (Bergeson, 2010a). Nanomaterials and biocomposites show useful characteristics such as stiffness, permeability, crystallinity, thermal stability, solubility, and biodegradability (Bouwmeester *et al.*, 2009 and Bordes *et al.*, 2009) important for formulating nanopesticides. Nanopesticides also have large specific surface area which increased affinity to the target (Jianhui *et al.*, 2005). There are types of nanopesticides such as nanoemulsions, nanoencapsulates, nanocontainers and nanocages have been recently discussed (Bergeson, 2010b; Bouwmeester *et al.*, 2009 and Lyons and Scrinis, 2009) for plant protection. Table 1 reports these kinds of nanomaterials and their application. Basically, nanomaterials should degrade faster in the soil than plants with residue levels below the regulatory criteria in foodstuffs. Jianhui *et al.* (2005) reported the advance of such sodium dodecyl sulfate (SDS) modified photocatalytic TiO_2/Ag nanomaterial joint with dimethomorph (DMM), commonly used pesticide in agricultural production. Modified formulation, 96 nm average granularity, improved dispersivity and breakdown of the pesticide in soil while enhancing its impact in vegetable seedling (of cabbage and cucumber) studies. The modification of the nanomaterials using SDS significantly improved the absorption of the DMM. Guan *et al.* (2010) fabricated encapsulated nano-imidacloprid with above properties to be used for pests control for vegetable production. The SDS modified Ag/TiO_2 imidacloprid nanoformulation was developed by a microencapsulation way that used chitosan and alginate. It was applicated on soybean plants that were transplanted to soil with 3.1% dry matter content and pH of 6.2. The formulation residues in soil and the plants degraded faster during the first eight days, and were minimal to undetectable after 20 days. The results revealed that POL manufactured nanoparticles photo-degraded faster during the same exposure period. Toxicity or biosafety of pesticides is a major concern in agricultural production. With the applications of Nanopesticides, the uncertainty on the long-term impacts of pesticides on the human health and environment rises. Shi *et al*. (2010) studied the toxicity of chlorfenapyr (nanopesticide) on mice. Formulation stability is an important issue at the nano level. Liu *et al*. (2008) successfully fabricated stable nanopesticide (bifenthrin) using polymer stabilizers such as Poly (acrylic acid)-b-poly (butylacrylate) (PAA-b-PBA), Polyvinylpyrrolidone (PVP), and Polyvinyl alcohol (PVOH). A flash nano-precipitation technique was used to prepare 60-200 nm bifenthrin nanoparticles and fertilizers.

Plant nanobionics and photosynthesis

Important discussions and studies are under way to fill the knowledge gaps in order to overcome the limitation of photosynthesis. Significant efforts are made working on different strategies, including

i) Engineering C3 crops to use C4 photosynthesis pathway
ii) Improving the efficiency of Rubisco
iii) Modifying the chlorophyll antenna size of chloroplast photosystems
iv) Improving the recovery rate from photoinhibition and broadening the photosynthetic light waveband

According to Evans, "recent technological developments now provide us with the means to engineer changes to photosynthesis that would not have been possible previously". There is no doubt whatsoever that nanotechnology is among these new tools. The scientific literature devoted to the relationships between plants and nanomaterials is not very large yet. However, a relatively large body of papers reported the positive effects of nanomaterials on photosynthesis. Early studies considered titanium oxide nanoparticles (nTiO2). More recently, the original idea to merge nanomaterials with living plants to enhance their native functions and to give them non-native functions has been more accurately focused. This approach assumed the name of "plant nanobionics" and potentially allowed to engineer faster-growing plants and become the key factor to design and develop artificial photosynthetic systems, a potential source of clean energy.

In addition, it could also lead to other innovations that we cannot imagine at this time.

Pesticide residue detection

Food and Drug Administration (FDA, 2005) reported about 1045 chemicals as pesticide residues. Nanomaterials based nanosensors can be used to detect many pesticide residues instead of traditional gas or liquid chromatography (GC/LC)-mass spectroscopy (-MS) techniques (Stan and Linkerhägner, 1996; Sicbaldi *et al*., 1997 and Balinova *et al*., 2007). While traditional techniques involve many steps including sampling, solid-phase extraction in laboratory, analyzing the sample, and define the obtained spectral peaks to determine the pesticide residues. Now, U.S. Department of Agriculture (USDA) developed a single and multi-residue methods based GC/LC-MS to evaluate "organophosphates, organochlorines, carbamates, triazines, triazoles, pyrethroids, neonicotinoids, strobilurins" residues in 85 agricultural commodities (USDA, 2010). Nanosensors for pesticide residue detection offer, "High sensitivity, low detection limits, super selectivity, fast responses, and small sizes" (Liu *et al*. 2008). Table 2 reports some of the nanosensors aimed to detect the pesticide residues such as methyl parathion (Kang *et al*., 2010 and Parham and Rahbar, 2010), parathion (Li *et al*., 2006 and Wang and Li, 2008), fenitrothion (Kumaravel and Chandrasekaran, 2011), pirimicarb (Sun and Fung, 2006), and dichlorvos and paraoxon (Vamvakaki and Chaniotakis, 2007). Additionally, Dyk and Pletschke (2011) have reviewed enzyme based biosensors for organochlorines, organophosphates, and carbamates residue detection. Some of these biosensors used C, Au, hybrid Titanium (Ti), Au-Platinum (Pt), and nanostructured lead dioxide (PbO2)/TiO_2/Ti to immobilize the enzymes on sensor substrate and to increase the sensor sensitivity.

Application of nanomaterial as biosensors: for pesticide residue detection is vast, nevertheless some issues such as:

1) Availability of the nanomaterials sensitive to much pesticide residues
2) Simplicity of sensor manufacture techniques and instrumentation
3) Desired dependability and repeatability in trace level detection
4) Cost
5) Concerns related to nanomaterial

As a starting point, nanosensors can be to detect major residuals that are extremely harmful to human health. Smart nanomaterials also can be used as sensors for pesticide detection. The smart nanomaterials and nanopesticides (Bergeson, 2010b) that act as a source of pesticide as well as indicative sensor make no need of sensors for detecting pesticide residues in soil. The nanomaterial that have slow targeted release of the material and also indicate deficiency (e.g. color change) of the nutrients in soil could work as an advanced alert system for farmers to adopt upon the dosage rate and frequency.

Smart fertilizers for crop nutrition

Nanotechnology can play an important role in the strengthening of agriculture sustainability, having provided the feasibility of the so-called “smart fertilizer.” In other words, nanostructures act as carriers of nutrients and allowed their controlled release. The design of smart fertilizers strongly influences the nutrient release and the minimization of losses. In field conditions such products are provided to crops via irrigation or sprayed to plant canopies.

Through the application of nanotechnologies in agriculture the fertilization will be carried out in different ways. In particular, the nutrient elements will be possibly administered as follows:

1. Delivered as particles or emulsions of nanoscale dimensions: a research body is being developed which aims to clarify whether nanoparticles (e.g., fullerenes, carbon nanotubes, $nTiO_2$, and $nSiO_2$) in different growth stages of crops may or may not partially replace traditional fertilizer practices
2. Encapsulated inside nanostructures designed to allow the controlled release of nutrients

Here are some examples of possible control mechanisms.

- **Slow release:** The capsule releases its payload slowly over a longer period of time so as to synchronize plant assimilation and limit leaching
- **Quick-release:** The capsule shell breaks upon contact with a leaf surface
- **Specific release:** The nutrient release occurs through a recognition mechanism between a receptor (molecule or functional group) bound to the shell and a target molecule
- **Moisture release:** The shell breaks down and releases nutrients in the presence of water

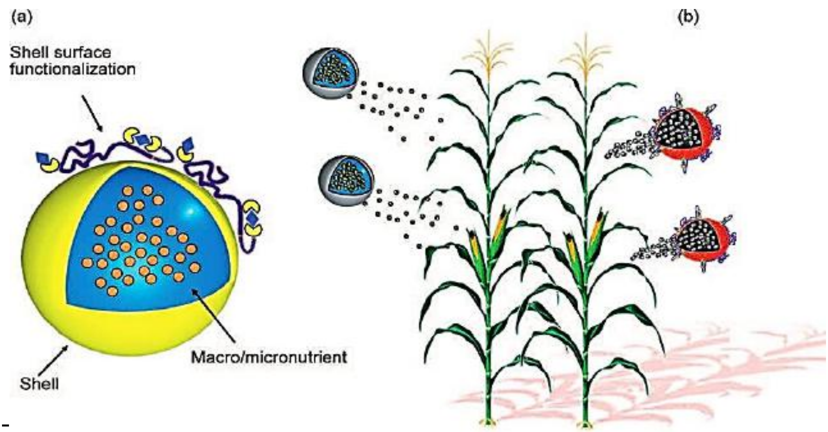

Fig 3: (a) Model of nanocapsule containing macro/microelements. Examples of opening strategies of nanocapsule: (b) release of nutrients as function of time to avoid or limit nutrient losses or designed to occur when a molecular receptor binds to a specific chemical.

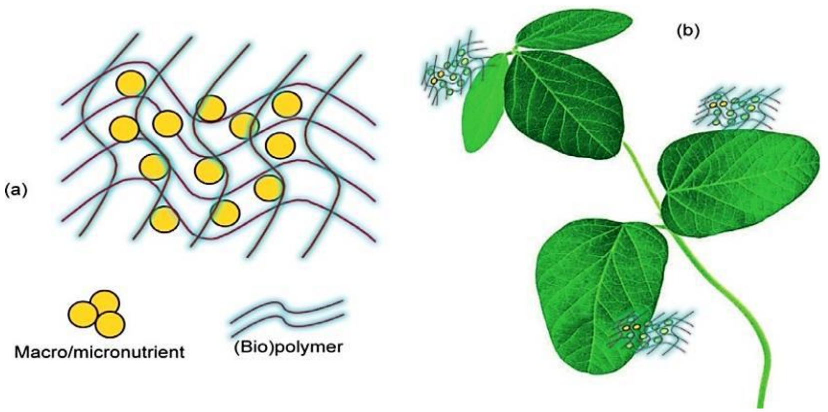

Fig 4: (a) Model of biopolymeric structure containing macro/microelements (b) Deposition onto the crop leaf after spray treatment.

- **pH release:** The shell breaks up only in specific alkaline/acidic environment (e.g., within plant tissues or inside a cell)
- **Magnetic/ultrasonic pulses:** The shell opens in response to a magnetic or ultrasonic pulse emitted by a man-controlled system (precision agriculture)

1. Delivered in a complex formed by nanocapsules incorporated in a matrix of organic poly-mers of biological or chemical origin which act as a carrier (Figure 4): Both of them provide the expected traits to nanofertilizers. The properties of the new nanostructure allow a

controlled release of nutrients as a function of time or after interactions with the environment. Studies are currently being conducted to test the potential of different materials, such as zeolites, polyacrylic acid and chitosan.

As far as the effectiveness of nanofertilizers is concerned, it must be said that the potential of nanofertilizer application has not been extensively studied yet. However, some successful examples demonstrated that such new formulates significantly improve the efficiency of fertilization.

Plant pathogen detection

Bergeson, (2010a) reported that application of pesticides and fertilizers come after detection, locate, and report on pathogens prior to the onset of symptoms. Consequently, nanomaterials could be used for state bacterial, viral and fungal plant pathogens (Boonham *et al*., 2008; Yao *et al*., 2009 and Chartuprayoon *et al*., 2010) in agriculture as a rapid analytical tool. Nanoparticles showed high accuracy for detecting viral pathogens in plant (Baac *et al*., 2006). Nanoparticles also can be modified to be used as a diagnostic tool to detect compounds revealing to a diseased condition. Nano-chips are kinds of microarrays which contain fluorescent oligo capture probes through which the hybridization can be detected (López *et al*., 2009). These nano-chips are known in detecting single nucleotide changes of bacteria and viruses due to their sensitivity and specificity (López *et al*., 2009). Yao *et al*. (2009) developed a fluorescence silica nanoparticles uploaded with antibody to detect *Xanthomonas axonopodis* pv. *vesicatoria* which causes bacterial spot disease in Solanaceae plants, showing that nanoparticle can be applied successfully for disease detection. Singh *et al*. (2010) used nano-gold based immune sensors by using surface plasmon resonance (SPR) that could detect Karnal bunt (Tilletia indica) disease in wheat. Particularly, they try to detect the disease using SPR sensor in wheat plots for seed certification and to form plant quarantines. Application of nanomaterials for detecting pathogen using nanosensors infield application is highly valuable for quick diagnosis and disease executive. Plants affected by different stress disorders through physiological changes. For example, the induction of systemic defense, that regulated by plant hormones: jasmonic acid, methyl jasmonate and salicylic acid. Wang *et al*. (2010) joined this indirect stimulus to develop a sensitive electrochemical sensor, by using modified gold electrode with copper nanoparticles, to monitor salicylic acid levels in oil seeds for fungi detection (Sclerotinia sclerotiorum). More work for developing nanosensors to detect pathogens, their byproducts, or monitor physiological changes in plants is needed.

Nanomaterials for soil reclamation and environmental remediation

Nanotechnology is a promising approach for reclamation of mine soils involves removing soil contaminants and enhancing soil quality and fertility. Two advantages of nanomaterials over the traditional amendments for soil reclamation include the higher reactivity due to smaller particle size and higher specific surface area and the easier delivery of the small-sized particles into the porous media (soils). High reactivity leads to a high efficiency and high rate of soil reclamation, while easy delivery is advantageous for in situ application. These nanomaterials with large potentials for mine soil reclamation include zeolites, zero-valent iron nanoparticles, iron oxides nanoparticles, phosphate-based nanoparticles, iron sulfide nanoparticles, and carbon nanotubes. With emphasis on their functions in soil quality improvements, Transport and mobility of those nanoparticles in the environment as well as their possible ecotoxicological effects are also briefly introduced in this section.

Soil conditioner-zeolites

Zeolites are crystalline, hydrated alumino silicates of alkali (Na+, or K+) and alkaline earth cations (Ca^{2+} or Mg^{2+}) characterized by an ability to hydrate/dehydrate reversibly and to exchange some of their constituent cations with aqueous solutions, without a major change in structure (Pabalan and Bertetti, 2001). Their unique feature is that the zeolites possess an open, three-dimensional cage-like structure and a vast network of open channels extending throughout. The channels and pores, typically 0.3 to 0.7 nanometers in diameter, impart the mineral large specific area (about 105 m^2 g^{-1}) for ion exchange and for selective capture of specific molecules (e.g., H_2O). Because of these structural features, zeolites generally have low density compared with that of other minerals. Nearly 50 natural species of zeolites have been recognized, and more than 100 species have been synthesized in the laboratory (Mumpton, 1985). Clinoptilolite is the most abundant zeolite species in the sedimentary deposits on the earth and also the most mined zeolite minerals in the world (Boettinger and Ming, 2002).

Using nano enhanced materials as solid waste stabilizers/conditioners

Solid wastes have mostly different environmental contaminants (detrimental impurities, pathogens, and sometimes nauseous odors). Thus, to make these wastes have benefits for landfill soil reclamation, secondary environmental contaminations should be eliminated. Nano-enhanced materials had proved to enhance the environmental safety and public acceptance for landfill application of these wastes in mine or agricultural remediation. For instance, Li *et al*. (2007) reported that a small amount of nZVI (0.1% by weight) significantly eliminate nauseous odors (caused by organic sulfur compounds), heavy metals, and organic contaminants in the bio-solids, indicating that nZVI could decrease the contamination of biosolids and increase beneficial uses of these wastes. Villasenor *et al*. (2011) claimed that addition of 10% zeolites produced composts compliant with Spanish regulations regarding heavy metal contamination. According to them, the zeolite-amended compost could either be applied directly to soil, or the metal-polluted zeolites could be separated from the compost prior to application to ensure the environmental safety. Using zeolites as heavy metal absorbents in compost is also verified by other researchers (Zorpas and Loizidou, 2008; Zorpas *et al*., 2002 and Zorpas *et al*., 1999). Moreover, application of the nanomaterials to stabilize or condition the conventional soil amendment materials (e.g., composts, biosolids, coal combustion by-products) could be a potential aspect of utilization of nanotechnology in the agriculture at low cost. Zeolites, nFeOs, phosphate-based nanoparticles, and sulfide-based nanoparticles are efficient in immobilizing inorganic contaminants in the solids, while C nanotubes have a high absorption capacity for organic pollutants and nZVI can destroy the OWCs present in the wastes by reduction reactions. Finally, incubation of the nanomaterials with solid wastes could in turn stabilize the former and reduce the risks of nanomaterials spill and contaminations resulting from direct application of the nanoparticles to the environment.

Using nano enhanced materials to control soil erosion

Soil erosion affected by rainfall or wind in a closed mining site, can result in loss of good soil, exposure the buried sulfide minerals, and transportation of the sediments and pollutants to surface water bodies besides. Therefore, soil erosion management is a high importance in a mine soil reclamation plan. Nanoenhanced materials have benefits to use for combat the harmful of soil erosion. The valuable effects are more evident when finer nanoparticles (140 nm) were used. Wang *et al*., (2007) suggested that the nanoparticles can increase the stretch of the chain-like structures of the polyelectrolyte, resulting in more effective bridging effects and better flocculation. As a matter of fact, the PE (polyelectrolyte)-NP (nanoparticles) flocculation systems have been widely used in effectively eliminating solid particles from the solution (Ovenden and Xiao, 2002 and Yan and Deng, 2000). The flocculation in such a system is induced by the sequential addition of a positively charged polyelectrolyte followed by negatively charged nanoparticles, such as bentonite and colloidal silica. The systems produce a better flocculation and drainage (dewatering) than conventional polymer-only flocculation systems (Ovenden and Xiao, 2002). These results suggest that double application of polyelectrolyte and nanoparticles could increase flocculation and improve soil particle size and particle stability and thus effectively manage soil erosions caused by wind or rain.

Carbon nanotube

The C nanotubes (CNTs) are C macromolecules consisting of sheets of C atoms covalently bonded in hexagonal lattices that seamlessly toll into a hollow, cylindrical shape with both ends normally caped by fullerene-like tips (Niu and Cai, 2012). According to their structures, CNTs could be categorized into: single-walled C nanotubes (SWCNT) and multi-walled C nanotubes (MWCNT). The diameter of CNTs can varied from hundreds nanometers and micrometers to 0.2 and 2 nm for SWCNT, and from 2 to 100 nm for coaxial MWCNT. CNTs a promising adsorbent material for nonpolar organic contaminants such as trihalomethanes, polycyclic aromatic hydrocarbons, or naphthalene, dioxin, herbicides, DDT and its metabolites, because of their large surface area, tubular structure and nonpolar property (Niu and Cai, 2012; Theron *et al*., 2008 and Mauter and Elimelech, 2008). Compared to an activated C, the purified CNTs possess two to three time's higher adsorption capacities for organic contaminants (Theron *et al*., 2008). CNTs has nonpolar characteristics, this was led to very low sorption of the polar metal ions while the sorption was increased after modification of the CNTs surface by creating a large amount of oxygen-containing polar functional groups (-COOH, -OH, or -C=O). These functional groups resulted in increasing negative charge on CNTs surface, and the oxygen atoms in functional groups provide single pair of electrons to metal ions, which raise the cations adsorption capacity of CNTs (Rao *et al*., 2007). For example, MWCNTs, pretreated with nitric acid, showed high adsorption for many kinds of heavy metal ions, including Pb(II) (97.08 mg g^{-1}), Cu(II) (24.49 mg g^{-1}), and Cd(II) (10.86 mg g^{-1}) from an aqueous solution. In addition, SWCNTs and. The former method directly enhances the hydrophilicity of the CNTS, while the latter options not only create a thermodynamically suitable surface in water but also provide steric or electrostatic repulsion among dispersed CNTs, thus preventing aggregation (Hyung *et al*., 2007). Natural organic matter may play serious roles in fate and transport of nanotubes in the environment due to its ubiquitous presence. Hyung *et al*. (2007) stated that the water samples taken from the Suwannee River, USA, presented a similar MWCNT stabilizing capacity as compared to fabricated solutions containing the model natural organic matter (SR-NOM). For the same initial MWCNT concentrations, the concentrations of suspended MWCNTs in SR-NOM solutions and the Suwannee River water samples were even significantly greater than that in a solution of 1% sodium dodecyl sulfate (surfactant used to stabilize CNTs in the aqueous phase). During studying the transport of carboxyl-functionalized SWCNTs in quartz-sand packed columns, Jaisi and Elimelech (2009) and Jaisi *et al*. (2008) reported that the performances of the nanotubes were generally similar to those traditionally got with colloidal particles and bacterial cells. For instance, ionic strength of the solution was increased due to increased SWCNT deposition in the column and divalent cations (e.g., Ca^{2+}) decrease the SWCNT stability higher than monovalent cations (e.g., Na^{+}) at the same ionic strength. Due to limited work studying the nanoparticles mobility in the soil media, the discussions above reported significant suggestions on transport of all types of nanoparticles in the soil environment On one hand, nanoparticles may reduced mobility and greater retention rate in soil media than what were reported using sand-packed column studies in the laboratory due to the more complicated pore structures and pore distributions in soils. Considered chronic occupational health hazard (via inhalation routes). Both SWCNTs and MWCNTs were also recognized to cause loss of phagocytic ability and ultrastructure damage to alveola macrophages (Jia *et al*., 2005). Additionally, CNTs have encouraged observable toxic responses in other cell cultures (Magrez *et al*., 2006).

Nano biosensors in agriculture

Nanobiosensors (NBSs) are analytical devices having at least one dimension no greater than 100 nm. Structured as nanoparticles, nanotubes, nanowires or nanocrystals, NBSs are manufactured for monitoring plant fractions, soil and water in the agro ecosystem. By exploiting the physico-chemical properties of nonmaterial, NBSs represent a powerful tool with advanced and improved features compared to existing analytical sensors and biosensors that combine biological element recognition with chemical or physical principles. Biological information is converted by a transducer into a signal yielded by an electronic component. This capability allows the agronomist with an accurate and real-time control of the needs of crops in terms of water and nutrient supply and early symptoms of diseases. A properly designed network of nanosensors would allow the optimization of crop yield and the most efficient agronomic management of factors, such as fertilizers, water, herbicides and pesticides.

Typically, an NBS consists of three components

1. **Biological sensitive probe**

A sensing element which interacts with the target (biomolecule) producing a signal proportional to the biomolecule concentration.

Some examples of probe/biomolecule interaction are:

i) Antibody-antigen

ii) Nucleic acid interactions

iii) Enzymatic interactions

iv) Cellular interactions (i.e., microorganisms, proteins)

2. **Transducer**

A physical component responsible for converting the recognition signal events into a digital signal. The nanomaterial properties suggest managing different kinds of signals such as electrochemical, optical and mass-sensitive signals.

3. **Data recording unit**

It consists of an amplifier and signal processor that are responsible for data transferred and storage. For plant monitoring applications, we therefore deploy a monitoring system comprising a hierarchical arrangement of nano- and microscale network devices. The control units manage clusters of nanodevices and the data flow. Data should be directed to gateways which relay the collected data from the nano network to the Internet. For its refinement, it will also be necessary to design spraying machines capable of adequately distributing suspensions with nanosensors onto crop canopies.

Nano networks for monitoring plant conditions can alert automatically suggesting a more efficient usage of crop inputs (e.g., fertilizers, water, pesticide, etc). Thus, the real time and monitoring of the crop growth lead to accurate and on-time decisions, reduced costs and waste, improved quality of production and above all sustainable agriculture.

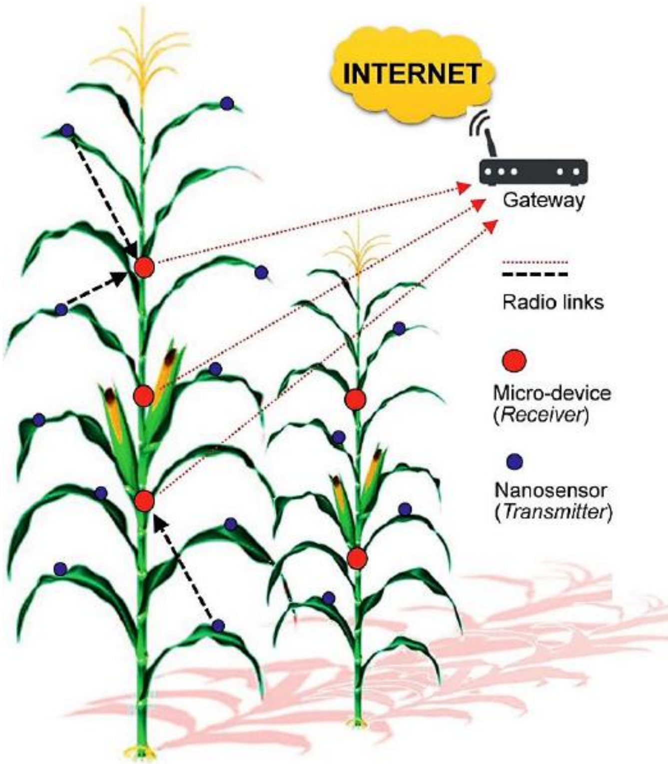

Fig 5: Valorization of agricultural residues for production of nanomaterials

There is a growing awareness of the importance of sustainability, in particular bearing in mind the increase of global population. This issue is intimately linked to the implementation of a circular economy based on regeneration of resources. One of the pillars of circular economy is waste reduction. Organization for Economic Cooperation and Development (OECD) defines agricultural waste as “waste produced as a result of various agricultural operations including manure and other wastes from farms, poultry houses and slaughterhouses; harvest waste; fertilizer run-off from fields; pesticides that enter into water, air or soils; and salt and silt drained from fields”. A meaningful proportion of agri-food production is lost in the form of residues and wastes. For this reason, it will be of the utmost importance to explore innovative technologies capable of providing new opportunities to achieve full sustainability. It is believed that nanotechnology can significantly contribute also in this direction. The development of advanced methods for valorization and the exploitation of agricultural raw materials and wastes are relevant contributions of nanotechnology toward strengthening the basic principles of the circular economy. The following are suggested as illustrative examples of this concept.

Cellulose nanofibers

Cellulose is the most abundant biopolymer available on the Earth, being the main component of plant tissues. The primary occurrence of cellulose is the existing lignocellulosic material in wood which is the most important industrial source of cellulose. Other cellulose-containing materials include agriculture residues, water plants, grasses and other plant substances. It is estimated that 10_{11}-10_{12} tons per year of cellulose are worldwide produced by photosynthesis. In plant tissues micro and macro fibrils represent the construction units of the hierarchical structure of cellulose fibers. Micro fibrils, in turn, consist of elementary fibrils (nanofibres) which have a diameter comprised in the range 3–35 nm depending on the cellulose source. In current last years, nanocellulose has been attracting much attention as a new bio-based nonomaterial with excellent optical properties, high strength and specific surface area. Nanocellulose can be extracted and chemically modified for a wide range of applications in the field of Nano composites. Various agricultural crops and residues, such as soy hulls and wheat straw, sugar beet pulp, potato pulp and rutabaga, are already considered as raw materials for new cost-effective methods of nano cellulose production.

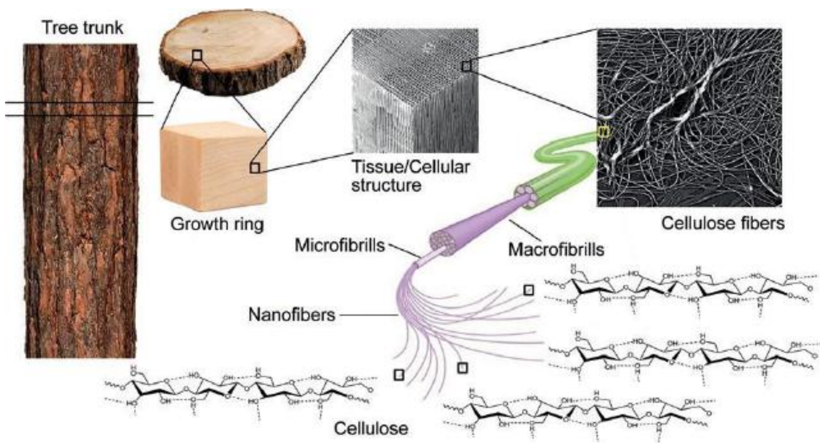

Fig 6: Nano fiber process

Rice husk-derived Si nanomaterials

FAO's preliminary forecast of global paddy production in 2017 is set at 503.8 million tons (milled basis). About 25% of this production is rice husk (RH) which is disposed as a by-product of rice milling. The RH is the coating on a grain of rice which has the role to protect the seed during the crop cycle. RHs are mainly composed of lignocellulose (ca. 72-85 wt %) and silica (ca. 15-28 wt %). Silicon is the second element of importance in the Earth's crust. Grasses assimilate large amounts of Si during their entire life cycle and deposit it into phytoliths as amorphous hydrated silica (SO2 nH2O). The Si content in the ash of grasses can reach 50-70%. Silica nanoparticles (nSi) have numerous potential applications in drug delivery and biomedicine, and in agriculture, as well. According to the principles of green chemistry and among the available agricultural raw materials, RH is considered to be a cost-effective bioprecursor for biosynthesis of nSi.

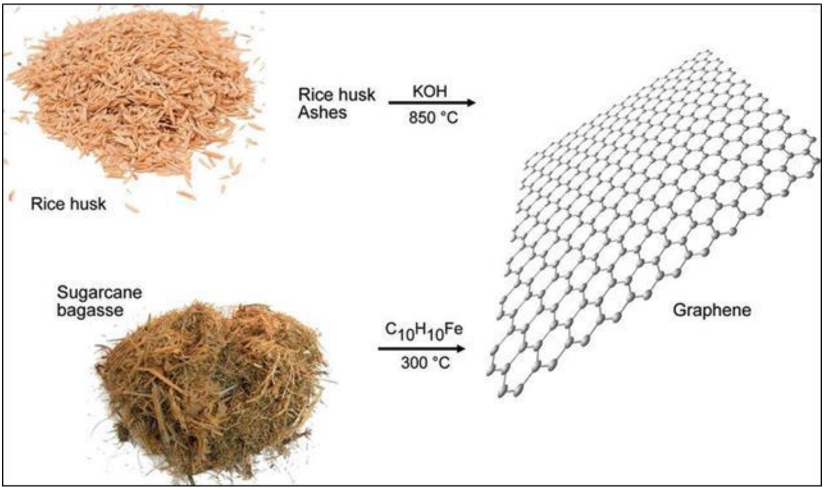

Fig 7: Rice husk formulation

Graphene

Graphene is a material consisting of a monoatomic layer of carbon atoms isolated in 2004 by Novoselov and Geim (University of Manchester, UK), who in 2010 received for that work the Nobel Prize in physics. Graphene has the mechanical strength of the diamond and the flexibility of the plastic and is already used in medicine, electronics, energy, defense and many other sectors. The European Commission, launched in 2013, financed The Graphene Flagship, a 10-year research initiative financed with € 1 billion, which involves more than 140 academic and commercial institutions in 23 countries.

Graphene is currently produced by mechanical and chemical exfoliation of graphite crystals, chemical synthesis and thermal chemical vapor deposition. Considering the large-scale production of graphene, the use of these methods poses several problems due to high process costs and the use of toxic substances. That is why, also in this case, there is considerable interest for the development of alternative, cheaper and environmental-friendly methods. Recent studies demonstrated that it is possible to use rice husk and sugarcane bagasse to produce graphene in a rapid, scalable and cost-effective manner (Figure 5). It is very useful to test other raw agricultural materials to expand the possibility to exploit other wastes or crop byproducts.

Conclusion

Nanotechnology had been attracted many researchers for its unique physical, chemical and biological characteristics in nano size that differ from those in a large scale model for the same material. nanomaterial's were developed for many applications in many fields such as Medicine, drug delivery, electronics, fuel cells, solar cells, food, space and etc. Among these application nanomaterial's had proved many benefits for agricultural purpose. Nanotechnology proved to have many benefits for plant germination and growth. The potential of nanotechnology in agriculture is huge, and need more work to state all benefits of nanomaterial's for agricultural section. Risks of nanotechnology application in the agriculture and food processing have been also explained. Major agriculture in rural Indian area is affected due to lack of land rehabilitation and reformation where sustainability is far beyond to the public practices. We have suggested possible application of (nano-) technology, depending upon agricultural practices, it can hinder or sustain the ability to sustain the function of ecosystems to provide goods and services. To achieve success in sustainable agriculture and food processing, human resources also need sophisticated training and awareness. Still application on nanotechnology in agriculture and food processing is under primitive stage and might take a few decades to move from laboratory to land and from land to human use, especially since it has to avoid the pitfalls experienced with ecosystem. The potential benefits of nanotechnology for agriculture, food, fisheries, and aquaculture need to be balanced against concerns for the soil, water, environment, and the occupational health of workers.

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Chapter - 3
Phytoremediation: Tools & Technique

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Chapter - 3

Phytoremediation: Tools & Technique

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Abstract

A major environmental concern due to dispersal of industrial and urban wastes generated by human activities is the contamination of soil. Controlled and uncontrolled disposal of waste, accidental and process spillage, mining and smelting of metalliferous ores, sewage sludge application to agricultural soils are responsible for the migration of contaminants into non-contaminated sites as dust or leachate and contribute towards contamination of our ecosystem. There are a number of conventional remediation technologies which are employed to remediate environmental contamination with heavy metals such as solidification, soil washing and permeable barriers. But a majority of these technologies are costly to implement and cause further disturbance to the already damaged environment. Phytoremediation is evolving as a cost-effective alternative to high-energy, high-cost conventional methods. It is considered to be a "Green Revolution" in the field of innovative clean up technologies. Bioremediation by use of plants constitutes phytoremediation.

Keywords: phytoremediation, metalliferous ores, environmental contamination, tools & technique

Introduction

A wide range of inorganic and organic compounds cause contamination, these include heavy metals, combustible and putrescible substances, hazardous wastes, explosives and petroleum products. Major component of inorganic contaminates are heavy metals, they present a different problem than organic contaminants. Soil microorganisms can degrade organic contaminants, while metals need immobilisation or physical removal. Although many metals are essential, all metals are toxic at higher concentrations, because they cause oxidative stress by formation of free radicals. Another reason why metals may be toxic is that they can replace essential metals in pigments or enzymes disrupting their function. Thus, metals render the land unsuitable for plant growth and destroy the biodiversity. Though several regulatory steps have been implemented to reduce or restrict the release of pollutants in the soil, they are not sufficient for checking the contamination.

There are a number of conventional remediation technologies which are employed to remediate environmental contamination with heavy metals such as solidification, soil washing and permeable barriers. But a majority of these technologies are costly to implement and cause further disturbance to the already damaged environment. Phytoremediation is evolving as a cost-effective alternative to high-energy, high-cost conventional methods. It is considered to be a "Green Revolution" in the field of innovative clean up technologies. Bioremediation by use of plants constitutes phytoremediation. Specific plants are cultivated at the sites of polluted soil. These plants are capable of stimulating the biodegradation of pollutants in the soil adjacent to roots (rhizosphere), although phytoremediation is a cheap and environment friendly clean-up process for the biodegradation of soil pollutants, it takes several years.

Types of phytoremediation

1. Phytoextraction

Phytoextraction is the uptake of contaminants by plant roots and movement of the contaminants from the roots to aboveground parts of the plant. Contaminants are generally removed from the site by harvesting the plants. Phytoextraction accumulates the contaminants in a much smaller amount of material to be disposed of (the contaminated plants) than does excavation of soil or sediment. The technique is mostly applied to heavy metals and radionuclides in soil, sediment, and sludges. It may use plants that naturally take up and accumulate extremely elevated levels of contaminants in their stems and leaves.

2. Rhizofiltration

Rhizofiltration is the adsorption or precipitation onto plant roots, or absorption into the roots of contaminants that are in solution surrounding the root zone, due to biotic or abiotic processes. Plant uptake, concentration, and translocation might occur, depending on the contaminant. Exudates from the plant roots might cause precipitation of some metals. Rhizofiltration first results in contaminant containment, in which the contaminants are immobilized or accumulated on or within the plant. Contaminants are then removed by physically removing the plant.

3. Phytostabilization

Phytostabilization is defined as (1) immobilization of a contaminant in soil through absorption and accumulation by roots, adsorption onto roots, or precipitation within the root zone of plants, and (2) the use of plants and plant roots to prevent contaminant migration via wind and water erosion, leaching, and soil dispersion. Phytostabilization occurs through root-zone microbiology and chemistry, and/or alteration of the soil environment or contaminant chemistry. Soil pH may be changed by plant root exudates or through the production of CO2. Phytostabilization can change metal solubility and mobility or impact the dissociation of organic compounds. The plant affected soil environment can convert metals from a soluble to an insoluble oxidation state.

4. Rhizodegradation

Rhizodegradation is the breakdown of an organic contaminant in soil through microbial activity that is enhanced by the presence of the root zone. Rhizodegradation is also known as plant-assisted degradation, plant-assisted bioremediation, plantaid in situ biodegradation, and enhanced rhizosphere biodegradation. Root-zone biodegradation is the mechanism for implementing rhizodegradation. Root exudates are compounds produced by plants and released from plant roots. They include sugars, amino acids, organic acids, fatty acids, sterols, growth factors, nucleotides, flavanones, enzymes, and other compounds. The microbial populations and activity in the rhizosphere can be increased due to the presence of these exudates, and can result in increased organic contaminant biodegradation in the soil. Additionally, the rhizosphere substantially increases the surface area where active microbial degradation can be stimulated. Degradation of the exudates can lead to co-metabolism of contaminants in the rhizosphere.

5. Phytodegradation

Phytodegradation (also known as Phytotransformation) is the breakdown of contaminants taken up by plants through metabolic processes within the plant, or the breakdown of contaminants external to the plant through the effect of compounds (such as enzymes) produced by the plants.

6. Phytovolatilization

Phytovolatilization is the uptake and transpiration of a contaminant by a plant, with release of the contaminant or a modified form of the contaminant to the atmosphere from the plant through contaminant uptake, plant metabolism, and plant transpiration. Phytodegradation is a related phytoremediation process that can occur along with Phytovolatilization.

7. Hydraulic control

Hydraulic control is the use of plants to remove groundwater through uptake and consumption in order to contain or control the migration of contaminants. Hydraulic control is also known as phytohydraulics or hydraulic plume control.

Phytoremediation plants

Varieties of plants are capable of reducing different contaminants in the surface water.

These plant species can be selected based on factors such as their ability to absorb or break down the contaminants of concern, adaptation to local climates, biomass, root structure, rate of growth, and their roots' ability to take up large quantities of water.

This diversity of phytoremediation plants means that they can be implemented to address specific contamination needs. Poplar trees are commonly used to clean up volatile organic compounds (VOCs) such as ethanol and formaldehyde, while colonial bent grass uptakes toxic heavy metals such as cadmium and mercury. Sunflower plants can uptake arsenic and store it in the vacuole.

Plants uptake accounts for 10 percent or less of the actual phytoremediation process. In fact, floating islands have been shown to reduce nutrients even without planted vegetation.

The rest of the job is handled by microorganisms naturally present in the water that require a surface area onto which they can cling. This is why the matrix material used for the floating wetlands is so important. These microbe colonies form a biofilm in and around the islands' matrix. The microbes break down nutrients and pollutants. Since the island itself houses biofilm development, the removal of nitrogen, ammonia and phosphorous through microbes begins immediately.

As the roots of the plants in the island grow deeper into the water, they become an excellent site for microbial activity.

A symbiotic relationship forms between the biofilm and the plants. This cooperation, which awards fixed nitrogen to the plants and an abundant carbon source to the microbes, boosts the efficiency of the cleaning by both participants. This partnership is what makes the phytoremediation method used in islands so effective.

The following list gives the media, contaminants and typical plants for the types of phytoremediation.

Table 1: The media, contaminants and typical plants for the types of phytoremediation

Application	Media	Contaminants	Typical Plants
1. Phytovolatilization	Soil, groundwater, Landfill leachate, land application of wastewater	Herbicides (atrazine, alachlor); Aromatics (BTEX); Chlorinated aliphatics (TCE); Nutrients; Ammunition wastes (TNT, RDX)	Phreatophyte trees (poplar, willow, cottonwood, aspen); Grasses (rye, Bermuda, sorghum, fescue); Legumes (clover, alfalfa, cowpeas)
2. Microorganism stimulation	Soil, sediments, Land application of waste water	Organic contaminants (pesticides aromatic, and polynuclear aromatic hydrocarbons	Phenolics releasers (mulberry, apple, osage orange); Grasses with fibrous roots (rye, fescue, bermuda); Aquatic plants for sediments
3. Phytostabilization	Soil, sediments	Metals (Pb, Cd, Zn, As, Cu, Cr, Se, U), Hydrophobic Organics (PAH, PCB, DDT, dieldrin)	Phreatophyte trees to transpire large amounts of water (hydraulic control); Grasses to stabilize soil erosion; Dense root systems are needed to sorb/bind contaminants
4. Phytoaccumulation/extraction	Soil, Brownfields, sediments	Metals (Pb, Cd, Zn, As, Cu, Cr, Se, U) with EDTA addition for Pb Selenium	Sunflowers; Indian Mustard; Rape seed plants; Barle, Hops; Crucifers; Serpentine plants; Nettles, dandelions
5. Degradation	Soil, groundwater, Landfill leachate, land application of wastewater	Herbicides (atrazine, alachlor); Aromatics (BTEX); Chlorinated aliphatics (TCE); Nutrients; Ammunition wastes (TNT, RDX)	Phreatophyte trees (poplar, willow, cottonwood, aspen); Grasses (rye, Bermuda, sorghum, fescue); Legumes (clover, alfalfa, cowpeas)

Table 2: Some aquatic plants for phytoremediation

Metal	Plants	Toxic effect
Al	*Lemna minor* L.	Decline in enzymatic activity, reduced efficiency of photosynthetic energy conversion
As	*Eichhornia crassipes* *Pistia stratiotes* L.	Stunted growth, chlorosis, wilting, death. Sharp reduction in the root volume, chlorosis, and organ also became darker, cell membrane damage, reduction in relative growth rate.
Cd	*Lemna minor* L *Eichhornia crassipes* *Pistia stratiotes* L.	Reduced shoot growth; inhibition of root growth. Stunted growth, plant height and root length decreased, chlorosis.
Cr	*Ipomoea aquatica*	Increased in root size, root length decreased
Zn	*Lemna minor* L *Eichhornia crassipes* *Pistia stratiotes* L.	Decline in enzymatic activity, reduced efficiency of photosynthetic energy conversion, decrease in chlorophyll.

Conclusion

Phytoremediation is an eco-friendly approach for remediation of contaminated soil and water using plants comprised of two components, one by the root colonizing microbes and the other by plants themselves, which accumulates the toxic compounds to further non-toxic metabolites. Various compounds viz., organic synthetic compounds, xenobiotics, pesticides, hydrocarbon and heavy metals, are among the contaminants that can be effectively remediated by plants. Phytoremediation is comprised of several different techniques that utilize vegetation, its related enzymes, and other complex processes. Collectively, these processes are able to isolate, destroy, transport, and remove organic and inorganic pollutants from contaminated media.

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Chapter - 4
IPRs and Plant Breeding

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Chapter - 4

IPRs and Plant Breeding

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Abstract

Plant breeding research and seed provision are vital industries that need to be fostered and stimulated. Plant breeding is important for food security at the local and global levels; the ability of adapted varieties to cope with environmental stresses contributes to strategies for sustainable agriculture, and the provision of productive options for commercial farming is essential for wider economic development. Therefore the prime challenge is to understand the degree to which stronger IPRs in plant breeding can help stimulate these industries.

Keywords: IPRs, plant breeding, farmer's privilege, breeder's exemption

Introduction

Recent years have witnessed increased attention to the strengthening of intellectual property rights (IPRs) in plant breeding. The number of countries that grant such rights has grown, the types of inventions that can be protected have expanded, and the scope of protection offered by extant IPR systems in different countries has broadened as well. The Agreement on Trade Related Aspects of Intellectual Property Rights (TRIPS 1993) of the World Trade Organization (WTO) dramatically changed the importance of IPRs in developing countries by requiring all WTO members to introduce at least a minimum level of protection of intellectual property in their national laws. Article 27.3(b) of the TRIPS Agreement asks all members to provide some form of protection for plant varieties. Patent protection needs to be available for all other inventions, including those in plant biotechnology.

The nature and scope of IPRs for genetic resources, including plant varieties, are also discussed in the frameworks of the Convention on Biological Diversity (CBD) and the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA), which entered into force in 1993 and 2004, respectively. Additional pressure to protect plant varieties in developing countries (beyond the minimum requirements of TRIPS) is being exerted in bilateral trade negotiations between developing countries and the USA or EU. The importance of IPRs for plant breeding and the seed industry has been further enhanced by the development of plant biotechnology, which not only has engendered patents for the genes, tools, and processes that are an increasingly common part of modern plant breeding but has spurred the introduction of utility patents for plant varieties and hybrids in some countries.

IPRs are just one set of regulations based on international agreements that impact plant breeding and seed production. International agreements influence plant breeding and seed production (Fig. 1), such as agreements over rights to traditional knowledge or national sovereignty over plant genetic resources. Systems for IPRs have been recognized for more than a century, yet until recently IPRs have not been an issue in the plant breeding and seed sector in most developing countries. Although IPR regimes for agricultural inventions have been used widely in industrialized countries for decades, most developing countries are in the early stages of implementing and/or enforcing IPRs related to plant varieties. The use of IPRs in plant breeding in developing countries raises a number of important issues, including smallholders' access to technology, the role of public agricultural research, the growth of the domestic private seed sector, the status of farmer-developed varieties, and the growing North-South technology divide that restricts access to plant germplasm and research tools. Since access to seed and new crop varieties is fundamental for agricultural development and rural welfare, it is important to understand the impact of these legal systems on the breeding and seed sectors in developing countries.

Convention on Biological Diversity (CBD)		World Trade Organization (WTO)	World Intellectual Property Organization (WIPO)		Food and Agriculture Organization of the United Nations (FAO)
Access and benefit sharing	Cartagena Protocol	Trade Related Aspects of Intellectual Property Rights (TRIPS)	Patent Cooperation Treaty (PCT), Substantive Patent Law Treaty (SPLT)	Intergovernmental Committee on Intellectual Property and Genetic Resources, Traditional Knowledge, and Folklore	International Treaty on Plant Genetic Resources for Food and Agriculture (IT PGRFA)
Genetic resources	Living modified organisms	Breeder's rights, patents, trademarks, trade secrets	Harmonization of IPRs	Traditional knowledge, genetic resources, folklore	Facilitated access, Farmers' Rights
		Breeders			

Fig 1: International Agreements that affect Plant Breeding and Seed Production

IPRs in plant breeding

Conventional IPRs protect printed text, inventions, industrial designs, trademarks, geographical indications, and trade secrets, all of which have different regimes for registration, scope, and duration of protection. Since none of these property rights is considered adequate for certain other sectors, additional, so-called "*sui generis*" systems have been developed for the protection of integrated computer circuits, databases, and plant varieties (Plant Breeders' Rights). Plant varieties present several important challenges for an IPR system. First, they are biological products that are easily reproduced and whose very use entails multiplication. Second, the users (and potential "copiers") of the technology are millions of individual farmers whose compliance with any protection regime is difficult and expensive to monitor. Third, the agricultural sector involves cultural values and food security and, in many countries, affects the livelihoods of the rural poor, making the imposition of any controls a sensitive political issue. Fourth, the inherent diversity of plant varieties makes it difficult to apply the narrow technical criteria of novelty and reproducibility used in the conventional patent system, whereas the use of standard breeding methodologies may frustrate the application of the "inventive step" criterion. Finally, the development of new plant varieties has always relied to some extent on public research, partly in response to the traditional public good nature of crop germplasm, and the application of IPRs to the products of a publicly funded endeavor can be problematic.

The advent of modern biotechnology has brought additional challenges for the application of IPRs in plant breeding. Not only do some countries allow the use of patents to protect plants, varieties, and genes, but the majority of the tools and processes of molecular biology and genetic transformation can be patented as well. Many of the techniques of biotechnology, which are an increasingly important part of conventional plant breeding, are also protected, raising implications for the owner-ship of any variety resulting from such research. Finally, because biotechnology allows a much more precise understanding of the genetic makeup of any crop variety, it opens the door to sophisticated screening and reverse engineering techniques, which in turn offer new possibilities for utilizing protected varieties, leading to pressure for more stringent protection.

IPRs as a policy issue

Plant breeding research and seed provision are vital industries that need to be fostered and stimulated. Plant breeding is important for food security at the local and global levels. The ability of adapted varieties to cope with environmental stresses contributes to strategies for sustainable agriculture, and the provision of productive options for commercial farming is essential for wider economic development. IPR regimes for plant breeding can play a part in agricultural development, but the challenge is to strike the right balance between incentives for innovation and access to productive resources. An IPR regime in plant breeding should perform two basic roles. First, in the interest of the public, the IPR regime should ensure that knowledge and materials enter the public domain at some point, and it should stimulate improvements and innovations that increase the choices available to farmers and consumers. Second, in the interest of the rights holder, the IPR regime should provide opportunities for breeders to recoup their investments, which may include the rights:

- To keep farmers from saving seed of the protected variety, sharing the seed with neighbours, or engaging in informal sale of the seed
- To keep competing commercial seed producers from multiplying and marketing the protected variety without a license
- To keep competing plant breeders from using a protected variety or technology in the development of a new variety

The role of IPRs in agriculture is an exceptionally controversial subject. The debates involve complex arguments defended by a range of interest groups. The optimum design of IPR regimes will vary ac-cording to local economic, institutional, and agricultural circumstances and will change as these determining conditions evolve. It is unrealistic to believe that there are any simple, uniform, or permanent formulas that will provide ready-made solutions. It is important to recall that IPR regimes are rights and privileges that are granted at the national level in order to contribute to the public good. It is therefore the responsibility of policy makers to define the particular societal goals that IPRs in agriculture are meant to address and to develop appropriate legislation.

Major issues in current IPR systems for plant varieties

Farmer’s privilege

The traditional right of farmers to save seed from their harvests to plant the following season is an important aspect of sui generis systems and is one of the most contentious aspects of IPRs in plant breeding. Although this practice is often described as a “farmer’s right,” it is referred to here by the UPOV term of “farmer’s privilege” to distinguish it from the broader concept of “Farmers’ Rights,” dis-cussed below.

The 1978 UPOV Convention assumed that farmers were permitted to save and reuse seed of protected varieties as part of "private and non-commercial use." However, article 15(2) of the 1991 UPOV Convention rules that on-farm seed saving is not permitted without the consent of the breeder, although it allows member states to specify crops for which the use of farm-saved seed is permitted, "taking into account the legitimate interests of the breeder." In the EU, this provision is interpreted as the right of smallholder farmers to save seed for specific crops and the right of the breeder to collect royalties on farm-saved seed used on larger farms. The 1991 Convention also prohibits any transfer of seed of protected varieties (through sale, barter, or gift) between farmers. Utility patents on plant varieties are even more rigid, and a patented variety normally cannot be saved for subsequent use as seed on the farm or traded or exchanged with other farmers. Various interpretations of farmer's privilege have favored the adoption of laws based on the more liberal 1978 UPOV Convention in many developing countries. In most cases in these countries, restrictions on saving seed of food crops on the farm are neither administratively feasible nor politically acceptable. Making the transfer of seed from farmer to farmer illegal is widely considered incompatible with the traditions of small-scale farming.

The issue of seed saving is a good example of how IPRs in plant breeding must be tailored to the conditions of national seed systems. Even within a single country, the requirements and conditions of different crop production systems are not uniform, and countries could consider legal options that address this variability. For instance, earlier seed law in the Netherlands included severe restrictions on saving planting materials for ornamental crops, while field crops were regulated on the basis of the more liberal UPOV 1978 Convention. Many vegetatively propagated commercial flower species can be multiplied very rapidly by farmers, which would considerably reduce revenues for breeders and provide inadequate incentives for innovation in a sector that is very important for Dutch agriculture. Thus an amendment to the law made the farm-level propagation of such species illegal. This example emphasizes that countries need to design appropriate levels of protection for different types of commodities, in accord with the domestic agricultural economy and plant breeding capacities.

Breeder's exemption

The breeder's exemption is the right of a breeder to use a protected variety for developing new varieties. This exemption stems from the traditionally unrestricted use of seed by farmers and breeders. It is seen as a way of promoting the development of the best varieties for farmers, limiting the development of long-term commercial advantages, improving opportunities for smaller breeding companies, and thus promoting competition in the sec-tor. Unlike the farmer's privilege, the breeder's exemption has not dramatically changed in later UPOV Conventions, prompting some companies in the USA to look to the patent system for protecting their germplasm. The only modification in the 1991 Convention is the limitation on EDVs, which may fall under the rights of the original breeder. The EDV provision is meant to limit the possibility of "cosmetic breeding," which produces a variety that is only slightly different from the original through techniques such as mutation breeding, repeated backcrossing, or genetic transformation (for example, simply inserting a transgene in a protected variety). The EDV concept is susceptible to different interpretations, however, and is the subject of an ongoing debate among breeders. An EDV can be protected when it is DUS and new, but to commercialize the variety, the breeder of the EDV must have the consent of the person or entity that holds the rights to the original variety. Some larger companies would like to introduce the concept of "genetic distance" in the definition of an EDV, but others fear that this step could lead to the monopolization of certain gene pools. After much debate, seed company representatives recently agreed upon arbitration rules for EDV disputes.

Farmers' rights

An issue that falls outside of the TRIPS requirements for IPRs in plant breeding but which elicits considerable debate is the concept of Farmers' Rights, which has several aspects, such as the right of farmers to save (and use, exchange, and sell) seed derived from their own harvests. The ITPGRFA brought three basic concepts under the scope of Farmers' Rights:

1) The right of benefit sharing, which gives farmers the right to be compensated for their contributions to the development and maintenance of genetic resources and for making them available for use in breeding
2) The right to be involved in the development of national policies
3) Rights related to the protection of traditional knowledge relevant to genetic resources

As a corollary, farmers may also claim ownership over their local varieties and apply for PVP. There is controversy over whether some of these aspects of Farmers' Rights should be included in PVP legislation to allow countries to comply with TRIPS, CBD, and IT PGRFA through one piece of legislation. Many national PVP laws make no mention of these issues, but India recently enacted “The Protection of Plant Varieties and Farmers’ Rights Act” and the Organization of African Unity produced model legislation for “The Protection of the Rights of Local Communities, Farmers, and Breeders, and for the Regulation of Access to Biological Resources.” In a given country, decisions on how to treat Farmers’ Rights will need to be based on an assessment of the major sources of innovation in plant breeding in the country, the aspirations of farming communities, and possibilities for administering and enforcing the wider aspects of Farmers’ Rights.

The right of benefit sharing would seem to offer attractive possibilities for ensuring that farmers’ ingenuity and experience are fairly rewarded. As a number of observers have pointed out, however, there is virtually no experience in the actual implementation or management of such rights in agricultural crops. The CBD would require a direct link between the benefit sharing and the use of a particular genetic resource. However, the extent to which particular local varieties (with identifiable “owners”) may be used in the development of new crop varieties, and the problems in calculating the exact contribution of such a variety, monitoring seed sales, and collecting the appropriate royalties, make the management of such compensation mechanism hugely problematic. A declaration of source is currently discussed in the framework of the CBD. A multilateral approach to benefit sharing is included in the ITPGRFA for a number of important crops, but the implementation rules have yet to be designed. Similarly, the degree to which farmer-bred varieties can be identified, registered, and marketed has yet to be tested.

Patents and biotechnology

In the past two decades, the contributions of biotechnology have transformed the science of plant breeding. The most visible (and controversial) aspect of plant biotechnology is the ability to transfer segments of DNA from one organism to another, resulting in transgenic varieties. The range of commercial transgenic crop varieties is still quite narrow (the majority feature herbicide tolerance or insect resistance), and about one-third of the global area planted to transgenic crops is in developing countries (the majority in Argentina, Brazil, China, India, and South Africa. Nevertheless, a recent review demonstrates considerable progress in research capacity for genetic transformation in the South (although concentrated in relatively few countries), including a range of crops and characteristics well beyond current commercial offerings. A less publicized but equally important contribution of biotechnology to plant breeding is the development of a range of tools and processes that allow plant breeders to link particular functions to specific genes or sequences of DNA and to track their presence during the course of conventional plant breeding. The genes and techniques used in developing transgenic crops, as well as the diagnostic tools and processes of marker-assisted breeding used to produce conventional plant varieties, are all candidates for patent protection.

National patent systems have been unable to keep pace with the rapid development of plant biotechnology, leaving many areas of uncertainty and dispute. In developing countries, only a small minority of patent offices have begun to consider applications related to plant biotechnology, while in several industrialized countries a number of claims to basic technologies are still the subjects of complex court cases. It is therefore impossible to chart an unambiguous course for the development of effective IPR regimes for biotechnology, but it is important to recognize the major parameters and to identify the issues that will affect IPR policy in the coming years. Areas of particular concern include the protection of genes and other sequences, the methods used for genetic transformation, information in bioinformatics databases, and the diagnostic techniques that biotechnology offers conventional plant breeding.

IPRs for biotechnology thus present a complex set of issues that will challenge policy makers, researchers, and the commercial sector for many years to come. Developing countries need to strengthen their capacity to understand the issues and to develop appropriate policies regarding the patentability of various biotechnologies and their products in order to support domestic development of biotechnology and promote access to foreign technologies.

In most cases, developing country researchers will need to do a thorough FtO analysis to under-stand the ownership implications of the tools, materials, or processes that contribute to a particular research project. The technology they use may have been acquired through nonofficial channels, by means of an MTA that may allow only research use, or through commercial purchase that includes other types of contractual restrictions. As biotechnology research in developing countries moves from theory to practice, an explicit understanding of the nature and implications of access to protected technology becomes increasingly important if products are to be delivered into farmers’ hands. A point of equal importance is that national patent offices must be prepared for a growing number of applications in plant biotechnology. They will have to define the types of claims that may apply for protection, given the details of the national law, and establish guidelines for determining the novelty of particular biotechnology inventions.

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Chapter - 5
Modern Perspectives of Food Biotechnology

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Chapter - 5

Modern Perspectives of Food Biotechnology

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Abstract

As a science Biotechnology deals with the applicability of various living organisms in development of useful products. The recent times has seen the application in field of flavor change, as food additives and develop a wide range of value added products. Three critical research areas of biotechnology are: Providing the best catalyst in the form of improved organism usually a microbe or pure enzyme, creating optimal conditions through engineering for a catalyst to act, and Downstream processing technologies to purify the protein/organic compound. Fruit juices ferment into wine, that milk can be used to develop products such as cheese or yogurt, or that beer can be made through the fermentation of malt and hops. Biotechnology in the production of enzymes to bring about desirable changes in food, in the production of food ingredients; flavours, fragrances, food additives and a range of other high valued-added products may a key player to full fill the requirements of consumers and traders related with this.

Keywords: food biotechnology, enzymes, genetics, genetic modification, safety standards

Introduction

Karl Ereky (Hungarian) coined the term “biotechnology, he used the word to refer to intensive agricultural methods. Since that time biotechnology has been variously defined, but it has nearly always been associated with food production and processing. In particular biotechnology has usually encompassed the traditional manufacture of bread, wine, cheese and other fermented foods. On these grounds, biotechnology can trace its roots back several thousand years to the ancient Sumerians, who brewed beer with naturally occurring yeasts. Food biotechnology the umbrella term covering a vast variety of processes for using living organisms-such as plants, animals, microbes, or any part of these organisms to develop new or improved food products. It includes the newer forms of food biotechnology that offer a faster and more precise means to develop food products.

For thousands of years people have been discovering that fruit juices ferment into wine, that milk can be used to develop products such as cheese or yogurt, or that beer can be made through the fermentation of malt and hops. In the 1860s, the scientist Gregor Mendel illuminated the genetic principles behind how parent plants donate certain traits to their progeny. These principles were used to breed hybrid corn, wheat, and many other crops in which certain traits could be selected in order to increase plant yield. Such breeding methods largely accounted for the phenomenal gains in crop productivity during the 20th century and led to modern farming practices. Today, in the arena of food, the primary goals of food biotechnology are to provide a more abundant, less expensive, and a more nutritious food supply in order to address the needs of our growing global population.

The applications and uses of biotechnology in food processing is immense and this includes the following applications such as-its utilization in fermentation of substances and also to enhance properties of the material goods such as the taste, fragrance, shelf-life, texture, quality and nutritional value of that particular food product. As the biotechnology has an important role in the production of enzymes and the use of certain enzymes leads to the required modifications in food. Biotechnology is used in the production of food constituents; flavours, aroma, food additives and an array of other high valued-enhanced products, genetically modified organisms and crops. Food testing and in diagnostics of food ingredients the utilization of advanced technologies of biotechnology is done. Biotechnology helps in increasing food production, provides enhanced harvesting index, nutritional and storage value is also increased, better raw materials production, enriched flavours and the production of food that contains vaccines. The remunerations of biotechnology in reducing the load on food production are immense.

Potential safety concerns associated with food biotechnology

The soybean is an incomplete source of protein for humans and animals; it is naturally low in methionine, an amino acid or protein component. In 1996, Pioneer Hi-Bred International used a gene from the Brazil nut containing complementary levels of methionine to improve the protein quality of the soybean. Soybeans enhanced with genes from the Brazil nut caused allergic reactions in sensitive people. Pioneer Hi-Bred International decided not to market the soybean and is looking for alternative sources of the protein.

Supporters of food biotechnology and federal regulators might see this as an example of the system at work. The soybean was tested for allergic responses before the seed went to market; when such responses were identified, the supplier withdrew the product and worked to develop a nonallergenic food. For critics of food biotechnology, this example might reaffirm concerns, as the transfer of allergens from one food to another is no longer hypothetical. Although the fortified soybean was not marketed, concern remains.

More recently, in 2011, FDA released a guidance document, "Regulation of Genetically Engineered Animals Containing Heritable Recombinant DNA." Under the Federal Food Drug and Cosmetic Act (FFDCA), the biotechnology process to alter the structure or function of the body of an animal, regardless of the intended use of products, is considered a "new animal drug" and is regulated through similar assessments as those for plants listed in the above bullet points.

There is no absolute requirement, however, that products developed through food biotechnology undergo premarket review unless a substance was introduced into the food and is not generally recognized as safe (GRAS) per Section 409 of FFDCA. Companies are voluntarily submitting new products to FDA for review. FMI supports the FDA review process.

EPA regulate food developed through biotechnology including factors

- Studies assessing risk to human health
- Studies assessing risk to non-target organisms and the environment
- The potential for gene flow (biotech crop traits transferring to non-biotech crops)
- The need for insect resistance management plans

Research (CGIAR), which is associated with government and research organizations worldwide, in the effort to use food biotechnology to reduce suffering in Africa and Southeast Asia from the inadequate intake of essential nutrients such as vitamin A, zinc, and iron. 14.

Both the World Health Organization (WHO) and the Food and Agriculture Organization (FAO), of the United Nations, assess food biotechnology as a tool that can be used to reduce hunger, improve food quality and sustainability if safety, environmental, methodology, and ethical concerns are addressed.

Biotechnology: in enzymes production: The industrial production of enzymes mainly involves the utilization of microorganisms. The microorganisms are cultured in enormous containers after which the desired enzymes are secreted into the medium in which the microorganism was fermented.

Enzymes that are produced with the above mentioned process is then removed, undergoes purification steps and this purified enzymes is further used in processing of food in the food industry and for various other uses. Purified enzymes do not comprise of cell or any other form of macromolecules such as DNA or RNAs. The efficiency enzymes production from microorganisms have upgraded as a result of genetic technologies. The use of the advanced technologies have augmented the obtainability of the enzymes, reduced the cost of production and upgraded their value. It is with the help protein engineering techniques, which leads to the generation of unique enzymes which have modification in their structures which in turn confers the desired and new properties to the enzymes, which includes thermo- stability property, enhanced activity, and the capability of the enzyme molecule to work on a new substrate and even at a higher pH. This process imitates expected evolution processes as it is carried out repetitively.

The use of enzymes is done at industrial level processing of food items as well as enhancing its production. The food processing industries worldwide make use of the enzymes that are produced with the help of organisms that are genetically modified. The enzymes thus produced comprises of carbohydrates' and proteases.

Biotechnology: in enhancing taste: Biotechnology has permitted scientists to produce fruits and vegetables with better shelf life and taste. Genetically modified crops that have enhanced taste include the following: seedless watermelon, cherries, tomato, eggplant and pepper etc. In this the removal of seeds from the above food crops enhanced the soluble sugar content which in turn enhanced the sweetness. With the use of biotechnology, modification in fermentation pathways is done to enhance the aroma in crops. For many consumer goods the volatile organic chemicals present in the crops such as flavors and aromas are the major factors that determine their acceptance and market value. There is a competition between the flavors that are produced from agricultural origin with the flavors that are produced from micro-organisms. With the application of biotechnology, there are more than 100 commercial aroma chemicals and flavors which are derived through the utilization of conservative bio-engineering technology. The flavors can also be selected through the selection for over-producers.

Reasons that decides the success or failure of biotechnology application

Socio-economic factors play the determining role in the adoption as well as use of microbial organisms in food industry. The use, uptake and implementation of advanced biotechnological techniques are generally slower, in circumstances where the price of food item is a principal issue. Demand for improved food has been elicited by the increase in the consumer's standards, educational qualification and new marketing scenarios. There is a drastic shift in the dietary habits and a wider variety of foods that is being consumed in urban centers across a number of developing countries, depending upon the increasing incomes and improved educational standards.

Enzymes

Food processing companies are using enzymes that are produced through genetically modified organisms (European food information council 2015). These enzymes comprises of proteases and carbohydrases. Genes for these enzymes have been cloned so as to get higher production in less time period. These enzymes are used for making cheese, curd and flavoring food items. Major percentage of these enzymes is used in food industry as in US more than 50% of proteases and carbohydrases are used in food industry. These enzymes include rennin and α-amylase.

Following are some genetically modified enzymes used in food industry

- Catalase used in mayonnaise production and it removes hydrogen peroxide
- Chymosin useful in cheese production as it coagulates milk
- Glucose oxidase is used in baking as it stabilizes the dough
- α-amylase converts starch into maltose and used in baking for sweetness
- Protease used for meat tenderization process, baking and dairy products

α-amylase: This enzyme is used in the production of high fructose corn syrup (nutritive sweetener). This enzyme provides continuous process of three steps providing higher yield. Through purification this yield can be increased up to 90%. In 1986, Grant devised a system to produce α-amylase through genetic engineering using *Bacillus subtilis* as a host. Plasmid named pCPC720 was use as vector. In same year FDA approved this system of genetic engineering to synthesize α-amylase to be used at industrial level.

Rennin enzyme: It is an active component of substance rennet used in dairy industry. It is a protease enzyme used for the production of curd and cheese. This hydrolysis the peptide bond of casein proteins of milk, hence denaturing these proteins results in curd formation.

Previously this enzyme was extracted from stomach of calves and used to curdle milk. But through this conventional method, lower quantity was obtained. But now bacteria (*Escherichia coli*) and fungi (*Aspergillus niger*) are genetically engineered to produce rennin at commercial level.

Shell life: Many juicy fruits possess short shell life. For example tomato is used all over the world. In order to be shipped, tomatoes should be picked at mature green stage. After picking, these are subjected to ethylene for ripening. Higher temperatures cause early ripening while lower temperature destroys its taste.

Biotechnology improving food nutrition: Every food item does not contain all essential components. That's why every food article is not possessing perfect nutrition. For example rice is used as staple food in many countries of world. But being devoid of vitamin A, it's not a perfect staple food. Use of Biotechnological techniques has solved these problems through introduction of foreign vitamin A gene.

Proteins and essential amino acids: More than half of worldwide protein production is attained from plants but plant proteins lack some essential amino acids like lysine and sulphur containing amino acids. Corn is genetically modified and it expresses proteins produced by soil bacteria *Bacillus thuringiensis*.

S. No.	Name of transgenic plant	Molecular pathway of modification	Enhanced essential amino acids	Foreign genes incorporated
01	Tobacco	Synthetic gene approach	Overall amino acids	*Asp1*
02	Sunflower seed	Manipulation of gene expression	Sulphur containing amino acids (MET)	Gene encoding 2S albumin
03	Potato	Manipulation of homologous protein	Mostly amino acids	*AMA1*
Source: Farkhanda Haroon and Mobeen Ghazanfar, (2016).				

Vitamins and minerals: These are a compulsory food component that's why to avoid their deficiency, transgenic technology is used. The first provitamin rich transgenic rice was produced by incorporating CRTI gene and PSY gene from bacteria and daffodils [10]. Variety of provitamin rich rice can eliminate malnutrition and blindness from developing countries and third world [11]. Scientists are working on introduction of other vitamins and macronutrients (iron, zinc etc.) genes in vitamin deficient food articles.

Iron: Iron is one the most important minerals required for a healthy body. The countries which use rice as a staple food are more vulnerable to iron deficiency because rice is deficient of iron. To resolve this problem, rice is transformed with a foreign gene encoding iron containing gene named ferritin. Transformed rice contains double content of rice as compared to non-transformed rice.

Carbohydrates and lipids: Carbohydrates, lipids can be modified in transgenic plants. In late 20th century, amylopectin rich potatoes and lauric acid rich canola oil was produced through agricultural biotechnology [10]. Potatoes have been genetically modified by inserting a gene from bacteria that encode enzyme involved in starch biosynthesis pathway. These GM potatoes contain 30-60% more starch.

Biotechnology: enhancing taste

Biotechnology has allowed scientists to produce fruits with better taste. GM foods with better taste include seedless watermelon, tomato, eggplant, pepper and cherries etc. Elimination of seed from these food articles resulted in more soluble sugar content enhancing sweetness. Fermentation pathways are modified using biotechnology to add aroma in win.

Methods used in biotechnology

Food additives and processing aids: Enzymes are specialized proteins that are essential for life. They catalyse all biological processes and thus control metabolism in living organisms. Once extracted from living organisms, these proteins allow certain processes in food production to be conducted. For thousands of years enzymes such as rennet from animals and papain from plants have been used to enhance the flavour, texture and appearance of food. Because of the diversity of microorganisms, it has been possible to find a wide range of microbial enzymes that are active in the conditions encountered in food processing. With genetic modification a greater range of pure and highly specific enzymes can be produced more efficiently. These enzymes can be used to make desirable changes to food both rapidly and at relatively low temperatures, with a subsequent reduction in fuel requirements and in the environmental impact of food processing. To the consumer, the direct benefits include better flavour, texture and shelf life of food, often with a reduction in the need for processing and additives.

Genetically modified plants: A vector system that is used for a wide variety of plants is the plant tumour-inducing plasmid (Ti-plasmid) found in the soil bacterium *Agrobacterium tumefaciens.* Through its plasmid, Agrobacterium has the ability to naturally engineer plant cells so that they grow tumours that produce compounds which the bacteria need to sustain themselves. Molecular biologists use disarmed (non-tumour-inducing) versions of this plasmid to introduce foreign genes of their choice into plants. Because every cell carries a complete copy of all the plant's genes in its chromosomes, it is possible to regrow an entire plant from a single modified cell. Specially modified Ti-plasmids have now been produced which help transfer fairly large genes into plants. Unfortunately, monocotyledons (including the important cereal crops) are resistant to Agrobacterium.

Fermented foods: Fermentation can make the food more nutritious, tastier or easier to digest or can enhance food safety. Fermentation also helps preserve food and increase its shelf life, reducing the need for additives, refrigeration or other energy-intensive preservation methods. For several thousand years, traditional fermentation (such as brewing) has given people the opportunity to cultivate microbes on a large scale and in a safe manner. Single-cell protein. In the 1960s, protein from microbial sources (single-cell protein or SCP) was thought to have considerable potential, particularly for Third World countries. Few of the early projects aimed to produce food for humans, aiming instead to provide nutritious, low cost animal feed. Unfortunately, most of the SCP organisms (yeasts, fungi, and bacteria) used petrochemical derivatives as a source of carbon. Even when oil prices were low, the processes were only marginally economic. Consequently the oil price rises of the 1970s ended most SCP projects. One company had an efficient large-scale process using the bacterium *Methylophilus methylotrophus* that could utilize methanol to produce a partially purified protein for animal feed. However, the cost of soya or fishmeal for animal feed remained considerably lower than that of the bacterial protein. Fungal protein (in the form of mushrooms and yeasts) has been accepted as food for generations.

As a form of SCP, algae are of interest in subtropical and tropical regions, where sunlight can be utilized as an energy source. Often the production of algal protein is associated with fish farming. Algae of the genera Chlorella and Scenedesmus have been used as food in Japan, and Spirulina is being produced commercially in several countries, including the United States, Mexico and Israel. Often the product is sold as a high-value “health food”.

Improved microbial cultures: All SCP processes use naturally occurring microorganisms that have been carefully selected from wild populations. Production of the fungal protein, for example, uses a strain of *Fusarium graminearum* that was isolated from a soil sample obtained close to a research laboratory. Before that, many thousands of samples from around the globe had been laboriously screened to see whether they contained a fungus with a suitable nutritional profile, pattern of growth and other desirable properties. For the microbial production of a substance such as an amino acid, it is occasionally possible to find a rare natural variant or "mutant" which lacks a critical step in one of its biochemical pathways and consequently overproduces the desired material. Where such mutants are hard to find, they can sometimes be induced artificially, but such techniques are slow and rely heavily on chance.

Genetically modified yeasts: In 1990 the United Kingdom became the first country to permit the use of a live, genetically modified organism in food. This was a special strain of baker's yeast engineered to make bread dough rise faster. Existing genes were placed under the control of stronger, constitutive promoters, which helped the yeast break down sugar maltose faster than usual. Ordinary brewer's yeast (*Saccharomyces cerevisiae*) is able to utilize a variety of carbohydrates as an energy source. These include glucose, sucrose and maltose. Although sucrose is readily available (as cane or beet sugar), glucose and the other sugars must be prepared by the enzymic breakdown of starch. Unlike *S. cerevisiae*, the closely related yeast *S. diastaticus* is able to grow on starch and dextrins because it makes an extracellular enzyme, glucoamylase, which catalyses the breakdown of starch.

Saccharomyces diastaticus cannot be used directly for brewing because it produces a compound which gives beer a spicy flavour. Great interest has therefore focused on transferring the gene for glucoamylase from *S. diastaticus* into S. cerevisiae. Such a yeast would be better able to utilize the carbohydrate present in conventional feedstocks, which would increase the yield of alcohol and enable the production of a full-strength, low-carbohydrate beer without the use of extra enzymes after the beer had been brewed. A modified yeast of this sort, produced by a research foundation, recently received approval for use in beer production in the United Kingdom. Food yeasts which have been genetically modified to metabolise a wider range of sugars also help reduce the levels of polluting waste in effluent. Sugar beet molasses is widely used as the main raw material in the production of baker's yeast. Beet molasses contains, in addition to sucrose, a small proportion of raffinose. This sugar is not fully broken down and utilized by the yeast, and the unused part (melibiose) is found in waste water from factories. The new strains of yeast utilize raffinose completely, enhancing the yield of baker's yeast and leading to a cleaner effluent.

Improved starter cultures for the dairy industry: When cheese, yoghurt and similar dairy products are made it is important that only the desired microorganisms be allowed to ferment the milk. Failure to exclude unwanted organisms can lead to poor flavours, low yields and even food poisoning. Scrupulous hygiene is required, and often the milk is heat treated to kill all or some of its microbial flora. Starter cultures of only the desired microbes are then added to the milk in sufficient volumes and in the appropriate conditions to ensure their rapid growth. When improved starter cultures are developed, it is sometimes possible to choose between long-established, conventional techniques and the modern methods of genetic modification. However, the organisms that are produced may be identical, irrespective of the method chosen. One example where different routes led to the same result is a new yoghurt that keeps its fresh "home-made" taste for several weeks without the risk of turning acidic and bitter.

Food additives and processing aids: For many years, a wide range of food additives, supplements and processing aids have been obtained from microbial sources. These include amino acids, citric acid, vitamins, natural colourings and gums as well as enzymes. The production microorganisms have been selected from nature to ensure that, for example, they produce high yields of a good-quality product and/ or are easy to grow or that the product is easy to separate and purify. Laborious screening and selection processes are now being augmented by modern genetics, allowing quicker, more precise selection and improvement of existing production strains.

Amino acids

In foods, amino acids are used to enhance flavours and to act as seasonings, nutritional additives and improvers (in flour). They are used in both human food and animal feed. Bacteria or fungi which have been specially selected to overproduce specific amino acids are grown in large Fermenter. The acids are secreted into the fermentation medium and harvested. Most of the 20 amino acids needed to make proteins are produced by fermentation in hundred-or thousand-tonne quantities. In 1990, a company made a batch of tryptophan that was subsequently implicated in a rare degenerative disorder. Concern arose because the tryptophan had been produced by a genetically engineered strain of Bacillus. However, it is thought that the illness was caused by insufficient purification of the tryptophan and not by the genetic modification itself.

Gums

Several gums produced by microorganisms and plants are used widely in the food industry as thickeners, emulsifiers and fillers. Recently a process was developed to turn relatively cheap guar gum (obtained from seeds) into something akin to the more expensive locust bean gum. An enzyme (α-galactosidase) from the guar seeds is responsible for this transformation. The gene encoding the enzyme was inserted into baker's yeast, and α-galactosidase can now be produced in quantity. Production and processing of α-galactosidase by modified organisms brings several other benefits. Bacterial polysaccharides currently occupy only a small fraction of the food ingredients market, but genetically modified cells could produce a wide range of novel gums with improved properties.

Sweeteners

Aspartame, a peptide which is 160 times sweeter than sucrose, is now used in an increasing range of foods and beverages. Aspartame's sweetness was (allegedly) discovered by accident when James Schlatter, working in the United States, licked his fingers to separate a stack of papers. He had previously spilt some aspartame on his hands while working in the laboratory. Chemists at another laboratory in the United Kingdom had independently synthesized aspartame some years before but had failed to notice its sweetness.

Enzymes: A wide range of microbial enzymes are used by the food industry. Some of the more important applications are shown in Table 2.

Table 2: Uses of enzymes in the food industry

Enzyme	Product	Use
α-Amylase	Sweeteners Beer Bread, cakes and biscuits	Liquefaction of starch Removal of starch haze Flour supplementation
Amyloglucosidase	Sweeteners Low-carbohydrate beer Wine and fruit juice Bread manufacture	Saccharification Starch removal Improved crust colour
β-Galactosidase (lactase)	Whey syrup Lactose-reduced milk and dairy products Ice cream	Greater sweetness Removal of lactose for those who are lactose intolerant Prevention of "sandy" texture caused by lactose crystals
Chymosin (rennin)	Cheese	Coagulation of milk proteins
Glucose isomerase	High-fructose syrup	Conversion of glucose to fructose

Glucose oxidase	Fruit juices	Removal of oxygen
Invertase	Soft-centred sweets	Liquefaction of sucrose Sugar syrups
Lipases	Cheese Flavourings	Flavour development Accelerated ripening Ester synthesis
Papain	Beer	Removal of protein
Pectinases	Wine and fruit juice Coffee	Increased yield, clarification Extraction of the bean
Proteases (various)	Dairy products Caviar Bread, cakes and biscuits Meat	Modification of milk proteins Viscosity reduction of "stickwater" Gluten weakening Tenderisation Removal of meat from bones
Source: Dean Madden (1995).		

Use of enzymes in food processing

Cheese manufacture: The Romans were the first Europeans to describe cheese making in detail. To coagulate the milk protein, an enzyme preparation from goat, lamb or even hare stomachs was mixed with sheep's or goat's milk (cow's milk was not produced on a large scale before the 13th century). After the whey had been drained from the coagulated milk, the curds that remained were salted and stored for consumption later in the year. Vegetarian cheeses were also produced using the juices of plants which possessed milk-clotting properties, such as lady's bedstraw (*Galium verum*) or butterwort (*Pinguicula vulgaris*).

Rennet substitutes: In the 1960s the Food and Agriculture Organization of the United Nations predicted a severe shortage of calf rennet. It was anticipated that an increased demand for meat would lead to more calves being reared to maturity, so that less rennet would be available. Over the last 30 years several substitutes for calf rennet have been developed, allowing the supply of enzymes to keep pace with cheese production. Today there are six major sources of protease for coagulating milk (that is, chymosins), three from animals (veal calves, adult cows and pigs) and three from fungi (*Rhizomucor miehei* [formerly *Mucor miehei*], *Endothia parasitica* and *Rhizomucor pusillus* [formerly *Mucor pusillus*]). In addition, there are now chymosins derived from genetically modified microbes (*Escherichia coli, Kluyveromyces lactis* and *Aspergillus niger*).

Other enzymes for cheese making: In some cheeses fat-degrading enzymes (lipases) may be added to promote the formation of piquant flavours as the cheese ripens. Many traditional Italian cheeses benefit from such additions to augment the activity of naturally occurring lipolytic microbes. Recently, lipase from genetically modified microbes has been introduced to accelerate the ripening of other cheeses. Cheddar cheese takes up to 9 months to mature fully. However, with the addition of a suitable lipase, this period can be reduced to a mere 6 weeks. In some countries food additive regulations based on traditional practices prohibit the use of enzymes in cheese other than those used to coagulate milk. These may be revised in the light of current technological developments.

Immobilised enzymes for whey processing: In several countries methods have been developed for the enzymatic treatment of surplus whey from cheese making. The enzyme lactase (α-galactosidase) is immobilised (for example, on porous beads) inside a tall column. Lactase is expensive and immobilisation permits it to be reused many times. Whey is passed over the beads in the column, emerging some 10 minutes later with 80-90% of its lactose sugar split into a mixture of sweeter-tasting glucose and galactose. After enzyme treatment the pH of the whey is adjusted and salt (from the cheese-making process) is removed. Finally the product is concentrated by evaporation to give opaque, honey-like, protein-rich syrup.

Food safety and regulatory approval

In addition to issues of environmental safety, the implications of modern biotechnology for food safety need to be considered. Food is considered safe if there is reasonable certainty that no harm will result from its consumption under anticipated conditions. Historically, food prepared and used in traditional ways is considered safe on the basis of long-term experience, even though it may naturally contain harmful substances. In principle, food is presumed to be safe unless a significant hazard has been identified. Modern biotechnology provides precise techniques for the direct and focused assessment of safety (for example, by the detection of minute amounts of contaminating material), which can be usefully applied to foods derived from both modern and traditional methods.

United States. In the United States, foods are regulated by three bodies. The Food and Drug Administration (FDA) is concerned with food safety relating to new plant varieties, dairy products, seafood, food additives and processing aids, whereas the Department of Agriculture regulates meat and poultry products and field tests all genetically modified plants. The Environmental Protection Agency is responsible for pesticide chemicals, and it may therefore have to approve new plant varieties resistant to attack by pests. Of the three agencies, the policy of the FDA with respect to new plant varieties is most clearly defined at present. The FDA regards the key factors in reviewing safety to be the characteristics of the food and its intended use, rather than the fact that new methods have been used in its production. Novel food products are not subject to regulatory approval if the constituents of the food are the same or substantially similar to substances currently found in other foods (such as proteins, fats, oils and carbohydrates). For example, if a gene from a banana were transferred to a tomato, approval would not ordinarily be required before that food was placed on the market. However, if a sweetening agent that had never been an ingredient of any other food were added to a variety of grapefruit, the novel food would need regulatory approval. The sweetener would be regarded as a food additive and therefore be subject to other, more stringent regulations.

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Chapter - 6
Genetically Modified Crops and Transgene Introgression: Towards a Solution

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Chapter - 6

Genetically Modified Crops and Transgene Introgression: Towards a Solution

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Abstract

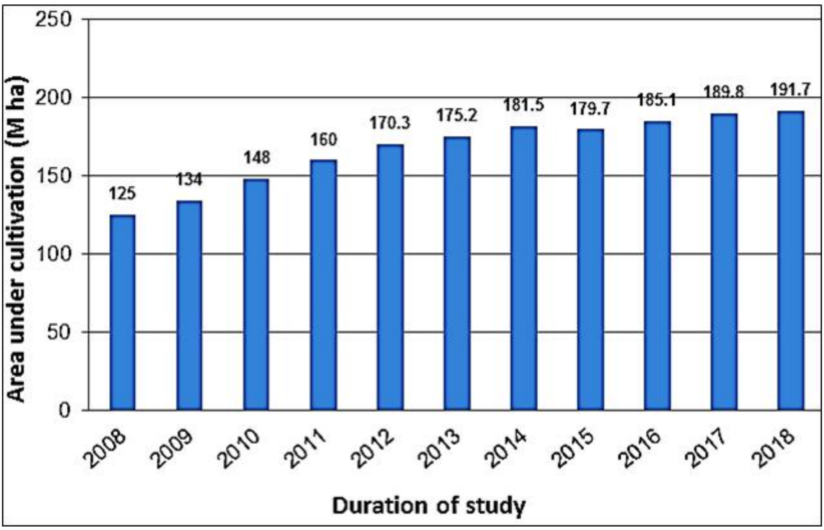
Within the next few years, many types of transgenic varieties will be ready for commercialization. Future generations of genetically modified plants are projected to be suitable for harsh environmental conditions, enhancement of nutrient content, production of pharmaceutical agents, bioenergy and biofuels. These transgenic crops have great potential to bring about many benefits including food security. However, commercialization of transgenic crops has several disadvantages. One of them is pollen drift, the term refers to the unintentional transfer of pollen from transgenic crops to nearby conventional crops by wind or insects and may have negative ecological consequences. Such problems can be prevented by carefully maintaining crop-specific isolation distances between different varieties, using border strips around fields to trap pollen and by some molecular methods. In this chapter, we reviewed the existing information about the gene flow in some main transgenic crops and strategies to prevent unintentional gene flow.

Keywords: transgenic crops, gene escape, spacing, site specific integration

Introduction

Genetically modified plants (GM plants) are plants where genetic material has been changed in such a way that does not takes place under natural conditions through cross-breeding or natural recombination. These plants are developed in such a way that they express the desired traits. Uses of such genetically modified plants are advocated especially for their role in ensuring food security. Food production uses significant proportions of arable land and natural resources. The efficiency of land use has to be increased because by 2050, the global population is expected to get higher above 9 billion, and the existing amount of arable land is expected to decrease significantly due to anthropogenic climate change and urbanization

(FAO 2010). GMOs conserving land to produce more food is a necessity for any long term plan. Biotechnology firms claim that transgenic crops promise more productivity with existing land. Therefore hold promise to lighten this burden on the Earth, GMO crops have been found to increase yields. Researchers found that Bt corn adoption has been increased to 10-percent which is associated with regular increase in yield from 2008 to 2018. Biotechnology companies state that such varieties of crops not only increase the production but also improve the livelihood of the farmers. Areas of transgenic crops have been increased from 125 million hectare in 2008 to 191 million hectare in 2018 (Fig. 1).



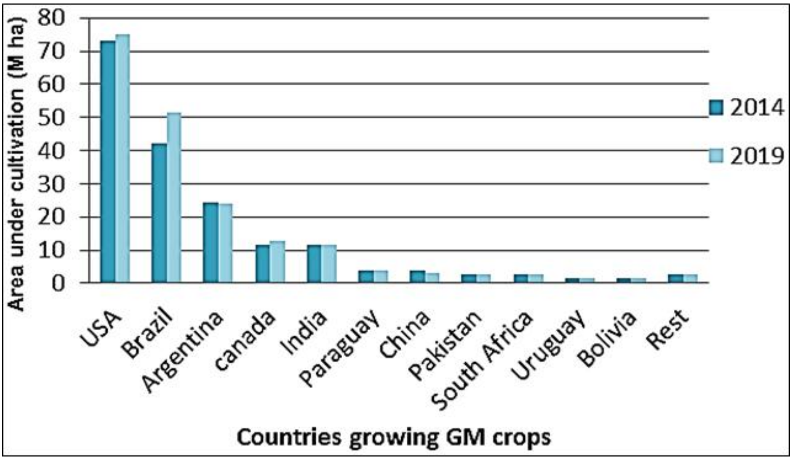
Source: ISAAA, 2018

Fig 1: Increase in cultivation area of transgenic crops in recent years

Transgenic crops are being grown commercially in all six continents of the world. Of the 28 countries planting biotech crops in 2014, 19 countries planted 50,000 hectares or more to transgenic crops. Soybean, cotton, maize and canola are the major transgenic crops. Major countries growing transgenic crops are USA, Brazil, Argentina, India, Canada, China, Paraguay, Pakistan, South Africa, Uruguay, Bolivia, Philippines and Australia (Fig. 2).

In 2014, 82% (90.7 million hectares) of the 111 million hectares of the soybean planted globally were transgenic. Transgenic cotton was planted to 25.1 million hectares, which is 68% of the 37 million hectares of global cotton growing area. Of the 184 million hectares of global maize planted in 2014, 30% (55.2 million hectare) was transgenic. In 2014, area covered with herbicide tolerant transgenic canola was 9 million hectares or 25% of the 36 million hectares of canola grown globally. If the global area (conventional and transgenic) of these four crops is aggregated, the total area is 368 million hectare, of which 49% (181.5 million hectare) was under transgenic cultivation (James 2014).

Increasing distribution of transgenic crops



Source: Statista, 2020

Fig 2: Comparison of production area of transgenic crops in major countries in 2014 and 2019

Of the 184 million hectares of global maize planted in 2014, 30% (55.2 million hectare) was transgenic. Herbicide tolerant transgenic canola was planted in 9 million hectares or 25% of the 36 million hectares of canola grown globally in 2014. If the global area (conventional and transgenic) of these four crops is aggregated, the total area is 368 million hectare, of which 49% (181.5 million hectare) was under transgenic cultivation (James 2014). Production area of transgenic crops slightly increased in USA and Brazil from 2014 to 2019. While in rest of the country there is a slight decrease in the production area of transgenic crops.

Problems associated with transgenic crops

Use of such genetically modified organisms (GMOs) has prompted controversy over following points:

1. Maximum numbers of the GM crops are developed by some key agricultural corporations e.g. Monsanto. Because of monopoly of agricultural giants, transgenic seeds are expensive to poor farmers. This may lead to farmer exploitation

2. Unknown health consequences are a common objection to GMO organisms
3. Cross-pollination with the cultivated and wild type with GM species may lead to genetic contamination of the cultivated and wild type, which could alter local ecosystems
4. Biotech crops may lead to monoculture, which can be a reason for loss of biodiversity
5. Transgene escape from these crops may lead to the development of super weeds

For agriculture scientists a much-debated issue regarding the commercial growing of genetically modified (GM) plants is the possible transfer of transgene pollen into neighbouring fields with similar crops and their wild relatives. In this chapter, we focused on potential environmental risks that are related to gene flow from transgenic crops to non-transgenic crops and their control measures. Like other crop genes, these novel transgenes can also be transferred to populations of related crops, wild relatives and weeds via pollen and seed dispersal (Ellstrand 2003). If a non-GM crop is fertilized by GM-pollen, a certain percentage of the harvested seed product will contain GM seeds. This may be objectionable to consumers and as per current regulations illustrated by the European Union (EU 2003). In organic farming, genetic engineering is not allowed in EU regulations for grain production system partly to assure GM-free products to the consumers (Nijhoff and Andersson 2001). If the crop is to be classified and sold as an organic crop, the proportion of seeds containing GMO may not exceed a critical detection level, e.g. 0.1%. The main sources for GM contamination of non-GM-crops at the farm level are: seed impurities, pollen dispersal from nearby fields and seed dispersal with machinery, dispersal of pollen and seeds from volunteer plants, and mechanical mixture (Kjellsson and Boelt 2002; Bock 2007). The out crossing by insects and wind from neighbouring plants in the field is difficult to control. Problem of genetic contamination from GMO crops is more in cross-pollinated crops then in self-pollinated crops. Cross-pollination may also show irregular patterns depending on prevailing wind directions (Eastham and Sweet 2002), the topography and distribution of insect pollinator populations, including beehives (Ramsay *et al*. 2003).

The dilution effect of foreign pollen from the same species may be used in the management for co-existence of organic and conventional crops with GM-crops. Ecologists look forward to minimize the environmental consequences of gene flow from most GM crops (NRC 2002; Snow *et al.* 2005). Hence, the proportion of successful GM-pollen in a non-GM field with the same crop may be reduced by:

1. Exclusion of a narrow or wide strip of the non-GM-field, i.e., the buffer zone, opposite the GM-crop at the time of harvest
2. Increasing the width of the non-GM-field
3. Increasing the distance between the GM and the non-GM-field, i.e., the isolation distance, or by using a combination of different methods

Introgression of transgenes from major transgenic crops and their management

GM Soybean covers the maximum area under production among other GM crops. Soybean is a self pollinated crop but there is still a problem of gene flow from GM varieties to non GM varieties. Mizuguti and coworkers (2010) conducted two year hybridization experiment to collect information on temporal and spatial factors affecting variation in hybridization between wild and GM soybean. They found that hybridization frequencies ranged from 0 to 0.097%. Gene transfer was more where GM and wild soybeans were adjacently cultivated. When they maintain an isolation distance of 2 m, 4 m and 6 m from a pollen source (GM soybean) only one hybrid was detected. Maintaining isolation of 50 m will be an effective strategy to minimize hybridization between GM and wild soybean.

Oilseed rape *(Brassica napus* L.) is an often cross-pollinated summer or winter annual crop. A number of GM varieties have been developed in this crop. The out-crossing varies between 12 and 47% due to pollen dispersed by wind and insects (Becker *et al*. 1992). Warwick and colleagues (2003) reported the first transgene escape from a commercially released GM crop to a wild relative in *Brassica*. To avoid contamination of organic oilseed rape crop, an isolation distance of 200 m is recommended between GM-oilseed rape and organic oilseed rape fields and even for very small fields (field width of 50 m). This requirement is same as required for production of certified seeds of oilseed rape (Tolstrup *et al*. 2003) where the minimum isolation distance maintained with other varieties are 100 m (self-fertile) and 300 m (hybrids) (Zhao *et al.,* 2013). For larger fields (field width of 100 m) 50 m isolation should be sufficient to avoid contamination from transgenic *Brassica* (Damgaard and Kjellsson 2005).

Widespread adoption of GM corn received the considerable attention of scientists because of the cross-pollinating nature of the crop where most pollination results from pollen dispersed by wind and gravity. Corn pollen grains are spherical and larger than the pollen produced by most grasses (Burris 2002; Gray 2003). These are among the largest particles found in the air. Because of large size pollens settle down to the earth very quickly, they travelled to the very short distance i.e. about 0.3 m/second as compared to the pollens of the other members of the grass family. Byrne *et al*. (2003) in their study at Colorado tracked the flow of pollen from blue corn and GMO Roundup Ready corn into adjoining conventional corn. Corn with GM traits (blue kernels or Roundup herbicide tolerance) was planted next to corn without GM traits. From their study they concluded that for corn fields over 20 acres in size, the isolation distance (of 200m) may be modified by post pollination removal of 16 border rows if the actual isolation distance is less than 50 m. This isolation distance may be modified by post pollination removal of 8 border rows if the isolation distance is between 50 and 200m. By maintaining these isolation and border row requirements, corn grain produced is not more than 0.5% contaminated with GMOs (Nielson 2003 and 2010).

In rice, pollen-mediated gene flow is influenced by variation in flowering times, out-crossing rates, population sizes, distances between populations, wind speed, humidity, and other factors, Rice is a highly self-pollinated crop and shows very little cross-pollination between nearby plants or fields (typically less than 1 percent). Messeguer *et al*. (2001) in their experiments in Italy found that pollen-mediated gene flow from a transgenic herbicide-resistant rice variety to adjacent plants of a non-transgenic counterpart was 0.05 to 0.53 percent. The rate of cross-pollination in rice is quite low though it is widely understood that transgenes introduced into modern rice cultivars will be transgressed in to weedy rice populations (Gealy *et al*. 2003). They reviewed that gene flow from cultivated to weedy rice were approximately 0.01 percent to 1 percent. Gene flow is more from cultivated rice to wild rice, because wild rice outcrosses to a greater degree than weedy rice (Song *et al*. 2003; Chen *et al*. 2004). The largest numbers of studies were conducted in Asian species such as the perennial *O. rufipogon*, the annual *O. nivara*, and intermediate forms of these taxa (Oka 1988; Vaughan 1994; Majumder *et al*. 1997; Song *et al*. 2004). Song and colleagues (2004) found that the maximum frequency of gene flow to adjacent plants of *O. rufipogon* was less than 3 percent, and about 95 percent for wild rice recorded on rice plants growing within 30 m of the crop. Pollen flow from rice crop to wild rice was detected up to 110 m. Environmental factors can also restrict opportunities of gene flow between cultivated and wild rice. An isolation distance of more than 250 m was suggested by Kanya *et al.* (2009) between fields of GM rice and other rice fields and wild rice populations to minimize gene flow to a very low level.

In brinjal, 30-40% of pollination is done by contact, gravity and wind, and the rest by insects. Many trials indicate that insects play a major role in pollination in brinjal (Quagliotti 1979). Cross-pollination of brinjal in Asia is by insects such as bumblebees (*Bombus* spp.), wild bees (*Exomalopsis, Xylocopa*, *Anthophora* spp.) and domestic bees (*Apis* spp.) (MoEF 2010). Cross-pollination was a significant factor in gene flow from *Bt* brinjal to non-GM brinjal. Different trials were conducted to study the effect of gene transfer in 2002-2003 and 2009 at different locations in India (Chaudhary and Gaur 2009). Bees were employed to assist pollination in this study. Results show that out-crossing (indicated by the presence of the *Bt* gene in F1 progeny) was measurable: 1.46-2.7% in the first study (isolation distance was 20m) and 0.14-0.85% (isolation distance was 30m) in the second. An isolation distance of 300 m is recommended for field trial of brinjal to minimize gene flow.

Sorghum (*Sorghum bicolor*) has high outcrossing rates so chances to hybridize with wild populations of the same species like the noxious weed Johnson grass (*Sorghum halepense*), *Sorghum almum* and *Sorghum propinquum* are greater (Adugna *et al*. 2013). Schmidt and Bothma (2006) in their experiment found that the average out-crossing rate for male sterile plants was 2.54% at 13 m isolation distance, below 1% at 26 m or greater, and eventually dropping to 0.06% at 158 m. They found that the maximum gene flow distance is expected to be between approximately 200 and 700 m. An isolation distance of 700 m can be recommended for the sorghum to reduce pollen drift.

Biotechnological methods to prevent introgression

Strategies such as isolation distances and border rows have most often been discussed as solutions to preventing gene flow from transgenic crops. Biotechnology that focuses on the properties of transgene constructs and their placement in the genome should be able to increase the barriers to introgression. Many biotechnological methods are available like male sterility (Mariani *et al*. 1990; Rose *et al*. 2009), insertion of transgene into nonnuclear region (Maliga 2002; Bock, 2007; Kittiwongwattana *et al*. 2007), Genetic use restriction technologies (Hills *et al*. 2007; Kausch *et al*. 2010; Gressel 2010), site specific integration of transgene by using homologous recombination (Terada *et al*. 2002; Terada *et al*. 2010) and Recombinase-mediated gene targeting (Ow 2002; Fladung and Becker 2010) etc. Recently, a more versatile and efficient genome editing tool has been developed based upon the bacterial clustered regularly interspaced short palindromic repeats (CRISPR)-associated protein (Cas) type II adaptive immune system and trialed in different organisms including plants (Cho *et al*. 2013; Cong *et al*. 2013; Gratz *et al*. 2013). These technologies have been discussed a lot as a tool for the prevention of transgene introgression but have not been commercially exploited. These all the technologies have their own pros and cons. Like if male sterility is used as a source of biocontainment then the seeds produced from the crossing of male-sterile GM crops and weeds or non GM crops may pose problems, because seeds of such hybrids will produce fertile pollen that would carry the GM trait.

Same as for the integration of transgene in the non-nuclear region sounds very good as gene is not introduced in the genomic region but still the technology has problems like transgene stability is not proven, high levels of transgene expression (Oey *et al*. 2009), introducing DNA into chloroplasts may also transform nuclear DNA (Elghabi *et al*. 2011), they may produce defective proteins (Waheed *et al*. 2011) etc. GURTs were originally developed as a way for obtaining intellectual property protection (IPP) so this technology was always on the target of social activist, farmer associations and political persons. This technology has a disadvantage but advantage in terms to prevent introgression that the crops from nearby fields will also suffer losses due to development of non-viable seeds from the cross-pollination from these gene safe plants. This technology was never been commercially exploited because of public pressure and other reasons, but it can be used as a good aspirant for preventing gene flow in transgenic crops.

Site specific integration of transgene by homologous recombination is a tedious job and needs to generate hundreds of transgenic lines to recover a few site-directed insertions (Fig. 3&4). Recombinase-directed site-specific integration can place a single-copy non-rearranged DNA fragment into the target site in 1 out of 3 selected events, a rate that is significantly higher than those reported for homology-dependent insertions (Albert *et al*. 1995; Zhongsen *et al*. 2009). But for site specific recombination in every plant we have to identify the suitable target site to introduce the transgene. Those suitable target sites are not available in all plants.

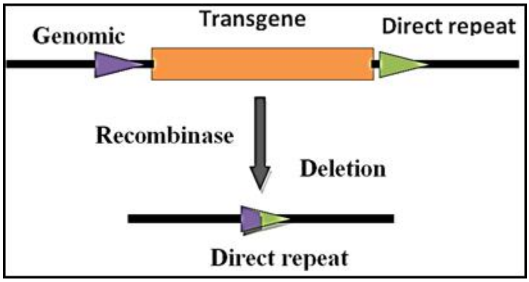


Fig 3: Schematic representation for gene deletion technology

If a pair of direct repeat (Purple and Green) oriented as DNA recombination site, Recombinase mediated intra-molecular recombination results in deletion of intervening DNA. The deleted DNA fragment will be degraded later in cell (LI, 2012).

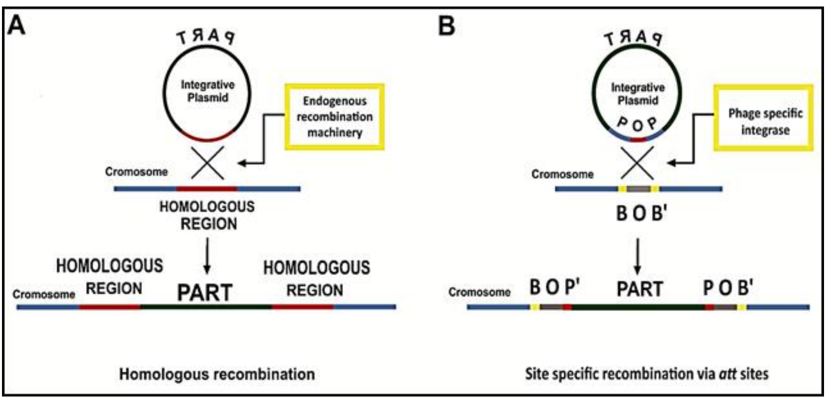


Fig 4: Plasmid-based methodologies for chromosomal integration in *E. coli*.

A: Homologous recombination. The integrative plasmid (green) carries a sequence (red) that is homologous with a region (red) in the bacterial chromosome (blue).

B: Site-specific recombination. The integrative plasmid carries a bacteriophage attachment site (attP) that targets the whole plasmid into the specific attachment site (attB) in the host genome (Zucca *et al*. 2013).

The CRISPR-Cas system provides a useful tool for efficient genome modifications in elite lines/cultivars in non-transgenic plants, which can address the ethical concerns being raised by transgenic plants (Fig. 5). Plant genome modifications through this technique are indistinguishable from those introduced by conventional breeding. As a result, crop varieties produced using CRISPR-Cas technologies may be classified as non-GM.

Still the problem of off-site mutation exist with this technology, so more studies are needed to optimize specificity and expression of Cas9 and sgRNA to increase efficiency of this approach (Kumar and Jain 2015).

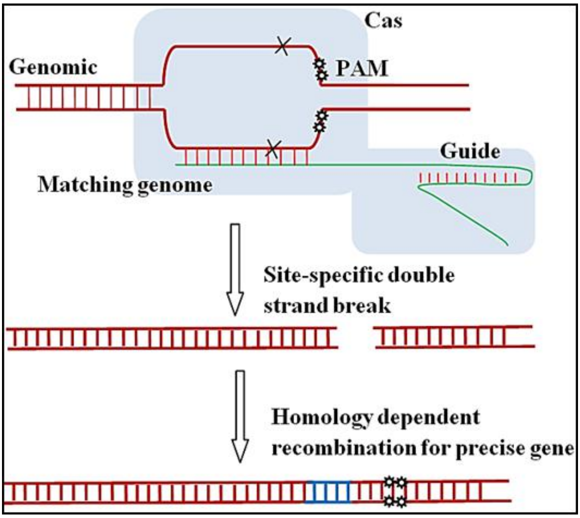


Fig 5: CRISPR-Cas9 target recognition

In the CRISPR system, a sgRNA (containing a CRISPR RNA (crRNA) and a partially complementary transactivating RNA (tracr RNA) is essential for RNA processing and for recognition by Cas9 (CRISPR-associated protein 9). Cas9 is a RNA-guided, dsDNA binding protein that uses a nuclease to cleave both strands of target DNA. Cas9 relies on the PAM site and base pairing with the sgRNA and the target DNA (LI, 2012)

Conclusion

The idea of gene flow from transgenic crops and the development of super weeds has become widespread. This review has focused on the key issue of introgression between crops and their wild relatives, gene flow from genetically modified crops will continue to receive much attention, even if it is only to other crops. Transgenic traits that have the potential to enhance the fitness of the crop's relatives should be assessed with extra caution, because these genes are expected to increase in frequency of crop-wild hybridization, and it is also difficult to predict their ecological consequences. Gene flow by managing isolation distance and discarding border can be reduced to some extent but cannot be stopped as pollen can be carried by wind and insects to long distances. The innovative transgene-containment strategies, coupled with a growing knowledge of the genetics and ecology of introgression among plants, indicate that the environmental risks can be minimized. These biotechnological approaches have not been yet commercially exploited. So for the existing transgenic varieties it is necessary to maintain isolation distance to prevent the gene flow from transgenic, especially in countries where lots of transgenic crops are under cultivation. Transgenic technology is going to stay in this world so environmental assessments that are scientifically rigorous and publicly accessible are essential for the long-term success of this important technology.

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Chapter - 7
Biofortification to Minimize Hunger and Malnutrition

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Chapter - 7

Biofortification to Minimize Hunger and Malnutrition

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Abstract

Malnutrition is an alarming problem in the world. While providing enough calories, monotonous diets based on cereals and other starchy staple foods often fail to provide sufficient quantities of essential minerals and vitamins like iodine, iron, zinc and vitamin A and thus create a “hidden hunger” of micronutrient malnutrition. Hidden hunger is insidious. It strikes people who, on the outside, may appear to be consuming an adequate amount of food, mainly staple crops grown on small family farms. Yet, the calories of many staple crops disguise an invisible hunger that affects the health and wellbeing of people living on the margins. Hidden hunger describes a condition of under nutrition where the body lacks essential vitamins and minerals that keep people healthy. Over two billion people worldwide are affected by hidden hunger. Biofortification is the process of breeding nutrients into food crops, provides a comparatively cost effective, sustainable, and long-term means of delivering more micronutrients. This approach not only will lower the number of severely malnourished people who require treatment by complementary interventions but also will help them maintain improved nutritional status.

Keywords: biofortification, hunger, malnutrition, nutritional status, food crops

Introduction

In total, more than two-thirds of the world population suffer from at least one micronutrient deficiency, where women and children are disproportionally affected: 2 billion people are iron deficient (WHO/WFP/UNICEF 2007), 2 billion are iodine deficient, about 150 million are vitamin A deficient and as many as 3 billion people are at risk of zinc deficiency (Hotz and Brown 2004). These nutrient deficiencies are not mutually exclusive, such that people have multiple dietary deficiencies due to the poor overall quality of their diets. Those at the bottom of the socioeconomic index are most likely to have dietary micronutrient deficiencies and thus are the most affected. According to the World Bank Report (2010), more than 1.3 billion of world's population survives on an income of less than one US dollar per day. This is the reason why mineral deficiency is most prevalent in developing countries. All though the global burden of micronutrient deficiencies fell between 1990 and 2010 by more than half, in many countries and particularly in Africa, micronutrient deficiencies in South Asia remain major public health problems and still rank among the top causes of death and disability (Wang *et al*. 2012; Lim 2012). Sustainable solutions to the hidden hunger can be achieved by closely linking agriculture to nutrition and health and by formulating agricultural and nutritional practices together with health policies to reflect this need (Graham *et al*. 2007). Humans require at least 49 known nutrients in consistent and adequate amounts to live healthy and productive lives (Ross *et al*. 2003). Persons living in developing countries often have diets that fail to meet these requirements. This failure is due to a combination of factors, including poverty, inadequate agricultural systems and lack of access to markets.

Hidden hunger is insidious. It strikes people who, on the outside, may appear to be consuming an adequate amount of food, mainly staple crops grown on small family farms. Yet, the calories of many staple crops disguise an invisible hunger that affects the health and wellbeing of people living on the margins. Hidden hunger describes a condition of under nutrition where the body lacks essential vitamins and minerals that keep people healthy. Over two billion people worldwide are affected by hidden hunger. Deficiencies in micronutrients such as zinc, iron and vitamin A can cause profound and irreparable damage to the body-blindness, growth stunting, mental retardation, learning disabilities, low work capacity, and even premature death. The effects of hidden hunger are acute during the first 1,000 days of a child's life-from conception to the age of two years. Micronutrient deficiencies are especially damaging to women. Five hundred million women aged 15 to 49, at the peak of their productive years, are anemic due to iron deficiency. This condition reduces their productivity, decreases their economic potential, and affects their reproductive health outcomes.

Biofortification

Biofortification is the process of breeding nutrients into food crops, provides a comparatively cost effective, sustainable, and long-term means of delivering more micronutrients. This approach not only will lower the number of severely malnourished people who require treatment by complementary interventions but also will help them maintain improved nutritional status. Moreover, biofortification provides a feasible means of reaching malnourished rural populations who may have limited access to commercially marketed fortified foods and supplements. The biofortification strategy seeks to put the micronutrient-dense trait in those varieties that already have preferred agronomic and consumption traits, such as high yield. Marketed surpluses of these crops may make their way into retail outlets, reaching consumers in first rural and then urban areas, in contrast to complementary interventions, such as fortification and supplementation, that begin in urban centers. Biofortified staple foods cannot deliver as high a level of minerals and vitamins per day as supplements or industrially fortified foods, but they can help by increasing the daily adequacy of micronutrient intakes among individuals throughout the life cycle (Bouis *et al*. 2011).

Conventional interventions have a limited impact, so biofortification has been proposed as an alternative long-term approach for improving mineral nutrition (Zhu *et al*. 2007). Biofortification focuses on enhancing the mineral nutritional qualities of crops at source, which encompasses processes that increase both mineral levels and their bioavailability in the edible part of staple crops. The former can be achieved by agronomic intervention, plant breeding, or genetic engineering, whereas only plant breeding and genetic engineering can influence mineral bioavailability. Plant breeding and genetic engineering are often compared because, in contrast to agronomic interventions, both involve changing the genotype of a target crop. The two processes are similar in aim, albeit different in scope. Both attempt to create plant lines carrying genes that favor the most efficient accumulation of bioavailable minerals-plant breeding achieves this by crossing the best performing plants and selecting those with favorable traits over many generations-whereas genetic engineering accesses genes from any source and introduces them directly into the crop. Plant breeding is limited to genes that can be sourced from sexually compatible plants, whereas genetic engineering has no taxonomic constraints and even artificial genes can be used. The main advantage of genetic engineering and plant breeding approaches for mineral enhancement is that investment is only required at the research and development stage, and thereafter the nutritionally enhanced crops are entirely sustainable. Furthermore, as stated above, mineral rich plants tend to be more vigorous and more tolerant of biotic stress, which means yields are likely to improve in line with mineral content (Frossard *et al*. 2000; Nestel *et al*. 2006). Unlike conventional intervention strategies, genetic engineering and plant breeding are both economically and environmentally sustainable (Stein *et al*. 2008). Although there are no commercial nutritionally enhanced plants derived from either method at the current time, this approach has the greatest long-term cost-effectiveness overall and is likely to have an important impact over the next few decades. Biofortification is also likely to be more accessible than conventional interventions in the long term because it removes hurdles such as the reliance on infrastructure and compliance. Moreover, plants assimilate minerals into organic forms that are naturally bioavailable and contribute to the natural taste and texture of the food. Economic studies have shown many potential health benefits of Biofortification strategies, especially in combination with conventional strategies (Buois 2002; Stein *et al*. 2008).

Molecular breeding

It is **a**lso called Marker Assisted Breeding, this is a powerful tool of modern biotechnology that encounters little cultural or regulatory resistance and has been embraced so far even by organic growers because it relies on biological breeding processes rather than engineered gene insertions to change the DNA of plants. This technique is expanding rapidly with the development of genomics, which is the study of the location and function of genes, and with the rapid decline in costs of screening plant tissue. Once scientists have identified the location of a gene for a desirable trait, they build a probe that attaches itself only to a DNA fragment, a so-called marker, unique to that gene. They then can use this marker as a way to monitor and speed up their efforts to move this trait into relatives of the plant using conventional breeding. For example, since the marker can be detected in the tissue of new seedlings, the presence or absence of the desired trait can be determined without having to wait for a plant to mature, often reducing by years the length of a typical crop development process. If molecular breeding reduces the number of generations required developing a pure line variety by three generations, this can save 3 years of research time. The use of molecular breeding has increased dramatically both by private seed companies and government plant breeders in developed countries, and it is gradually spreading to developing countries (Pray 2006). Using this technique, plant breeders also can stack into one variety several different genes that code for different traits, for example, QPM, disease resistance, and drought tolerance in maize (Pray 2006). This technique has also been used to find recessive traits in plants that cannot be located by conventional breeding or other techniques.

Genetic engineering

Genetic engineering is the latest weapon in the armory against mineral deficiency and uses advanced biotechnology techniques to introduce genes directly into breeding varieties. The genes can come from any source (including animals and microbes) and are designed to achieve one or more of the following goals (Zhu *et al*. 2007):

a) Improve the efficiency with which minerals are mobilized in the soil

b) Reduce the level of antinutritional compounds

c) Increase the level of nutritional enhancer compounds such as inulin

Genetic engineering, or rDNA, is a technique that offers still greater speed and reach because it moves specific genes with desired traits from a source organism-one which does not have to be a related organism-directly into the living DNA of a target organism. The transgenic trait is added without normal biological reproduction, but once in the plant it becomes inheritable through normal reproduction. Scientists first developed this technique in the laboratory in 1973 and have been using it to transform agricultural crop plants since the 1980s. Once a useful gene has been identified (which can require a major research project and many years), it is attached to both marker and promoter genes and then inserted into a plant, usually using a nonviable virus called Agrobacterium as a carrier. GE produces plants that are known as transgenics or less precisely as GMOs. GE has great reach because it can add valuable characteristics that are not currently found in the seeds of individual plant species. GE was necessary for the development of golden rice, which contains the precursor to VA from a daffodil plant. This was a trait missing from rice plants, and it could not be introduced conventionally since daffodils cannot be crossed with rice plants. In addition, GE can take much less time to incorporate desired traits into a crop plant than either traditional or molecular breeding. The choice of which technology to use when biofortifying crops comes down to a calculation by breeders of how to get the best results most quickly, given their budget constraint. Conventional plant breeding requires less investment in labs or highly trained human resources (molecular biologists) than either marker-assisted selection or genetic engineering, and it faces lower and less costly regulatory hurdles. However, if there are no genes for the VA precursors in the genome of a crop (as one example), no amount of conventional plant breeding can put them there, and scientists must turn to GE. Molecular breeding and GE also have advantages over traditional breeding because they make it easier to develop crops with multiple desired nutritional traits, maintain agronomic viability of biofortified crops, adapt agriculture improvements arising in the United States for obscure crops in developing countries, etc.

Fighting vitamin a deficiency

Vitamin A deficiency, particularly prevalent among children in Africa and Southeast Asia, causes irreversible blindness, and increased susceptibility to disease and mortality. Rice plants produce β-carotene (provitamin A) in green tissues, but not in the seeds. A public-private partnership to produce rice varieties rich in provitamin A culminated in the development of Golden Rice, in which two genes were introduced by genetic engineering.

Golden rice

Golden rice is a variety of rice (*Oryza sativa*) produced through genetic engineering to biosynthesize beta-carotene, a precursor of vitamin A, in the edible parts of rice. It is intended to produce a fortified food to be grown and consumed in areas with a shortage of dietary vitamin A, a deficiency which each year is estimated to kill 670,000 children under the age of 5 [3] and cause an additional 500,000 cases of irreversible childhood blindness. Rice is a staple food crop for over half of the world's population, making up 30–72% of the energy intake for people in Asian countries, making it an excellent crop for targeting vitamin deficiencies.

Golden rice differs from its parental strain by the addition of three beta-carotene biosynthesis genes. The parental strain can naturally produce beta-carotene in its leaves, where it is involved in photosynthesis. However, the plant does not normally produce the pigment in the endosperm, where photosynthesis does not occur. Golden rice has met significant opposition from environmental and anti-globalization activists that claim that there are sustainable, long-lasting and more efficient ways to solve vitamin A deficiency that do not compromise food, nutrition and financial security, as they claim golden rice does. A study in the Philippines is aimed to evaluate the performance of golden rice, if it can be planted, grown and harvested like other rice varieties, and whether golden rice poses risk to human health. There has been little research on how well the beta-carotene will hold up when stored for long periods between harvest seasons, or when cooked using traditional methods.

In 2005, Golden Rice 2 was announced, which produces up to 23 times more beta-carotene than the original golden rice. To receive the USDA's Recommended Dietary Allowance (RDA), it is estimated that 144 g/day of the high-yielding strain would have to be eaten. Bioavailability of the carotene from golden rice has been confirmed and found to be an effective source of vitamin A for humans. Golden Rice was one of the seven winners of the 2015 Patents for Humanity Awards by the United States Patent and Trademark Office. In 2018 came the first approvals as food in Australia, New Zealand, Canada and the USA.

Golden rice (right) compared to white rice (left)

Biofortification for increased protein content

Human cells can produce only 10 out of the 20 amino acids, the building blocks of proteins, and so the missing essential amino acids must be supplied in the food. As the body cannot store excess amino acids, their intake must be daily. In many poor developing countries, the daily intake of essential amino acids is often not sufficient due to the scarcity of high-protein sources such as meat, fish, or soybean. Rice, cassava and potato are important sources of carbohydrates, but they are low in protein content. Suitable protein candidates for Biofortification include the storage protein Sporamin A from sweet potato, the seed albumin AmA1 protein from Prince’s Feather (*Amaranthus hypochondriacus*), and ASP1, an artificial storage protein rich in essential amino acids. ASP1 has been introduced and expressed successfully in rice and cassava, and efforts are under way to optimize expression and increase the level of protein accumulation in transgenic plants.

Iron-rich crops against anemia

Iron deficiency anemia affects more than 2 billion people in virtually all countries, which makes iron deficiency by far the most common micronutrient deficiency worldwide. Iron is found in vegetables, grains, and red meat. However, the bioavailability of iron in plants is low, and in rice, the problem is aggravated by the presence of phytate, a potent inhibitor of iron resorption, and by the lack of iron resorption-enhancing factors. Expression of the iron storage protein ferritin from French bean and soybean in the endosperm of rice results in a 3-fold increase of iron in seeds. In order to decrease the level of phytate, an enzyme that degrades it (known as phytase) has also been transformed into rice, and efforts are currently under way to optimize the construct. Finally, over-expression of a cysteine-rich protein that transports metals in rice can improve the rate of iron resorption during digestion.

Increased folic acid in tomato

Folic acid deficiency is a global health problem that affects mainly, though not exclusively, women over the age of 30, and it is the main cause of anemia in at least 10 million pregnant women in developing countries. In food, most of the folic acid occurs as folate. In order to engineer tomatoes with higher level of folate, scientists have over-expressed in the fruit the genes encoding the enzymes catalyzing the synthesis of two folate precursors (Díaz de la Garza *et al*., 2007). In plants were both traits were combined by crossing, vine-ripened transgenic fruit accumulated up to 25 times more folate than controls.

Biofortification: strategic advantages

The Biofortification strategy seeks to take advantage of the consistent daily consumption of large amounts of food staples by all family members, including women and children who are most at risk for micronutrient malnutrition. As a consequence of the predominance of food staples in the diets of the poor, this strategy implicitly targets low-income households. After the one-time investment is made to develop seeds that fortify themselves, recurrent costs are low and germplasm may be shared internationally. It is this multiplier aspect of plant breeding across time and distance that makes it so cost-effective. Once in place, the biofortified crop system is highly sustainable. Nutritionally improved varieties will continue to be grown and consumed year after year, even if government attention and international funding for micronutrient issues fade. Moreover, biofortification provides a truly feasible means of reaching malnourished populations in relatively remote rural areas, delivering naturally fortified foods to people with limited access to commercially marketed fortified foods, which are more readily available in urban areas. Biofortification and commercial fortification, therefore, are highly complementary. Breeding for higher trace mineral density in seeds will not incur a yield penalty. In fact, biofortification may have important spin-off effects for increasing farm productivity in developing countries in an environmentally beneficial way. Mineral packed seeds sell themselves to farmers because, as recent research developments proved that seeds rich in trace elements are stronger to resist against biotic and abiotic stresses including diseases and environmental stresses (Bouis 2003). Further, fortified or enriched seeds also have more plant vigour, seedling survival, faster initial emergence and grain yield.

Future challenges

- Produce crops for human nutrition with increased iron concentration. Biofortification strategies alternative to reduction in concentration of phytic acid or polyphenols should be explored further, in order to increase iron absorption without loss of their beneficial effects. When overexpressing ferritin, such crops should be tested for concentration of various heavy metals, in laboratory as in open-field trials, before releasing to the public. Detailed knowledge on mechanisms regulating iron compartmentalization in various plant organs will offer a major contribution for reaching such goal
- Expand research on prebiotics and iron absorption. Crops biofortified with prebiotics have the potential to partially circumvent the "iron paradox" caused by host-pathogen competition for iron, by favoring amelioration of gut health and gut-associated immune defense
- Promote initiatives supporting large-scale prospective studies on the effects of iron biofortified crops on effectiveness of the adopted biofortification strategy in relieving iron deficiency anemia and in improving general health
- Improve the efficiency with which minerals are mobilized in the soil
- Improve the efficiency with which minerals are taken up from the soil into the roots of the plant
- Improve the transport of minerals from the roots to storage tissues, such as grain
- Increase the capacity of storage tissues to accumulate minerals in a form that does not impair plant vegetative growth and development, but remains bioavailable for humans
- Reduce the level of antinutritional compounds such as phytic acid, which inhibit the absorption of minerals in the gut

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Chapter - 8
Bioinformatics and Its Applications in Crop Improvement

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Chapter - 8

Bioinformatics and Its Applications in Crop Improvement

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Abstract

Bioinformatics is a rapidly developing branch of science and is highly interdisciplinary, using concepts and techniques from informatics, mathematics, statistics, biology, chemistry, biochemistry, physics, and linguistics. Bioinformatics application is in information technology to manage biological data that helps in plant genomes study. Biological research that earlier used to start in laboratories, fields and plant clinics is now starts at the computational level using computers (In-silico) for analysis of the data, experiment planning and hypothesis development. Bioinformatics database and tools have various application in biological research enables storage, retrieval, analysis, annotation and visualization of results to promotes and better understanding of biological system. This will help in crop improvement and plant disease diagnosis to improve the quality of Plant.

Keywords: bioinformatics, genomics, agriculture, crop improvement and biotic stress

Introduction

Bioinformatics is defined as the study of information content and its flow in biological systems. It is an interdisciplinary branch of the science composed of biology, mathematics and computer science. According to the National Centre for Biotechnology Information (NCBI), “bioinformatics is the research development or application of computational tools and approaches for expanding the use of biological, medical, plant data base for acquire, store, organize, archive, analyze or visualize such data”. Although bioinformatics is a new field of science but it is making progress in every field of biotechnology. Bioinformatics common activities includes, mapping, aligning different DNA, protein sequences, creating and viewing 3-D models of protein structures (Nilges and Linge, 2009). The purpose of bioinformatics is to understand the genetic and molecular basis of all biological processes in plants that are relevant to the specie. Bioinformatics and functional genomics should lead to a greater understanding of the genetic networks that are activated during plant responses to pathogens and virulence. (Koltai and Volpin, 2003).

Bioinformatics tools are required for the scientific discoveries made in genomics. Phylogenetics Analysis, Gene Expression Analysis and Comparing Genomes are specialized topics in the genomics field. Bioinformatics is gaining increasing importance in life science especially in the field of molecular biology and plant genetic resourced. Main points related to bioinformatics are given below:

1. It is the interface between computer and biology. In other words, it is the application of information technology in the study of biology
2. It utilizes information science for the study of biology
3. It is used for computer based analysis of biomolecular data specially large scale data set derived from genome sequencing
4. It is used for analysis of data related to genomics, proteomics, metabolomics and other biological aspects
5. It has wide application in handling data related to plant genetic resources

Branches of bioinformatics

Bioinformatics is broadly divided into two groups, viz., animal bioinformatics and plants bioinformatics.

1. **Animal bioinformatics:** It deals with computer aided study of genomics, proteomics and metabolomics in various animal species. It includes study of gene mapping, gene sequencing, animal breeds, animal genetic resources etc. It can be further divided as bioinformatics of mammals, reptiles, birds, fishes etc.
2. **Plant bioinformatics:** It deals with computer aided study of plant species. It includes gene mapping, gene sequencing, plant genetic resources data base etc.

It can be further divided into following branches-

1. **Agriculture bioinformatics:** It deals with computer based study of various agricultural crop species It is also referred to as crop bioinformatics
2. **Horticultural bioinformatics:** It refers to computer aided study of horticultural crops, viz., fruit crops, vegetable crops and flower crops

3. **Medicinal plants bioinformatics:** It deals with computer based study of various medicinal plant species
4. **Forest plant bioinformatics:** It deals with computer based study of forest plant species

Computer programs used for study of biology

Computers refer to electronic devices which can input, store and manipulate data and output information in a desired form. Now various types of computers such as micro-computer, mini-computer, mainframe computer, super computer, laptop computer and palmtop computers are available which can be used for multiple purposes.

Various computer programmes are used for the study of biological problems. Such programmes include Microsoft word (M.S word), Microsoft excel (MS Excel) and Microsoft power point (MS Power point). A brief description of these programmes is presented below:

a) **MS Word:** It is a very useful programmes for preparation of project reports, annual reports, writing research papers, varietal information system, plant genetic resources data base, etc.

b) **MS Excel:** It is useful computer programme for various types of statistical and biometrical analysis. It can also be used for graphical and diagrammatic display of experimental results

c) **MS Power Point:** It is widely used for preparation of slides and presentation of results in various scientific meetings

Selected internet resources for plant bioinformatics (Kushwaha, *et al.*, 2017)

1. Arabidopsis Genome Initiative (AGI) http://ge no me-www.stanford.edu/Arabidopsis/AGI
2. Arabidopsis Genome Data Analysis, Cold Spring Harbor Laboratory http://nucleus.cshl.org/protarab
3. Plant Genome and Information Center, USDA http://www.nal.usda.gov/pgdic
4. UK Crop Plant Bioinformatics Network http:// synteny.nott.ac.uk/agr/agr.html
5. The Institute for Genomic Research (TIGR) Database http://www.tigr.org
6. Arabidopsis Genome Center at the University of Pennsylvania http://genome.bio.upenn.edu/ATGCUP.html

7. The Genome Sequencing Center of Washington University in St Louis http://genome.wustl.edu/gsc
8. Grain Genes Database http://wheat.pw.usda.govMaize Genome Database http://www.agron.missouri.edu
9. Arabidopsis Internal Coding Exon Finder http://clio.cshl.org/genefinder/ARAB/arab.htm
10. Net Plant Gene V2.0 Web Prediction Server http://www.cbs.dtu.dk/NetPlantGene.html

Table 1: Landmarks in the History of Bioinformatics

Year	Scientist name and discovery
1665	Robert Hooke published Micrographia, described the cellular structure of cork. He also described microscopic examinations of fossilized plants and animals, comparing their microscopic structure to that of the living organisms they resembled.
1683	Anton van Leeuwenhoek discovered bacteria.
1686	John Ray, John Ray's in his book "Historia Plantarum" catalogued and described 18,600 kinds of plants. His book gave the first definition of species based upon common descent.
1843	Richard Owen elaborated the distinction of homology and analogy.
1864	Ernst Haeckel (Häckel) outlined the essential elements of modern zoological classification.
1865	Gregor Mendel (1823-1884), Austria, established the theory of genetic inheritance.
1902	The chromosome theory of heredity is proposed by Sutton and Boveri, working independently.
1962	Pauling's theory of molecular evolution
1905	The word "genetics" is coined by William Bateson.
1913	First ever linkage map created by Columbia undergraduate Alfred Sturtevant (working with T.H. Morgan).
1930	Tiselius, Uppsala University, Sweden, A new technique, electrophoresis, is introduced by Tiselius for separating proteins in solution. "The moving-boundary method of studying the electrophoresis of proteins" (published in *Nova Acta Regiae Societatis Scientiarum Upsaliensis*, Ser. IV, Vol. 7, No. 4)
1946	Genetic material can be transferred laterally between bacterial cells, as shown by Lederberg and Tatum.
1952	Alfred Day Hershey and Martha Chase proved that the DNA alone carries genetic information. This was proved on the basis of their bacteriophage research.
1961	Sidney Brenner, François Jacob, Matthew Meselson, identify messenger RNA,
1965	Margaret Dayhoff's Atlas of Protein Sequences
1970	Needleman-Wunch algorithm

1977	DNA sequencing and software to analyze it (Staden)
1981	Smith-Waterman algorithm developed
1981	The concept of a sequence motif (Doolittle)
1982	GenBank Release 3 made public
1982	Phage lambda genome sequenced
1983	Sequence database searching algorithm (Wilbur-Lipman)
1985	FASTP/FASTN: fast sequence similarity searching
1988	National Center for Biotechnology Information (NCBI) created at NIH/NLM
1988	EMBnet network for database distribution
1990	BLAST: fast sequence similarity searching
1991	EST: expressed sequence tag sequencing
1993	Sanger Centre, Hinxton, UK
1994	EMBL European Bioinformatics Institute, Hinxton, UK
1995	First bacterial genomes completely sequenced
1996	Yeast genome completely sequenced
1997	PSI-BLAST
1998	Worm (multicellular) genome completely sequenced
1999	Fly genome completely sequenced
2000	Jeong H, Tombor B, Albert R, Oltvai ZN, Barabasi AL. The large-scale organization of metabolic networks. Nature 2000 Oct 5;407(6804):651-4
2000	The genome for *Pseudomonas aeruginosa* (6.3Mbp) is published.
2000	The A. thaliana genome (100 Mb) is sequenced.
2001	The human genome (3 Giga base pairs) is published.
2002	A team of Scientists Sequenced Rice genome under international rice Genome sequencing Project
2005	Syngenta, Rice, A new variety called Golden Rice 2 was announced which produces up to 23 times more beta-carotene than the original variety of golden rice.
2006	Tuskan, *et al*., Poplar, Sequenced genome of Poplar (populous tricarpa).
2007	Jaillon, *et al*., Grapes, Sequenced genome of Grapes (Vitis vinifera)
2007	Jaillon, *et al*., Papaya, Sequenced genome of Papaya (Carica papaya).
2008	Ming, *et al*., Apple, Sequenced genome of Apple malus domestica
2008	Sato, *et al*., Lotus, Sequenced genome of Lotus (Lotus Japonicas)
2009	Schnable, P. *et al*., Maize, Sequenced genome of Corn (Zea mays).
2009	Paterson, A. *et al*., Sorghum, Sequenced genome of Sorghum (Sorghum bicolor)
2009	Haung *et al*., Cucumber, Sequenced genome of Cucumber (Cucumis sativa)
2010	Schmutz, *et al*., Soybean, Sequenced genome of Soybean (Glycine max)
2010	AP Chan, *et al*., Caster bean Sequenced genome of Caster bean (Ricinus communis).

2010	Vogel, J *et al*., Brachypodium, Sequenced genome of Brachypodium
2010	Reccardo Velasco, *et al*., Peaches, Sequenced genome of Peaches (Prunus persica).
2010	Eman K Al-Dous *et al*., Date palm Sequenced genome of Date palm (Phoenix dactylifera).
2011	Varshney, *et al*., Pigeon pea Sequenced genome of Potato (Solanum tuberosum)
2011	PGS Consortium, Potato Sequenced genome of Potato (Solanum tuberosum).
2011	Harm van Bakel, *et al*., Cannabis Sequenced genome of Cannabis (Cannabis sativa)
2011	Bernd Weisshaar, *et al*., Sugar beet Sequenced genome of Sugar beet (Beeta vulgaris).
2011	Tina T. Hu, *et al*., Arabidopsis, Sequenced genome of Arabidopsis lyrata
2011	Wang, *et al*. Mustard, Sequenced genome of Mustard (Brassica rapa).
2012	Angelique D'Hont, *et al*., Banana Sequenced genome of Banana (Musa acuminate).
2012	Zheng G, *et al*., Foxtail Millet. Sequenced genome of Foxtail Millet (Setaria italic).
2012	Tomato Genome Consortium, Tomato Sequenced genome of Tomato (Solanum lycopersicum)
2012	Angelique D'Hont, *et al*., Banana Sequenced genome of Banana (Musa acuminate).
2012	Garci- Mas J., *et al*., Melon Sequenced genome of Melon (Cucumis melo).
2012	Wang, *et al*., Flax. Sequenced genome of Flax (Linum usitatissimum).
2012	Kunbo Wang, *et al*., Cotton Sequenced genome of Cotton (Gossypium raimondii).
2012	Angelique D'Hont *et al*., Sweet Orange, Sequenced genome of Sweet Orange (Citrus sinensis).
2012	Wang & Jhou, Clementine Orange, Sequenced genome of Clementine Orange (Citrus Clementina).
2016	Scott A. Jackson, Rice: The First Crop Genome
2017	*Cocos nucifera* (Coconut palm) Xiao Y, Xu P, Fan H, Baudouin L, Xia W, Bocs S, *et al*. (November 2017). "The genome draft of coconut (*Cocos nucifera*)". *Giga science*. 6(11):1-11.
2018	*Lablab purpureus* (Hyacinth Bean) Chang Y, Liu H, Liu M, Liao X, Sahu SK, Fu Y, *et al*. (March 2019). "The draft genomes of five agriculturally important African orphan crops". Giga Science. 8 (3).
2019	*Castanea mollissima* (Chinese chestnut) Xing Y, Liu Y, Zhang Q, Nie X, Sun Y, Zhang Z, *et al*. (September 2019). "Hybrid de novo genome assembly of Chinese chestnut (Castanea mollissima)". Giga Science. 8 (9)

2019	*Acer yangbiense*, Yang J, Wariss HM, Tao L, Zhang R, Yun Q, Hollingsworth P, *et al*. (July 2019). "De novo genome assembly of the endangered Acer yangbiense, a plant species with extremely small populations endemic to Yunnan Province, China". Giga Science. 8 (7).
2019	*Solanum aethiopicum* (Ethiopian eggplant) Song B, Song Y, Fu Y, Kizito EB, Kamenya SN, Kabod PN, *et al*. (2019-10-01). "Draft genome sequence of Solanum aethiopicum provides insights into disease resistance, drought tolerance, and the evolution of the genome". *Giga Science*. 8(10).

Biological database

A database is a collection of information that is organized so that it can easily be accessed, managed, and updated. Database consists of basic units called records or entries. Each record consists of fields, which hold pre-defined data related to the record. For example, a protein database would have protein entries as records and protein properties as fields (e.g., name of protein, length, amino-acid sequence).

A biological database is a large, organized body of persistent data, usually associated with computerized software designed to update, query, and retrieve components of the data stored within the system. A simple database might be a single file containing many records, each of which includes the same set of information. For example, a record associated with a nucleotide sequence database typically contains information such as contact name; the input sequence with a description of the type of molecule; the scientific name of the source organism from which it was isolated; and, often, literature citations associated with the sequence. In one view, databases can be classified according to types of content: bibliographic, full-text, numeric, and images. Biological databases are stores of biological information.

Currently, a lot of bioinformatics work is concerned with the technology of databases. These databases include both "public" repositories of gene data like Gen Bank or the Protein Data Bank (the PDB), and private databases like those used by research groups involved in gene mapping projects or those held by biotech companies. A few popular databases are Gen Bank from NCBI (National Center for Biotechnology Information), Swiss Prot from the Swiss Institute of Bioinformatics and PIR from the Protein Information Resource.

Primary and secondary database

Primary databases

Primary databases consisting of data derived experimentally such as nucleotide sequences and three dimensional structures are known as primary databases. Primary Databases International Nucleotide Sequence Database (INSD) consists of the following databases.

1. DNA Data Bank of Japan (National Institute of Genetics)
2. EMBL (European Bioinformatics Institute)
3. Gen Bank (National Center for Biotechnology Information)

The three databases, DDBJ (Japan), Gen Bank (USA) and European Nucleotide Archive (Europe), are repositories for nucleotide sequence data from all organisms. All three databases accept nucleotide sequence submissions, and then exchange new and updated data on a daily basis to achieve optimal synchronisation between them. These three databases are primary databases, as they house original sequence data.

Secondary databases

Those data that are derived from the analysis or treatment of primary data such as secondary structures, hydrophobicity plots, and domain are stored in secondary databases.

- Inter Pro (protein families, motifs and domains)
- UniProt Knowledgebase (sequence and functional information on proteins)
- Ensembl (variation, function, regulation and more layered onto whole genome sequences)

Genome databases

These databases collect genome sequences, annotate and analyze them, and provide public access. Some add curation of experimental literature to improve computed annotations. These databases may hold many species genomes, or a single model organism genome.

1. Bioinformatic Harvester
2. Gene Disease Database
3. SN Pedia
4. CAMERA Resource for microbial genomics and metagenomics
5. Corn, the Maize Genetics and Genomics Database

6. Eco Cyc a database that describes the genome and the biochemical machinery of the model organism *E. coli K-12*
7. Ensembl provides automatic annotation databases for human, mouse, other vertebrate and eukaryote genomes

RNA databases

1. C-It-Loci [6]-A database of RNA expression and conserved loci for studying lncRNAs across species
2. LncRNAWiki, a wiki-based database for community curation of known human long non-coding RNAs
3. Rfam, a database of RNA families
4. miRBase, the microRNA database
5. snoRNAdb, a database of snoRNAs
6. lncRNAdb, a database of lncRNAs

Protein sequence databases

1. Uni Prot Universal Pesource (EBI, Swiss Institute of Bioinformatics, PIR)
2. Protein Information Resource (Georgetown University Medical Center (GUMC))
3. Swiss-Prot Protein Knowledgebase (Swiss Institute of Bioinformatics)
4. PEDANT Protein Extraction, Description and Analysis Tool (Forschungszentrum f. Umwelt & Gesundheit)
5. PROSITE Database of Protein Families and Domains
6. Database of Interacting Proteins (Univ. of California)
7. Pfam Protein families database of alignments and HMMs (Sanger Institute)
8. PRINTS a compendium of protein fingerprints from (Manchester University)
9. Pro Dom Comprehensive set of Protein Domain Families (INRA/CNRS)

Bioinformatics-programs and tools

Bioinformatic tools are software programs that are designed for extracting the meaningful information from the mass of data and to carry out this analysis step.

Major categories of bioinformatics tools: There are data-mining software that retrieves data from genomic sequence databases and also visualization tools to analyze and retrieve information from proteomic databases. These can be classified as homology and similarity tools, protein functional analysis tools, sequence analysis tools and miscellaneous tools.

BLAST

BLAST (Basic Local Alignment Search Tool) comes under the category of homology and similarity tools. It is a set of search programs designed for the Windows platform and is used to perform fast similarity searches regardless of whether the query is for protein or DNA. Comparison of nucleotide sequences in a database can be performed. Also a protein database can be searched to find a match against the queried protein sequence. NCBI has also introduced the new queuing system to BLAST (Q BLAST) that allows users to retrieve results at their convenience and format their results multiple times with different formatting options.

Depending on the type of sequences to compare, there are different programs:

- BLASTp compares an amino acid query sequence against a protein sequence database
- BLASTn compares a nucleotide query sequence against a nucleotide sequence database
- BLASTx compares a nucleotide query sequence translated in all reading frames against a protein sequence database
- tBLASTn compares a protein query sequence against a nucleotide sequence database dynamically translated in all reading frames
- tBLASTx compares the six-frame translations of a nucleotide query sequence against the six-frame translations of a nucleotide sequence database

FASTA

FAST homology search all sequences. An alignment program for protein sequences created by Pearsin and Lipman in 1988. The program is one of the many heuristic algorithms proposed to speed up sequence comparison. The basic idea is to add a fast pre-screen step to locate the highly matching segments between two sequences, and then extend these matching segments to local alignments using more rigorous algorithms such as Smith-Waterman.

EMBOSS

EMBOSS (European Molecular Biology Open Software Suite) is a software-analysis package. It can work with data in a range of formats and also retrieve sequence data transparently from the Web. Extensive libraries are also provided with this package, allowing other scientists to release their software as open source. It provides a set of sequence-analysis programs, and also supports all UNIX platforms.

CLUSTALW

It is a fully automated sequence alignment tool for DNA and protein sequences. It returns the best match over a total length of input sequences, be it a protein or a nucleic acid.

RasMol

It is a powerful research tool to display the structure of DNA, proteins, and smaller molecules. Protein Explorer, a derivative of RasMol, is an easier to use program.

PROSPECT

PROSPECT (Protein Structure Prediction and Evaluation Computer Tool Kit) is a protein-structure prediction system that employs a computational technique called protein threading to construct a protein's 3-D model.

Pattern hunter

Pattern Hunter, based on Java, can identify all approximate repeats in a complete genome in a short time using little memory on a desktop computer. Its features are its advanced patented algorithm and data structures, and the java language used to create it. The Java language version of Pattern Hunter is just 40 KB, only 1% the size of Blast, while offering a large portion of its functionality.

Applications in crop improvement

Bioinformatics has wide practical applications in genetics and plant breeding. Some important applications of bioinformatics in plant breeding and genetics are listed below:

1. **Varietal information system:** Bioinformatics has useful application in developing varietal information system. Variety refers to a genotype which has been released for commercial cultivation (by state variety release committee or central variety

release committee) and notified by the government of India. Various types of Varieties are used in plant breeding. All such terms are defined below;

Various types of varieties

S. No.	Type of variety	Definition/brief description
1.	Primitive cultivars	Varieties which were selected and cultivated by farmers for many generations; also known as landraces.
2.	Obsolete cultivars	Improved varieties of the recent past are known as absolete cultivars
3.	Modern cultivars	Currently cultivated high yielding varieties are known as modern cultivars
4.	Popular variety	A widely grown cultivar is referred to as popular variety
5.	Commercial cultivar	A variety which is used for cultivation on large area.
6.	Check variety	A variety which is used for comparing the performance of strains in breeding experiments is called check variety
7.	Example variety	In DUS testing, a variety which is used for comparing trait.
8.	Reference variety	All released and notified extant varieties of common knowledge which are under seed multiplication chain. It includes global collection of released varieties.
9.	Candidate variety	A variety which is tobe protected under plant variety protection Act is called candidate variety
10.	Extant variety	All released and notified varieties which have not been protected under plant variety protection Act are called extant varieties. In includes four types of material, viz. Notified varieties, Private sector varieties, Varieties of common knowledge and farmer’s varieties.
11.	Public Sector variety	Varieties developed and released by government organizations are known as public sector varieties.
12.	Private Varieties	Varieties developed by private seed companies are called private varieties
13.	Farmers varieties	Varieties developed by farmers and used for cultivation are known as farmers varieties
14.	Exotic varieties	A foreign variety which is directly recommended for commercial cultivation

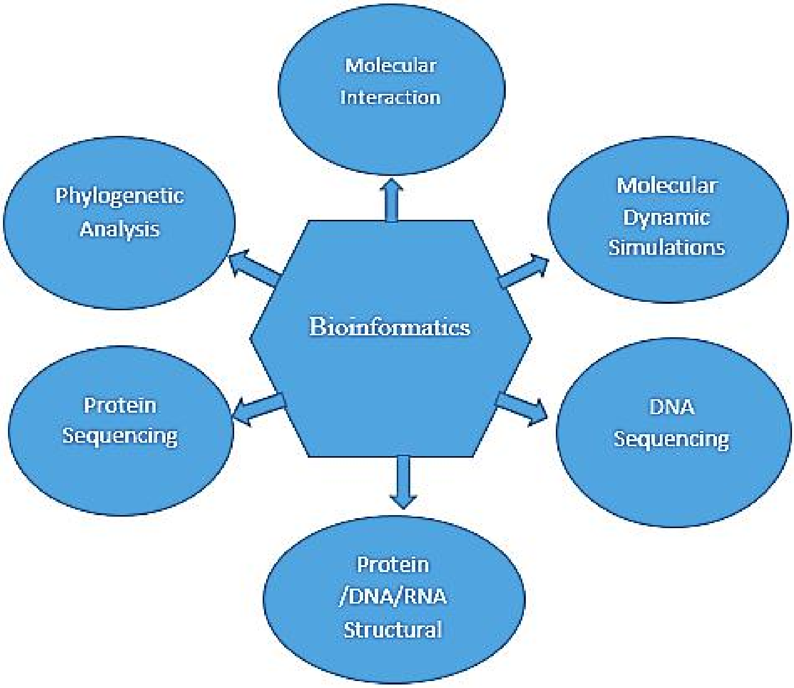

Fig 1: Application of bioinformatics

The detailed information about various types of varieties can be developed using highly heritable characters. Such information can be used in various ways as given below:

a) In Distinctness Uniformity and Stability (DUS) testing for varietal identification

b) In grouping of varieties on the basis of various highly heritable characters

c) In sorting out of cultivars for use in pre-breeding and traditional breeding

The information can be stored in the computer memory and be retrieved as and when required.

1. PGR data base

Genetic material of plant which of value as resource for present and future generations of people is referred to as plant genetic resources. It is also known as gene pool, genetic stock and germplasm. The germplasm is evaluated for several characters such as highly heritable morphological and other characters as given below:

a) Highly heritable morphological traits

b) Yield contributing traits

c) Quality characters

d) Resistance to biotic and abiotic stresses

e) Characters of agronomic value

International plant genetic resources institution (IPGRI), Rome, Italy has developed descriptors and descriptor states for various crop plants. Such descriptors help in uniform recording of observations on germplasm of crop plants throughout the world. Thus huge data is collected on crop germplasm for several years. Bioinformatics plays an important role in systematic management of this huge data. Bioinformatics is useful in handling of such data in several ways as follows:

a) It maintains the data of several locations and several years in a systematic way

b) It permits addition, deletion and updating of information

c) It helps in storage and retrieval of data

d) It also helps in classification of PGR data based on various criteria

e) It helps in retrieval of data belonging to specific group such as early maturity, late maturity, dwarf types, tall types, resistant to biotic stresses, resistant to abiotic stresses, genotypes with superior quality, genotypes with marker genes, etc.

All such data can be easily managed by computer aided programmes and can be manipulated to get meaningful results.

2. Studies on genome

Genome refers to the basic set of chromosome. In a genome each type of chromosome is represented only once. The study of structure and function of entire genome of an organism is referred to as genomics. It is being developed as a sub discipline of genetics which is devoted to the mapping sequencing and functional analysis of genomes. The word genomics was coined by Thomas Roderick in 1986.

The discipline of genomics consists of two groups, viz.

a) Structural genomics

b) Functional genomics

These are defined as follows

a) **Structural genomics:** It deals with the study of the structure of entire genome of an organism. In other words, it deals with the study of the genetic structure of each chromosome of the basic set of chromosome i.e. genome.

b) **Functional genomics:** It deals with the study of genome function. It deals with transcriptome and proteome. Transcriptome refers to complete set of RNAs transcribed from a genome and proteome refers to complete set of proteins encoded by a genome.

There are three methods of gene mapping, viz.

a) Recombination mapping
b) Deletion mapping
c) Molecular mapping

The last method is widely being used for gene mapping these days. It is computer aided method which is useful in genome mapping. It has been used for genome mapping in various crop plants such as Arabidopsis, rice and maize. It is a rapid and accurate method of gene mapping. Now computer aided genome mapping, sequencing and functional analysis studies are being carried out with almost all important field crops. Computer aided programmes have made such studies very simple.

3. Studies on proteomics

Proteomics refers to the study of structures and functions of all proteins in an individual. In other words, it deals with the study of entire protein expression in an organism Proteomics is of two types, viz.

a) Structural proteomics
b) Functional proteomics

These are defined below:

a) **Structural genomics:** It refers to the study of the structures of all proteins found in a living organism

b) **Functional proteomics:** It deals with functions of all proteins found in a living organism

In fact, proteomics is a new sub-discipline of functional genomics. It is the study of proteomes which refer to complete set of proteins encoded by a genome. A variety of techniques are used for the study of proteomes. Now computer aided programmes are available for the study of proteomics.

4. Studies on metabolomics

Metabolomics refers to the study of all metabolic pathways in a living organism. In other words, it is the computer aided information of all metabolic pathways of a living organism.

Main points related to metabolomics are listed below:

a) It deals with study of all metabolic pathways in a living organism

b) It is computer based information about metabolic pathways in a living organism

c) It helps in identification and correction of metabolic disorders in an organism

d) It helps in selection of individuals with normal metabolic pathways

e) It helps in early detection of genetic disorders associated with metabolic pathways

5. Modelling of plants

Bioinformatics, plays an important role in modelling of crop plants. Such computer aided studies have already been made in field pea and several other field crops. First the plant model is conceptualized using various plant traits and then efforts are made to develop such model by using appropriate breeding procedures. For example, in cotton following characters can be used for developing conceptual plant model.

a) Maturity duration 160 days

b) Plant height 150cm

c) Number of monopodia 2

d) Length of symbodia 50cm

e) Number of symbodia 20

f) Boll weight 4g

g) Ginning percent 38

h) Fibre length 28mm

i) Leaf: small and thick

j) Plant surface-hairy

First donor sources for these traits are identified from the available germplasm. Then efforts are made to combine these traits in one genotype particularly in a popular variety. Such computer based studies help in developing plant ideotype suitable for machine picking and use in multiple cropping system.

6. Pedigree analysis

Computer aided studies are useful in pedigree analysis of various cultivars and hybrids. Information about the percentage of cultivars and hybrids is entered into the computer memory which can be retrieved any time. The list of parents that are common in the pedigree of various cultivars and hybrids can be sorted out easily. It helps in the pedigree analysis which in turn can be used in planning plant breeding programmes especially in the selection of parents for use in hybridization programmes. Through study of protein structures, it helps in pedigree analysis.

7. Biometrical analysis

In plant breeding and genetics, various types of biometrical analysis such as correlation, path coefficient, discriminant function, diallel, partial diallel, triallel, quadriallel, generation means, line × tester, triple test cross, stability parameters, D^2 statistics, metrogyl path etc. are carried out. Computer aided programmes are very much useful in carrying out such biometrical analyses. The information obtained from such biometrical analysis is used in better planning of plant breeding programmes for achieving specific goal.

8. Forecasting models

Computer aided programmes have wide applications in developing various types of forecasting models especially useful for predicting crop production and productivity and in forecasting incidence of insects and diseases in crop-plants. Weather parameters are used in making such predictions. Computer aided remote sensing techniques are used for such prediction.

9. Plant disease management

Genomic studies focused on whole genome analysis, have opened up a new era for biology in general and for agriculture in particular. Along with the use of genetic plant models and the progress in sequencing agriculturally important organisms, the combination of bioinformatics and functional genomics globally enhance agricultural genomics. These studies are likely to pave the way towards better understanding of plant-pathogen biological network, and eventually to lead to break thoughts in promotion of plant resistance to pests (Koltai and Volpin, 2003). Bioinformatics plays a great role in plant disease management.

10. Other applications

Besides agricultural applications, bioinformatics have several other useful applications.

Such applications include use of bioinformatics in

a) Medical science
b) Forensic science
c) Pharmaceutical and biotech industry

In medical science, computer aided studies are useful in detection of genetic diseases at an early stage of life. It can help in cure of genetic diseases in some cases. The pedigree analysis helps in advising future parents to prevent certain genetic diseases. In forensic science, bioinformatics is useful in settling disputed cases of children and detecting criminal cases. In pharmaceutical industry, computer aided programmes help in detection various metabolic pathways involved in the production of a medicine. Computational approaches are useful tools to interpret and guide experiments to expedite the antibiotic drug design process. Structure based drug design (SBDD) and ligand based drug design (LBDD) are the two general types of computer-aided drug design (CADD) approaches in existence (Hoque *et al*., 2017). Thus it can help in mass production of such chemicals.

Advantages of bioinformatics

Bioinformatics has several practical applications in genetics and plant breeding as discussed above. Its main advantages in crop improvement are given below:

1. It provides systematic information about genomics, proteomics and metabolomics of living organisms. This information is useful in planning various breeding and genetical programmes.
2. It helps in finding evolutionary relationship between two species. Studies of nucleotide X and protein sequences help in such matter. The closely related organisms have similar sequences and distantly related organisms have dissimilar sequences. The time of divergence between two species can also be estimated from such studies. Thus bioinformatics helps in the study of evolutionary biology. It helps in drawing phylogenic trees (trees of relatedness).
3. Rapid method: It is a rapid method of gene mapping and sequencing. Earlier methods of gene mapping were time consuming

and painstaking. Bioinformatics has made this task very simple. Now gene hunting has become faster, cheaper and systematic.

4. Identification of similar genes: Computer aided studies help in identification of similar genes in two species. For example, genes similar for biotic and abiotic stresses in two species can be easily detected.
5. High Accuracy: The computer based information has very high level of accuracy and is highly reliable
6. Bioinformatics has led to advances in understanding basic biological processes which in turn have helped in diagnosis, treatment and prevention of many genetic diseases.
7. It is has become possible to reconstruct genes from expressed sequence tags (EST). The EST is nothing but short pieces of genes which can express.
8. Computer aided programmes have made it possible to group proteins into families based on their relatedness.
9. Computer aided programmes are useful in designing primers for PCR reaction. Such primers can be designed with little efforts. Such primers are used to sequence unknown genes or genes of interest. The effective design of primers for methylation-sensitive high-resolution melting, this tool was supported by in silico evaluation. Users requiring visual construct primers can now spend less time in primer design using BiCVisualizer tool (Hernan *et al*., 2019).
10. In life science, computer aided programmes are useful in storing, organizing and indexing huge data bases.

Limitations

Computer based programmes have helped in better understanding of various processes of life science. However, there are some limitations of bioinformatics which are listed below:

1. Bioinformatics requires sophisticated laboratory of molecular biology for in depth study of biomolecules. Establishment of such Laboratories requires lot of funds
2. Computer based study of life science requires some training about various computer programmes applicable for the study of different processes of life science. Thus special training is required for handling of computer based biological data

3. There should be uninterrupted electricity (power) supply for computer aided biological investigations. Interruption of power may sometimes lead to loss of huge data from the computer memory
4. There should be regular checking of computer viruses because viruses may pose several problems such as deletion of data and corruption of the programmes
5. The maintenance and up keeping of molecular laboratories involves lot of expenditure which sometimes become a limiting factor for computer based molecular studies

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Chapter - 9
Genome Editing in Plants using CRISPR for Crop Improvement

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Chapter - 9

Genome Editing in Plants using CRISPR for Crop Improvement

Nishi Mishra, Prakash N. Tiwari, Vinod Kumar Sahu and Yogendra Singh

Abstract

Advancement in genome editing approaches and availability of genome sequences for many crops have opened up breeding possibilities for any desired trait. Genome editing technologies such as zinc finger nuclei (ZFN), advance activator such as implanter nuclei (TALENs) have made it possible for molecular biologists to more precisely target the interest of any gene. CRISPR/Cas9 system, one of the best tools which not only provides a powerful platform to efficiently modify target traits, but also broadens the scope and prospects of genome editing. It involves simple designing and cloning methods, as well as making Cas9 potentially available for use with various guide RNAs targeting multiple sites in the genome. In addition, the availability of Cas9 enzymes from additional bacterial species has made available options to increase the specificity and efficiency of gene editing methods. The application of these techniques will result in the development of non-genetically modified (non-GMO) crops with desired characteristics that may contribute to increasing yield potential in conditions of biological and abiotic stresses.

Keywords: genome editing, CRISPR, crop improvement, abiotic stresses, biotic stress

Introduction

The most important challenge facing by human beings is to provide food security to the growing population. By 2050, the human population will reach 10 billion and to feed the world, food production needs to increase by 60-100%. Increasing the population growth, reduced availability of agricultural land, biotic and abiotic stresses are significant barriers to farming production and productivity. Genome editing technologies with site-specific nucleases (SSNs) which demonstrated precise gene editing in plant systems. These SSNs create double-stranded breaks (DSB) in the target

DNA and DSBs are repaired through non-homologous end joining (NHEJ) or homology-directed recombination (HDR) pathways resulting in insertion/deletion (INDELS) and substitution mutations in the target region(s), respectively (Jinek *et al*., 2012). Genome edited crops have edited DNA for the desired trait (Malzahn *et al*., 2017). Genome edited crop has lesser consumption issues as compared to transgenic crops/GM crops (Waltz, 2018). Genome editing technology used for the improvement of crop species, as well as enhance the nutritive value of crops. In this book chapter, we discussed about the second-generation genome editing techniques such as CRISPR/Cas9 and its derivatives over the first-generation genome editing tools such as mega nucleases, zinc finger nucleases (ZFNs) and transcription activator-like effector nucleases (TALENs).

Genome editing tools

In genome editing techniques several DNA, RNA, and protein-based tools have been developed to edit and incorporate suitable agronomic traits into the desired crops. Random integration of genes into the existing genomes of target organisms to obtain a transgene construct is one of the most common mechanisms for gene targeting. Hence, plant biologists used transposons or retro-transposons to incorporate a transfer DNA (T-DNA) insertion mutant, resulting in random insertions. Sometimes, the random insertion fails to completely knockout the open reading frame(ORF) of a gene, leading to the increased possibility of obtaining mutant plants with partial functions, dominant-negative effects, or aberrant protein products. The introduction of single nucleotides into the genes (or amino acids into the proteins) cannot be completed using such methods. However, chemical mutagenesis methods and target-induced local lesions in genomes have been developed to overcome such problems. With the beginning of the first transgenic experiments in the 1980s, strategies have been developed to establish new traits in crops by combinatorial use of strong or tissue-specific promoters fused to protein encoding genes. After realizing that certain transgenes and even similar endogenous genes were silenced, strategies were established for knocking down genes responsible for certain unwanted traits, which are based on RNA interference (RNAi). However, these approaches did not lead to complete gene knockouts in many cases and have not been widely adopted in plant breeding so far. Many efforts techniques have been undertaken to develop homologous recombination (HR) in plants, which was widely used in bacteria, yeast and mouse for gene replacements or corrections, but could not be established in plants with a promising success rate. A paradigm shift was established in the middle of the 1990s with the introduction of double strand breaks (DSBs) by mega nucleases that have a recognition site of 18bp and were first identified in yeast mitochondria. With induced DSBs by mega nucleases, much higher numbers of HR events could be observed and finally DSBs have also lead to induced mutations by incorrect repair mechanisms, with the use of mega nucleases, the position for a HR or a putative mutation was exactly predictable.

Zinc finger nucleases

ZFNs are chimeric molecules with 3 to 4 zinc finger DNA binding domains, from which each recognizes a triplet of nucleotides by binding, and a Fok-I nuclease. Zinc finger nucleases are proteins bearing multiple zinc finger domains that are capable of recognizing a specific sequence of 6 to 9 consecutive base pairs within the genome of a particular organisms, to the C terminal end of this DNA recognition molecule is added a nonspecific nuclease domain from the restriction enzyme Fok-I to create one-half of a ZFN pair. The second half of the pair has a similar structure and designed to recognize and bind to a DNA sequence on the opposite DNA strand approximately 6 nucleotides away from the first ZFN.

The DSB is often repaired by the nonhomologous end joining (NHEJ) DNA repair mechanism that is error-prone. During the repair process, usually small number of nucleotides can be deleted or added at the cleavage site. If this faulty repair is in the coding region of a gene, it can disrupt the reading frame and create an inactive (knockout) gene. Alternatively, if a DNA fragment with strong homology to the disrupted gene (but not the exact same sequence) is present, the new DNA fragment can bind and displace the original gene sequence by a process called homologous recombination and result in 'gene replacement.

Transcription activator-like effectors nucleases (TALEN)

TALEN are engineered from fusing a TAL effectors DNA-binding domain to a DNA cleavage domain (a nuclease which cuts DNA strands). Transcription activator-like effectors (TALEs) can be engineered to bind to practically any desired DNA sequence, so when combined with a nuclease, DNA can be cut at specific locations. The restriction enzymes can be introduced into cells, for use in genome editing with engineered nucleases. Over the last years, leveraging technologies and methodologies previously developed for the use of ZFNs, several groups have used TALENs to modify endogenous genes in yeast, fruit fly, roundworm, crickets, zebra fish, frog, rat, pig, cow, cress, rice, silkworm, and human somatic, and pluripotent stem cells Supplementary and presumably the technique will continue to extend to additional organisms. Furthermore, a recent large-scale test demonstrated that TALENs have a very high success rate and can be used to target essentially any DNA sequence of interest in human cells. The essentially limitless targeting range of TALENs make them suitable for the use by non-specialist researchers.

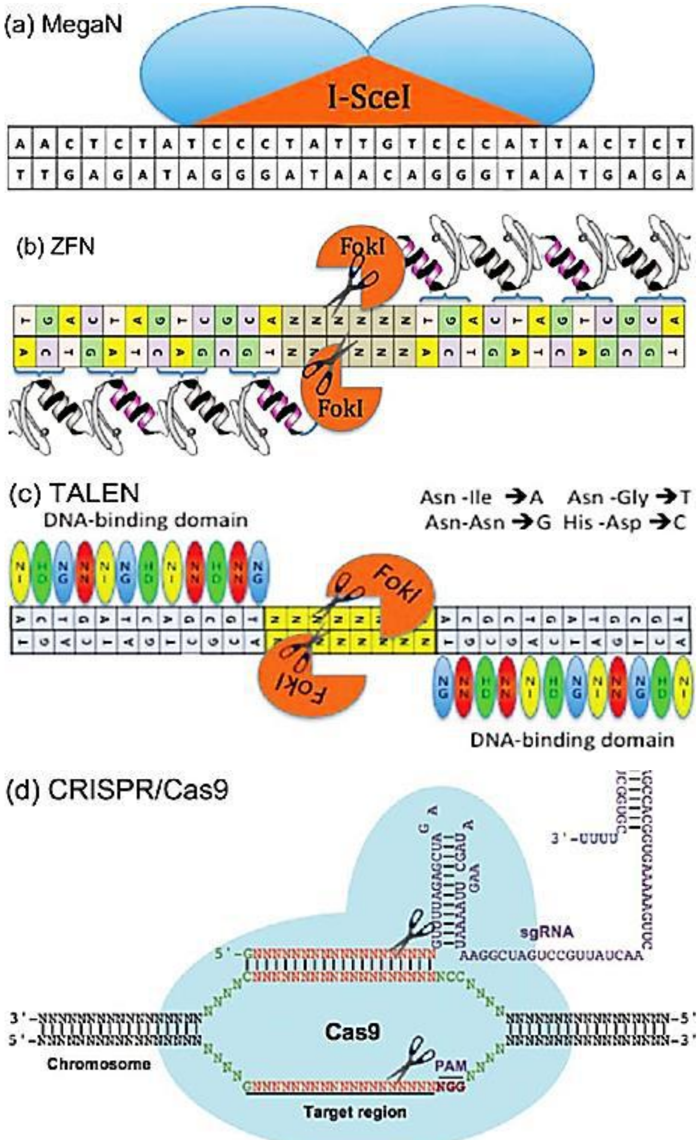

Fig 1: The structure of SSRs platforms

Principal of CRISPER

Clustered Regularly Interspaced Short Palindromic Repeats, (CRISPER) is an integral part of a bacterial defence system. CRISPR molecule is made up of short palindromic DNA sequences that are repeated along the molecule and are regularly-spaced. Between these sequences are “spacers”, foreign DNA sequences from organisms that have previously attacked the bacteria. The CRISPR molecule also includes CRISPR-associated genes, or Cas genes. These encode proteins that unwind DNA, and cut DNA, called helicases and nucleases, respectively.

CRISPR immune system protects the bacteria from repeated virus attacks thru three steps:

1. **Adaptation:** When DNA from a virus invades the bacteria, the viral DNA is processed into short segments and is made into a new spacer between the repeats. These will serve as genetic memory of previous infections.
2. **Production of CRISPR RNA:** The CRISPR sequence undergoes transcription, including spacers and Cas genes, creating a single-stranded RNA. The resulting single-stranded RNA is called CRISPR RNA, which contains copies of the invading viral DNA sequence in its spacers.
3. **Targeting:** The CRISPR RNAs will identify viral DNA and guide the CRISPR-associated proteins to them. The protein then cleaves and destroys the targeted viral material.

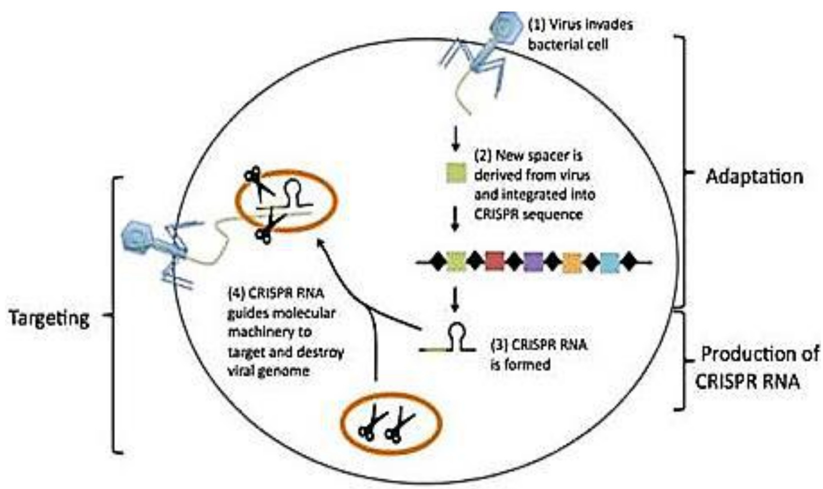

Fig 2: The steps of CRISPR-mediated immunity

CRISPR-Cas9 systems' recognition of specific DNA sequences and apply it in the process of development of improved crops. Instead of viral DNA as spacers, scientists design their own sequences, based on their specific gene of interest. If a gene's sequence known, it can be easily used in CRISPR. It will then act just like a spacer for the system and guide the Cas9 protein to a DNA matching sequence.

CRISPR/Cas9 mechanism

The CRISPR cleavage methodology requires

i) A short synthetic gRNA sequence of 20 nucleotides that bind to the target DNA
ii) Cas9 nuclease enzyme that cleaves 3-4 bases after the protospacer adjacent motif (PAM; generally 5′ NGG; Jinek *et al*., 2012)

The Cas9 nuclease is composed of two domains

a) RuvC-like domains
b) A HNH domain, with each domain cutting one DNA strand

Following the development of the CRISPR cleavage methodology, it has been widely applied in plant and animal genome editing. Between 2010 and 2018, nearly 5000 articles have been published detailing the use of CRISPR [1].

Implementing a CRISPR project involves simple steps *viz.*

i) Identifying the PAM sequence in the target gene
ii) Synthesizing a single gRNA (sgRNA)
iii) Cloning the sgRNA into a suitable binary vector
iv) Introduction into host species/cell lines transformation followed by
v) Screening
vi) Validation of edited lines (Figure)

The simple steps involved in CRISPR/Cas9 mediated genome editing (CMGE) allows even a small laboratory with a fundamental plant transformation set up to carry out genome editing projects. CRISPR/Cas9 techniques have been used more extensively to edit plant genomes in the last half decade compared to ZFNs/TALENs and are reflective of its ease of use (Figure). However, in plants, most editing has been demonstrated in model species such as *Arabidopsis*, rice and tobacco and only a few crop species have been researched using CRISPR technology (Jiang *et al*., 2013; Figure).

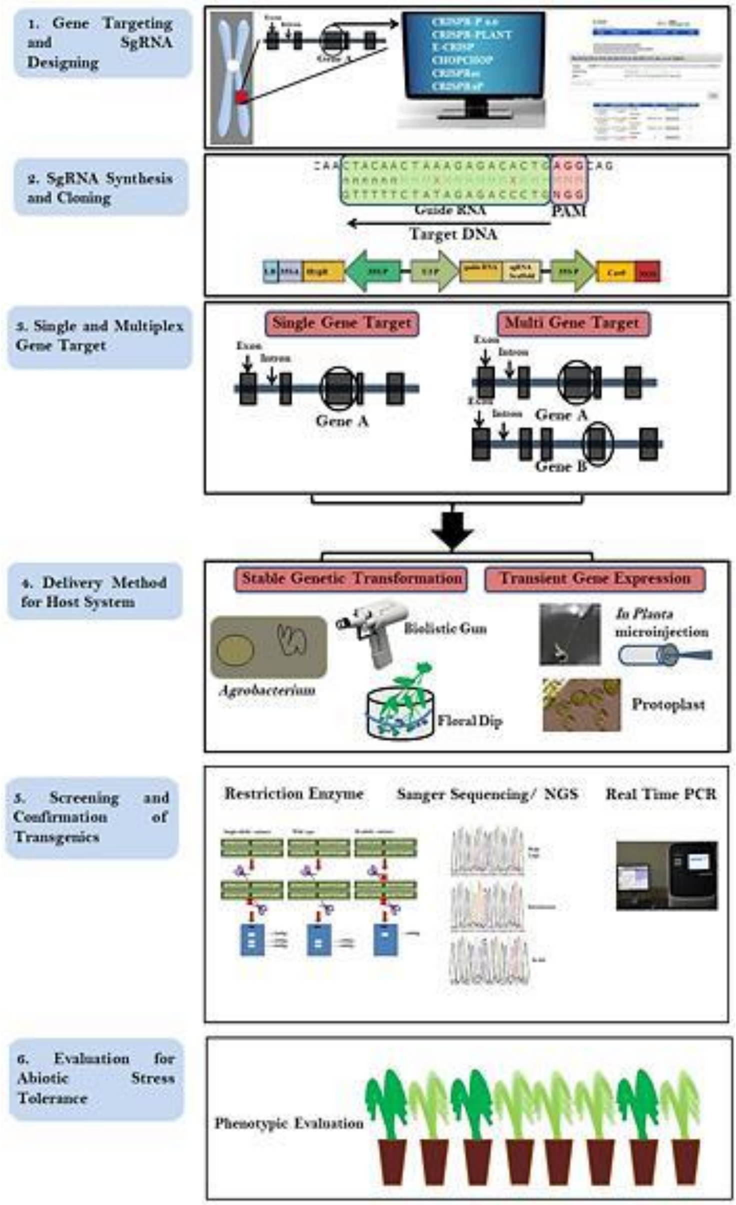

Fig 3: Flow chart describing the steps involved in CRISPR/Cas9 based genome editing. Step 1 describes the selection of gene and designing of gRNA, Step 2 describes the cloning of the gRNA in a suitable binary vector. Step 3 shows the availability single and multiplex editing. Step 4 describes methods of transformation, Step 5 explains screening methods of edited crops and Step 6 demonstrates the evaluation and selection of the desirable transgene-free plant for the target trait

CRISPR-Cas9 allows researchers to perform the following

Gene knock-out

Gene silencing using CRISPR starts with the use of a single guide RNA (sgRNA) to target genes and initiate a double stranded break using the Cas9 endonuclease. These breaks are then repaired by an innate DNA repair mechanisms, the non-homologous end-joining (NHEJ). However, NHEJ is error-prone and results in genomic deletions or insertions, which then translates into permanent silencing of the target gene [4, 7, 8].

DNA-free gene editing

CRISPR can be used for DNA-free gene editing without the use of DNA vectors, requiring only RNA or protein components. A DNA-free gene editing system can be a good choice to avoid the possibility of undesirable genetic alterations due to the plasmid DNA integrating at the cut site or random vector integrations [4, 7].

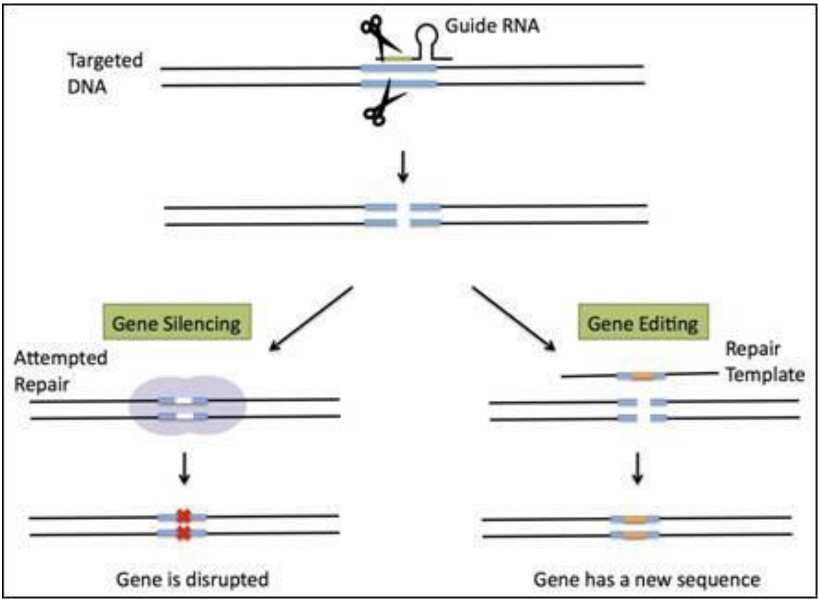

Fig 4: Mechanism of gene editing of CRISPR/Cas9

Gene insertions or "knock-ins"

The CRISPR-induced double-strand break can also be used to create a gene "knock-ins" by exploiting the cells' homology-directed repair. The precise insertion of a donor template can alter the coding region of a gene. Previous studies have demonstrated that single-stranded DNA can be used to create precise insertions using CRISPR-Cas9 system.

Transient gene silencing

By modifying the Cas9 protein so it cannot cut DNA, transient gene silencing or transcriptional repression can also be done. The modified Cas9, led by a guide RNA, targets the promoter region of a gene and reduces transcriptional activity and gene expression. Transient activation or upregulation of specific genes can be effectively done.

Classification of CRISPR/Cas9 system

The first attempt to classify CRISPR/Cas system was done by Haft *et al*. (2005). He defined 45 CRISPR-associated (Cas) protein families that are categorized into core proteins (Cas1, Cas2, Cas3, Cas4, Cas5, Cas6), 8 CRISPR/Cas subtypes and RAMP (repair associated mysterious protein) module in prokaryotic genomes. Makarova *et al*. (2011) classified CRISPR/Cas systems into three types: type I, type II, and type III depending on the presence of signature Cas3, Cas9 and Cas10 proteins, respectively (Table 2). This system was divided into 10 subtypes depending on the presence of additional signature proteins. This three-type classification system is further modified into two class-five type classification systems depending on the type of signature proteins and CRISPR loci (Makarova *et al*., 2015). Major Differences between CRISPR classes are based on the composition of crRNP complexes. Class 1 CRISPRs have multiple subunit effector complexes while class 2 CRISPRs concentrates most of their functions with single protein effectors. Class 1 CRISPR system, for example, have different nucleases for pre-crRNA processing, spacer sequence loading, and targeted cleavage processing. In class 2, a single protein performs all of these functions. Type IV and type V belongs to class I and class II systems respectively. Two subtypes of type V system and VI type is also recognized, elaborating the classification to two-class-six-type-19-subtype system (Shmakov *et al*., 2015; Table 2). Cas1 and Cas2 genes are ubiquitous in all CRISPR/Cas types (Makarova *et al*., 2011).

Table 1: Comparison between the different systems of site-specific nuclease used for genome editing

	MegaN	ZFN	TALEN	Cas9
Recognition site	Between 14	Typically 9-18 bp per	Typically 14-20 bp per	22 bp (20-bp guide sequence C 2-bp
	and 40 bp	ZFN monomer,	TALEN monomer,	Protospacer adjacent motif (PAM)
		18-36 bp	28-40 bp per	for Cas9; up to 44 bp for double
		per ZFN pair	TALEN pair	nicking

Specificity	Small number	Small number of	Small number of	Positional and multiple consecutive
	of positional	positional	positional	mismatches tolerated
	mismatches	mismatches	mismatches	
	tolerated	tolerated	tolerated	
Targeting	Targeting novel	Difficult to target	5′ targeted base must	Targeted sequence must pre- cede
	sequences often	non-G-rich	be a T for each	a PAM
	results in low efficiency	sequences	TALEN	
			monomer	
Cleavage efficiency	Low efficiency	Low efficiency	Efficient	Highly efficient
Off-target effects	Possible off-target	Possible off-target	Limited off-target	No off-targeted activities reported in
	activities	activities	activities,	Plants, but high off-target levels
			not fully studied	Reported in other systems.
			in plants	
Mechanism of	Introduction of	Introduction of	Introduction of	Introduction of DSBs in target DNA
Action	double-strand breaks	double-strand	double-strand	by wtCas9 or single strand nicks
	(DSBs) in target DNA	breaks (DSBs)	breaks (DSBs)	by Cas9 nickase
		in target DNA	in target DNA	
Cleavage efficiency	Efficient	Efficient	Efficient	High efficient
Affordability	Limited	Limited	Affordable but	Highly affordable
			resource	
			intensive	
Programmable	Highly difficult	Highly difficult	Difficult	Easy
Structure	Monomer	Dimer	Dimer	Monomer

CRISPR-Cpf1 (Class II, Type V CRISPR from *Prevotella* and *Francisella1*) is an advanced tool that uses a single Cpf1 protein for crRNA processing, target site recognition, and DNA cleavage. Cpf1 is functionally conserved to Cas9 protein but differs substantially in many aspects. The differences are as follows: it is a ribonuclease that processes precursor crRNA; it recognizes a thymine rich (like 5^0-TTTN-3^0) PAM sites (Zetsche *et al.*, 2015a). PAM sequence is located upstream of the protospacer sequence and tracrRNA is not required for guiding Cas9 to the target site. The most important characteristic of Cpf1 is the generation of 4 bp overhangs in contract to blunt ends produced by Cas9 (Zetsche *et al*., 2015a). These sticky ends would provide more efficient genomic insertions due to sequence complementarity into a genome. Among several proteins in the Cpf1 family, LbCpf1 from *Lachnospiraceae bacterium* ND 2006 and AsCpf1 from *Acidaminococcus* sp. BV3L6 act more effectively in human cells compared with other orthologs (Kim *et al*., 2016). Class 2 type VI is characterized by an effector protein C2c2 (Class 2, candidate 2). C2c2 contains two nucleotide binding (HEPN) conserved domains, which lacks homology to any known DNA nuclease (Abudayyeh *et al*., 2016). HEPN domains function as RNases, hence it is visualized as a new RNA targeting tool guided by a single crRNA which can be engineered to cleave ssRNA carrying complementary protospacers. Hence, C2c2 does not target DNA (Abudayyeh *et al*., 2016). C2c2 is similar to type III-A and III-B systems in having HEPN domains that are biochemically characterized as ssRNA specific endoribonucleases but there is a significant line of difference between these two types. Cas10-Csm in type IIIA and Csx in type III B have less target specificity and have to dimerize to form active sites. C2c2, in contrast, contains two HEPN domains and function as monomeric endoribonuclease (Abudayyeh *et al*., 2016). dCas9 analogs of C2c2, dC2c2 can be produced by alanine substitution of any of the four predicted HEPN domain. Further examination is required to clarify the mechanism of the C2c2 system and the class of pathogens against which it can protect bacteria. Currently, type VI system is found in *Carnobacterium gallinarum, Leptotrichia buccalis, L. shahii, L. wadei, Listeria newyorkensis, L. seeligeri, L. weihenstephanensis, Paludibacter propionicigenes*, and *Rhodobacter capsulatus* (Choi and Lee, 2016).

Table 2: Classification of CRISPR/Cas9 system

Class	Type	Subtypes	Organism harboring respective types	Signature Cas proteins	Other core proteins
Class 1	I	I-A	Archaeoglobus fulgidus	Cas3, Cas8	Cas1, Cas2, Cas5, Cas6, Cas7
		I-B	Clostridium kluyveri	Cas3, Cas8	Cas1, Cas2, Cas5, Cas6, Cas7
		I-C	Bacillus halodurans	Cas3, Cas8	Cas1, Cas2, Cas5, Cas7
		I-D	Cyanothece sp.	Cas3, Cas10	Cas1, Cas2, Cas5, Cas6,

					Cas7
		I-E	Escherichia coli	Cas3, Cas8	Cas1, Cas2, Cas5, Cas7
		I-F	Yersinia pseudotuberculosis	Cas3, Cas8	Cas1, Cas2, Cas5, Cas6, Cas7
		I-U	Geobacter sulfurreducens	Cas3, Cas8	Cas1, Cas2, Cas5, Cas6, Cas7
	III	III-A	Staphylococcus epidermidis	Cas10	Cas1, Cas2, Cas5, Cas6, Cas7
		III-B	Pyrococcus furiosus	Cas10	Cas1, Cas2, Cas5, Cas6, Cas7
		III-C	Methanothermobacter thermautotrophicus	Cas10	Cas5, Cas7
		III-D	Roseiflexus sp.	Cas10	Cas5, Cas7
	IV	IV	Acidithiobacillus ferrooxidans	Csf1	Cas5, Cas7
Class 2	II	II-A	Streptococcus thermophilus	Cas9	Cas1, Cas2
		II-B	Legionella pneumophila	Cas9	Cas1, Cas2
		II-C	Neisseria lactamica	Cas9	Cas1, Cas2
	V	V	Francisella cf. novicida	Cpf1	Cas1, Cas2
	VI	VI	Leptotrichia shahii	C2c2	Cas1, Cas2

Regulatory concerns for the crops developed using genome editing tools

New breeding technologies like ZFNs, TALENs, and CRISPR does not fall under the definition of a GMO under regulatory regimes in many countries. The United States Department of Agriculture (USDA) has stated that CRISPR/Cas9 edited crops can be cultivated and sold free from regulatory monitoring (Waltz, 2018). This can save several million dollars on getting regulations of GMO crops for the field test and data collections. In addition, it also reduces time as it usually takes several years to release a GMO crop. It also will remove the uncertainty of consuming GMO crops among the public. To date, there are five crops edited with CRISPR/Cas9 approach in the pipeline that USDA has declared not to regulate including a white button mushroom (*Agaricus bisporus*); resistance to browning was developed using CRISPR/Cas9 by knocking out a gene polyphenol oxidase (PPO) (Waltz, 2016). Similarly, waxy corn (*Z. mays*) with enriched amylopectin has been developed by inactivating an endogenous waxy gene *Wx1* and has also been exempted from GMO regulations. Green bristlegrass (*Setaria viridis*) with delayed flowering time achieved by deactivating the *S. viridis* homolog of the *Z. mays ID1* gene, Yield 10 Bioscience edited camelina for increased oil content and drought tolerant soybean (*Glycine max*) edited for *Drb2a* and *Drb2b* genes will also not be subject to regulatory evaluation.

CRISPR-Cas9 applications

CRISPR has played a huge part in the increase in genome editing studies in recent years. The system has broad applications in plant and animal improvement, as well as in the medical field. As a relatively young technique, various discoveries and innovations for its efficient use in wider applications are in the offing. The CRISPR-Cas9 system can be applied to nearly every organism. Early studies using CRISPR-Cas9 for gene editing have focused on crops important for agriculture. It was realized early on that the system could be used in crops to improve traits, such as yield, plant architecture.

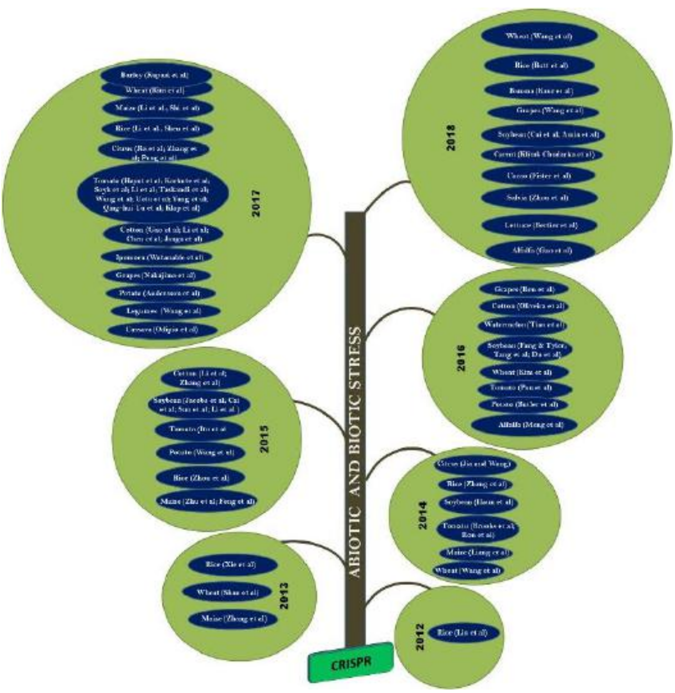

Fig 5: Application of CRISPR/Cas9 approach in plants: In 2013, CRISPR was demonstrated on rice, wheat, and maize. Whereas, in 2014, the technique was applied to tomato, soybean, and citrus. It was adopted in cotton and potato during 2015. Followed by watermelon, grapes, and alfalfa in 2016. CRIPSR/Cas was also applied to cassava, ipomoea, and legumes during 2017. Its is also applied to carrot, cacao, salvia, and lettuce during 2018 and many more crops yet to be reported

Table 4: Application of CRISPR based genome editing approach in plants for biotic, abiotic, and nutritional traits

Crop	Method	Target gene	Stress/trait	References
Biotic stress				
A. thaliana/N. benthamiana	NHEJ	dsDNA of virus (A7, B7. and C3 regions)	Beet severe curly, top virus resistance	Ji *et al*., 2015
A. thaliana	NHEJ	*elF(iso)4E*	Turnip mosaic virus (TuMV) resistance	Pyott *et al*., 2016
N. benthamiana	NHEJ	BeYDV	Bean yellow dwarf virus (BeYDV) resistance	Baltes *et al*., 2015
N. benthamiana	NHEJ	ORFs, and the IR sequence sDNA of virus	Tomato yellow leaf curl virus (TYLCV, and Merremia mosaic virus (MeMV)	Ali *et al*., 2015
Rice	NHEJ	*OsERF922* (ethylene responsive factor)	Blast Resistance	Wang F. *et al*., 2016
Rice (IR24)	NHEJ	*OsSWEET13*	Bacteria blight disease resistance	Zhou *et al*., 2015
Bread wheat	NHEJ	*TaMLO-A1, TaMLO-B1,* and *TaMLOD1*	Powdery mildew resistance	Wang *et al*., 2014
Cucumber	NHEJ	*ElF4E* (eukaryotic translation initiation factor 4E)	Cucumber vein yell. Virus (CV. Zucchini Yalow mosaic virus (LYMV). and Papaya nng spot mosaic virus typo W (PRSV W)	Chanderasekaran *et al*., 2016
Abiotic stress				
Maize	HDR	*ARGOS8*	Increased gran yield under draught stress	Shi. *et al*., 2017
Tomato	NHEJ	*SIMAPK3*	Drought tolerance	Wang *et al*., 2017
A. thaliana	NHEJ	*UGT79B2,UGT79B3*	Susceptibly to cold, salt, and drought stresses	Zhao *et al*. 2016
A. thaliana	HDR	*MIR169a*	Drought tolerance	
A. thaliana	NHEJ	*OST2 (OPEN STOMATA 2) (AHA1)*	Increased stomatal closure in response to abscisic acid (ABA).	Osakabe *et al*., 2016
Rice	NHEJ, HDR	*OsPDS, OsMPK2, OsBADH2*	Involved in Various Abiotic stress tolerance	Shan *et al*. 2013

Rice	NHEJ	*OsMPK5*	Various abiotic stress tolerance and disease resistance	Xie and Yang *et al*., 2013
Rice	NHEJ, HDR	*OsMPK2, OsDEP1*	Yield under stress	Shan *et al*., 2014
Rice	NHEJ	*OsDERF 1, OsPMS3, OsEPSPS, OsMSH1, OsMYB5*	Drought tolerance	Zhang *et al*., 2014
Ricc	NHEJ	*OsAOX1a, OsAOX1b, OsAOX1c, OsBEL*	Various abiotic stress tolerance	Xu *et al*., 2015
Rice	NHEJ	*OsHAK-1*	Low cesium accumulation	Cordones *et al*., 2017
Rice	NHEJ	*OsPRX2*	Potassium deficiency tolerance	Mao *et al*. 2018
Nutritional and other traits				
Rice	NHEJ	*25604 gRNA* for *12802* genes	Creating genome wide mutant library	Meng *et al*., 2017
Maize	NHEJ	*ZmlPK1A, ZmlPK* AND *ZmMRP4*	Phytic acid synthesis	Liang *et al*., 2014
Wheat	HDR	*TeVIT2*	Fe content	Connorton *et al*., 2017
Soybean	NHEJ	*GmPDS11* and GmPDS18	Carotenoid biosynthesis	Du *et al*. 2016
Tomato	NHEJ	Rin	Fruit ripening	Ito *et al*., 2015
Potato	HDR	*ALS1*	Herbicide resistance	Butler *et al*., 2016
Cassava	NHEJ	*MePDS*	Carotenoid biosynthesis	Odipio *et al*., 2017

Future perspectives

Plants are used as sources of food, feed, fiber, medicines and biofuels. For many years, conventional breeding was used to improve the properties of domestic crops. The presence of different alleles in nature allows the improvement of crops, either by traditional breeding, genetic engineering or genome editing. In addition, mutation has been used to develop new alleles, but as they are random and could affect many non-targeted alleles, they must be subjected to substantial screening and backcrosses. Genome editing, however, targets a specific position in the genome, so less screening or backcrossing is required. In addition multiple alleles could be modified simultaneously using CRISPR/Cas9 system. Genome editing targets modifications to the genome easily and efficiently, its utilities help to improve food and feed, drug development, animal models, genetic variation, materials, fuel, gene surgery, in addition to investigating chromosome structure and functional dynamics. The modifications produced via genome editing could be divided into 3 different types. Type-1 produced from NHEJ which acts as simple mutagen causing SNPs or INDELs causing switch off a specific gene. In that situation, remnants of transgenes can be eliminated by selfing or backcrossing. The modifications produced by this type are indistinguishable from the mutations that occur spontaneously or during mutation breeding, which is significantly more genetically disruptive. Genome editing in the type-2 mode is the most challenging for regulators and ironically will probably be the most useful for plant breeding because it enables editing of existing alleles to redefine their function or new ones to be 'knocked-in'. The editing could be designed either to retain the function from existing useful alleles already in the gene pool but where modified or lost its function during conventional breeding to development of commercial germplasm, or from redesigning the allele to create novel traits. In that case an HR repair system, like Genome Repair Oligonucleotide technology, is required (Jones, 2015a; Jones, 2015b; Jones, this issue).Type-3 editing provides the introduction of a complete functional transgene targeted to a pre-determined 'safe harbor site' in the genome. It is useful compared to GMO products, as the insertion site in the genome could be predetermined, avoiding adverse position effects (i.e. disruption of native genes).

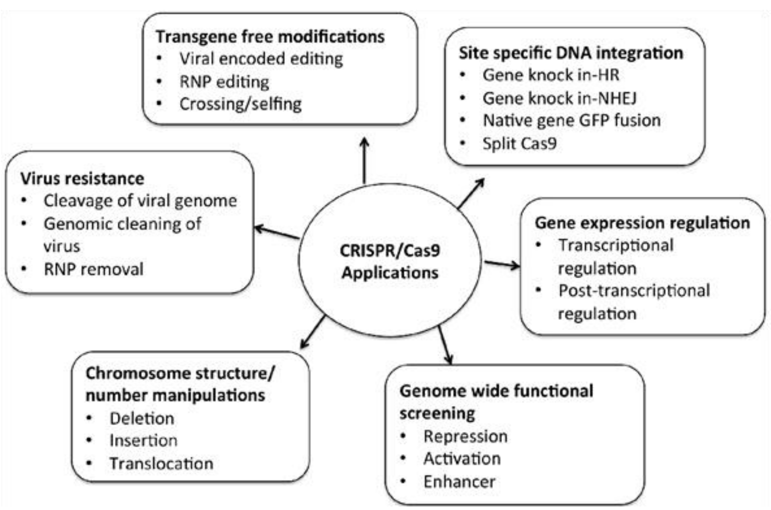

Fig 6: Various applications of CRISPR/Cas9 system many of which are yet to be tested in plants

For over 100 years, scientists have devoted their efforts to develop and refine the techniques for improving the quality and quantity of crops starting from using conventional breeding to modern biotechnology techniques. Genome-editing technologies provide many advantages compared with traditional breeding and trans-genic methods (Table 2). Although traditional breeding technologies have provided improved traits for crops, the long breeding cycles, high heterozygosities, lack of various degrees of precision in hybridization, and low frequencies of desirable mutations have made new varietal development highly resource-demanding. Trans- genic technology has a wide applications in improving crops as it can overcome the incompatibility barriers between species. However, this technique faces a number of obstacles including regulatory obstacles, public acceptance, time and cost of risk assessments required before commercialization. Now-a-days, using the new gene editing technology are time saving, more precise and efficient for improving traits. Crops developed by genome editing are expected to be more acceptable to consumers as they are considered non-transgenic. Combining all the 3 modification technologies will help even more in improving crop traits. Judicious application of genome editing techniques will provide more food, feed and fiber, produced in a more sustainable manner, thus contributing to a more food secure future globally. In addition, Transgene-free plants could be modified using SSN platforms via transient expression of the nuclease components using agroinfiltration or viral vectors, the delivery of the components directly as functional gRNA and Cas9 protein or developing mono-allele transgenic plants with Cas9 followed by incorporating the gRNA in a separate chromosome to the targeted locus so that they can be removed by segregation.

Conclusion

In the last several years, genome editing has emerged as a technology and revolutionized the field of functional genomics and crop improvement in various plants. Genome editing tools are becoming popular molecular tools of choice for crop improvement, especially engineered nucleases, have had a revolutionary influence on basic research in plants as well as crop improvement. These technologies rely on engineered endonucleases to generate double stranded breaks (DSBs) at target loci. CRISPR/Cas9 has emerged as the most promising approach due to its simplicity, ease of use, versatility, accuracy and tolerable off-target effects. The genome editing system holds great promise in generating crop varieties with enhanced disease resistance, improved oil composition, biotic and abiotic stress resistance, improved yield and quality and novel agronomic traits which will be beneficial for farmers and consumers. The technology has been successfully used for targeted mutagenesis in various crops. New breeding techniques provide scientists the ability to precisely and quickly insert the desired traits than conventional breeding. CRISPR/Cas9 based genome editing is a fundamental breakthrough technique. Application of genome editing tools in crop improvement to enhance yield, nutritional value, disease resistance and other traits will be a prominent areas of work in the future. In the last 5 years, it is being applied vigorously in many plant systems for functional studies and combating biotic and abiotic stresses as well as to improve other important agronomic traits. Though several modifications to this technology have to lead to increasing on-target efficiency, most work carried is preliminary and needs further improvement. Nevertheless, CRISPR/Cas9 based genome editing will gain popularity and be an essential technique to obtain 'suitably edited' plants that will help achieve the zero hunger goal and maintain feed the growing human population.

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Chapter 8

STUDY ON SEEDLING POPULATION RESPONSE TO DISTURBANCE OF A GARHWAL HIMALAYAN OAK (*QUERCUS LEUCOTRICHOPHORA* A. CAMUS) FOREST

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ABSTRACT

An extensive study was conducted to access the population status of *Quercus leucotrichophora* seedlings in a part of Garhwal Himalaya Oak forest. Permanent plots were established in different altitudes and aspects.

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K. K. Vikrant, D. S. Chauhan and R. H. Rizvi (2021), Assessment of Biomass and Carbon Stock Along Altitudes in Traditional Agroforestry System in Tehri District of Uttarakhand, India, In: Akshat Uniyal & Isha Sharma, (eds) Trends in Agriculture: Traditional And Modern Approaches. pp. 243-256

11. Assessment of Biomass and Carbon Stock along Altitudes in Traditional Agroforestry System in Tehri District of Uttarakhand, India

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Abstract

Agroforestry represents an integration of agriculture and forestry to increase productivity and sustainability of farming systems and farm income. Now it has been recognized as a carbon sink due to the need for climate change mitigation. The objective of this study was to compare the carbon stock in living biomass between altitudes and the agroforestry system in Tehri district, Uttarakhand. The system compared was: Agri-horti-silvi-culture system (Trees, crops and fruits), Agri-horticulture system (Trees and Fruits) and Agri-silviculture system (Trees and crops.). 1350 sample plots were selected in three altitudes. Lower (286-1200m), Middle (1200-2000m) and Upper (2000-2800m). Results indicated that carbon was influenced by the altitudes. Carbon stock in the lower altitude (286-1200m) was higher compared to the middle and upper altitudes. Agri-horti-silviculture system contained maximum carbon stock as compared to others. It is concluded that agroforestry systems are playing an important role in biodiversity conservation, soil enrichment and carbon storage in the Tehri district of Uttarakhand.

Keywords: Agroforestry system, Climate change, Altitudes, Carbon storage

1. Introduction

The third Intergovernmental Panel on Climate Change (IPCC) Assessment Report on climate change (IPCC, 2000) contains an endorsement of the potential for agroforestry to contribute to an increase in carbon stock in agricultural lands. Agroforestry is an ideal option to increase the productivity of wasteland, increase tree cover outside the forest and reduce human pressure on forests under different agro-ecological regions and viable option to prevent and mitigate climate change effect (Dhyani *et al.*, 2009).

Most, if not all, agroforestry systems have the potential to sequester carbon for a short period (Rizvi *et al.*, 2011) with adequate management of trees under agroforestry systems, a significant fraction of the atmospheric C could be captured and stored in plant biomass and the Soils (Rizvi *et al.*, 2011). An IPCC special report (IPCC, 2000) indicates that conversion of unproductive croplands and grasslands to agroforestry has the best potential to soak up atmospheric C. In agroforestry, the soil restoration process involves the recovery of organic-based nutrients through replenishment of soil organic matters, about half of which is C (Newaj and Dar, 2009). Agroforestry systems are believed to have good potential to sequester carbon (Bijalwan *et al.*, 2009) and thus, immensely important in the era of climate change. Human activities changed carbon stocks in terrestrial ecosystems through rapid land-use transformations (Brown *et al.*, 1994). At the moment, agroforestry has generated much enthusiasm as a result of the National Action Plan for Climate Change (NAPCC, 2008) which, under its Green India mission, has exclusively emphasized the agroforestry interventions. It is proposed that under agroforestry, 0.80 m ha of the area would involve improved agroforestry practices on the existing lands and 0.70 m ha would involve additional lands under agroforestry. There is no consensus that the agroforestry systems and practices hold the viable potential to meet the present basic human needs, besides addressing several major agro-ecological, carbon sequestration and socioeconomic issues. Moreover, The C sequestration potential of agroforestry systems is estimated to be between 12 and 228 Mg, with a median value of 95 Mg. Therefore, based on the earth's area that is suitable for the practice, 1.1-2.2 Pentagram C could be stored in the terrestrial ecosystems over the next 50 years. There are many shortcomings, however, that need to be emphasized such as the change in vegetation under agroforestry systems, *etc.* (Albrecht and Kandji, 2013). There is less amount of data on the carbon storage of agroforestry in the Himalayan region. This study was examined to determine the carbon stock capacity of different agroforestry systems in Indian Himalayas along different altitudes.

2. Materials and Methods

2.1. Study Area

The present study was undertaken in Tehri district of Uttarakhand state which lies in the Northern region of India. Of the total 8,479,562 human population of the state, 78% lives in rural areas. The agricultural land in the hills of Uttarakhand is scattered and fragmented and the per capita land holding of Uttarakhand farmers is 0.2 ha and about 36% of rural families live below the poverty line and agriculture contributes around 37% to state gross domestic production (Maikhuri *et al.*, 2009). The Tehri district lies between 30° 03′ and 30° 53′ North latitude and 77° 56′ and 79° 04′ East longitude having a geographical area of 3,642 km^2 (FSI, 2015). The geographical area of the district is 3642 km^2, out of which the forest area is 3221.56 km^2 (District Tehri, 2011-2012). Tehri district lies in the hilly areas of the state and agriculture is the major occupation. The total population in the district is 616409, population density is 169 person/km^2 and the rate of increase in population is 2.37% per ten years. The location map showing the details of the study area is presented in Fig. 11.1.

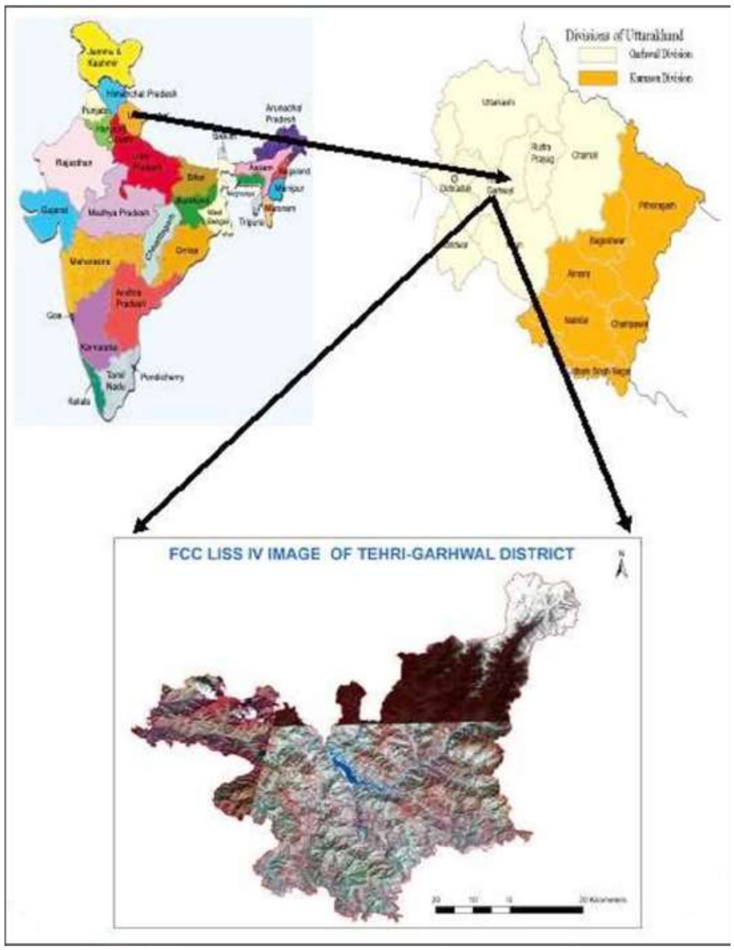

FIGURE 11.1: Location map of the study area

The land use pattern shows 2,236 km^2 areas under forest cover (including reserve forest, civilsoyam forest, community land and community forest), 1142.42 km^2 under cultivation and the rest are a wasteland, barren land, Pastureland and grooves and snow-covered mountains (FSI, 2011) with 58,569 ha area under cultivation, of which irrigated land in only 12.21% (District Tehri, 2011-2012). Average rainfall in his district is 1395 mm and means average temperature varies from 14.8°C to 29.5°C with an average relative humidity of 60.5%. Based on different altitudes and agro-climatic zone (Singh & Singh, 1992), the district was divided into three zones *viz*. foothill/subtropical zone is lower altitude (286-1200 m), middle altitude *i.e.*, Sub temperate zone (1200-2000 m) and upper altitude *i.e.*, temperate zone (2000-2800 m) and above 2800 m areas there is no habitation in the district. Therefore, this area is not under study. Out of nine developmental blocks six blocks representing three zones, were selected for the present study villages in Tehri district. The details of the villages studied are given in Table 11.1.

TABLE 11.1: Study villages in Tehri district

Blocks	Altitudes (m)		
	Lower (286–1200 m)	Middle (1200–2000 m)	Upper (2000–2800 m)
Devprayag	Bagi, Grothikhanda, Palisen, Bachhendrikhal	Langur, Dungi	Juranaa
Kritinagar	Maikhandi, Jakhnand, Dhaulangi	Timal gaon, Dagar, Riskoti	No settlement area
Chamba	Kyari, Pali	Guldi, Purshal	Saud, Chopriyal gaon
Thauldhar	Dharwal, Jaspur	Indra, Sonara	No settlement area
Jakhnidhar	Raswari, Undoli	Manthal, Chah	No settlement area
Pratapnagar	Bausari	Kothaga, Kandakhal	Kualgarh, Banali

2.2. Description of Systems

Farmers practice mainly three agroforestry systems *viz*. agrisilvicultural system (trees and agriculture crops are growing in the same piece of land), agrihorticultural system (edible fruit trees and agriculture crops are growing in same Piece of land) and agrihortisilvicultural system (trees including edible fruit trees, forest trees and crops are growing in the same Piece of land) in the district. The characteristics of each system are as follows:

2.2.1. Agri-silviculture System (AS)

It is quite common throughout the district. This system is managed for the production of fuel, fodder, fibre and small timber trees with the crops. Agriculture crops such as wheat (*Triticum aestivum*), peas (*Pisum sativum*), potato (*Solanum tuberosum*), cauliflower (*Brassica oleracea*) and mustard (*Brassica compestris*) *etc*. during the winter season; maize (*Zea mays*), tomato (*Lycopersicon esculentum*), pepper *(Pepper nigrum)* and French bean (*Phaseolus vulgaris*) *etc*. during the summer season are grown in monoculture or mixed cropping on the permanent terraces prepared across the hill slopes, while fodder, fuel and timber trees such as *Grewia oppostifolia, Celtis australis, Bauhinia variegata, B. purpuera, Albizia leeback etc.* are deliberately left or grown on the bunds of terraces.

2.2.2. Agri-horticulture System (AH)

This system is commonly practised in those areas where fuel and fodder are easily available from other sources and the size of the landholding is large. Agriculture crops mainly leafy and rhizomatous crops are grown within the space of horticulture trees such as *Mangifera indica* (Mango), *Citrus limon* (Nimbu), *Musa paradisica* (Kela), *Psidium guajava* (Amrud), *Mallus domestica* (Apple), *Prunus domestica* (Plum), *Prunus armeniaca* (Apricot), *Prunus persica* (Peach), *Prunus dulcis* (Almond) and *Pyrus communis* (Pear) *etc.*

2.2.3. *Agri-horti-silviculture System (AHS)*

This system is managed for the production of fruits, grains, fodder and fuelwood. Fruit trees are planted in regular space in the fields and fodder or small timber trees are left on the field bunds while the annuals are grown as intercrop. Species grown are the same as those in the other two systems.

3. Plot Selection & Forest Inventory

Ten sample plots of (100 m^2) size each were randomly laid out in each agroforestry system at each altitude. The shape of the plot is trapezoidal, with a short parallel to the contours at the top of the site. All three agroforestry systems are covered in each block on each altitude. The (100 m^2) size plot was used for tree (woody perennials) enumeration and 1x1 m size plot was used for (annuals *i.e.*, agricultural crop, grass and weeds). All trees falling in the plot (100 m^2) were enumerated. The DBH (diameter at breast height (i.e., 1.37 m) was measured with tree caliper and height with Haga altimeter.

3.1. Estimation of Biomass

Stem volume was measured with bark using the following formula was given by (Presselar, 1865)

$$V = f \times h \times g \qquad \text{Eq 1}$$

V=Volume; f= form factor; h= height; g=basal area

The form factor was calculated using formula as given in equation 2 (Pressler, 1865; Bitterlich, 1984) was used for calculating the form factor

$$f = 2h_1/3h \qquad \text{Eq 2}$$

Where f= form factor; h_1= is the height at which diameter is half of the diameter at breast height and h = is the total height

Stem biomass was estimated by multiplying the stem volume with wood specific gravity (IPCC, 2006).

The value of wood specific gravity of different agroforestry species in Garhwal Himalaya was used as reported by various authors (Kumar *et al.*, 1989; Sheikh *et al.*, 2011; Choudhry and Ghosh, 1958; Rajput *et al.*, 1985; Raturi *et al.*, 2002) as mentioned in table 11.2.

TABLE 11.2: Specific gravity of agroforestry species

Sl. No	Species	Specific gravity (gm/cm^3)	Source
1	*Quercus leucotrichophora*	0.826	Raturi *et al.*, (2002)
2	*Grewia oppositifolia*	0.606	Purkayastha, (1982)
3	*Melia azedirach*	0.491	Raturi *et al.*, (2002)
4	*Celtis australis*	0.444	Rajput *et al.*, (1985)
5	*Toona ciliate*	0.424	Raturi *et al.*, (2002)
6	*Adina cardifolia*	0.583	Raturi *et al.*, (2002)
7	*Mangifera indica*	0.588	Chowdhury and Ghose, 1958
8	*Citrus limon*	0.91	Ting and Blaier,1965
10	*Pyrus communis*	0.676	Tumen, 2014
11	*Ficus roxburghii*	0.443	Sheikh *et al.*, (2011)

Sl. No	Species	Specific gravity (gm/cm^3)	Source
12	*Prunus cerasoides*	0.69	Kumar, 1989
13	*Anogeissus latifolia*	0.757	Purkayastha, 1982
14	*Psidium guajava*	0.59	Sheikh *et al*., (2011)
15	*Morus alba*	0.603	Purkayastha, 1982
16	*Citrus sinensis*	0.916	Joseph and Abdullahi, 2016
17	*Juglanse regia*	0.59	Wani *et al*., 2014
18	*Bahunia verigata*	0.55	Kanawajia *et al.,* 2013
19	*Ficus palmate*	0.578	Sheikh *et al.,* 2011
20	*Malus domestica*	0.67	Miles and Smith,2009
21	*Prunus armenica*	0.50	Miles and Smith, 2009
22	*Prunus persica*	0.90	Babu *et al.,* (2014)
23	*Myrica esculenta*	0.737	Sheikh *et al*. (2011)
24	*Pyrus pashia*	0.70	Kumar, 1989
25	*Ficus auriculata*	0.443	Sheikh *et al*., (2011)
26	*Punica granatum*	0.99	Felter and Lloyd, 1898
27	*Carica papaya*	0.918	Afolabi, I. S. and Ofobrukweta, K. 2011
28	*Bombax ceiba*	0.33	Troup,1921
29	*Rhododendron arboretum*	0.512	Rajput *et al.*,(1985)
30	*Pinus roxburghii*	0.491	Rajput *et al.*,(1985)
31	*Embilica officenalis*	0.614	Sheikh *et al.,* (2011)
32	*Psidium guajava*	0.59	Kanawjia *et al.,* (2013)
33	*Celtis australis*	0.444	Rajput *et al,.* (1985)
34	*Albizia leeback*	0.69	Mani and Parthasarathy, 2007
35.	*Rhus parviflora*	0.620	Chowdhury and Ghose, 1958
36.	*Wood fructicosa*	0.55	Chaturvedi *et al.,* (2012)
37	*Musa paradisica*	0.29	Omotosa and Ogunsile, 2010
38	*Acacia catechu*	0.825	Purkayastha,1982

For Branch biomass a total number of branches irrespective of size were counted on each of the sample trees, then these branches were categorized based on basal diameter into three groups viz < 6cm, 6-10cm and > 10cm. From each sampled tree, two branches from each group were randomly selected and were weighed for obtaining fresh weight. Subsamples of each component were oven-dried to constant weight at 65˚ C. The following formula (Chidumaya, 1990) eq. 3 was used to determine the dry weight of branches:

$$B_{dwi} = B_{fwi}/1+M_{cbdi} \qquad \text{eq 3}$$

Where B_{dwi} - the oven-dry weight of the branch, B_{fwi} - fresh/green weight of branches, M_{cbdi} - moisture content of branch on a dry weight basis. Leaves from the sampled branches were also removed, weighed and oven-dried separately to a constant weight at 65°C to determine leaf biomass eq. 4 (Chidumaya,1990)

$$L_{dwi} = L_{fwi}/1+M_{cbdi} \text{---- eq 4}$$

Where L_{dwi} - oven-dry weight of Leaves, L_{fwi} - fresh/green weight of Leaves, M_{cbdi} - moisture content of leaves on a dry weight basis

Total above-ground biomass was the sum of stem biomass, branch biomass and leaves biomass (Kanime *et al*., 2013). Below ground biomass of tree was calculated by multiplying the aboveground biomass by a factor of 0.25 for broad-leaved species and 0.20 for coniferous species (IPCC, 1996). The biomass carbon of the tree was estimated from the sum of above-ground biomass and below-ground biomass of the tree. Crop biomass was estimated using 1m X 1m quadrates by a destructive method. During 2015-2016, when the crops were at their peak biomass in March to April for *Rabi* (winter) and August to September for *Kharif* (summer) seasons. All the crops, grasses and weeds occurring within the border of the quadrates were harvested at ground level and sorted out and collected samples were weighted. Fresh weight was converted into a dry weight based on plant samples kept in the oven for drying at 80°C for 24 hours. The crop biomass was converted into carbon by multiplying with a factor of 0.45 (Woomer, 1999). In annual crops, below-ground biomass was estimated by multiplying with reference root:shoot ratio for each crop species (IPCC, 1996). The total biomass carbon stock of the agroforestry system was the sum of total biomass carbon of trees and total biomass carbon of crops. The biomass carbon was estimated from total biomass by multiplying biomass with a factor of 0.45 (Woomer, 1999).

4. Statistical Analysis

The data were analyzed applying two-way analysis of variance (ANOVA) Wherever the effects exhibited significance $P \leq 0.0\,5$ probabilities, All Analysis was performed using GEN STATISTICS 32 version (VSN International 2017).

5. Results and Discussion

In the Himalayan region, many indigenous agroforestry systems have been known from Himachal Pradesh (Atul and Khosla, 1990) and Uttarakhand (Dadhwal *et al.*, 1989) out of which agri-horti-silviculture system, agri-silviculture system and agri-horticulture system are very common and frequent. Dadhwal *et al.* (1988) and Toky *et al.* (1989) have recognized these three agroforestry systems with their multifarious benefits to the hill farmers. Existing agroforestry systems and their components in Tehri district have been reported in Vikrant *et al*., 2015. In lower altitudes, the agroforestry system differed significantly in above-ground biomass, below ground biomass (AGB), Total tree biomass (TTB), Total biomass (TB) and Total Carbon (TC) ($P \leq 0.05$). In general, Total carbon was observed higher in agri-horti-silviculture system (2.44 Mg ha^{-1}) followed by agri-silviculture system (1.60 Mg ha^{-1}) (Table 11.3).

TABLE 11.3: Comparison among agroforestry systems for AGB, BGB, TTB, CB, TB and TC (Mg C ha^{-1}) along lower altitudes of Tehri district, Uttarakhand (n=60)

Parameters	System			DF	Type III	Mean square	F	Pr>F
	AHS	AS	AH					
AGB	2.79	2.45	1.84	2	202.25	101.12	16.89	0.00
BGB	0.7	0.62	0.47	2	50.56	25.28	4.22	0.00
TTB	3.49	3.07	2.31	2	269.67	134.83	22.53	0.00
CB	1.95	0.37	0.28	2	5.04	2.52	29.97	0.00

Parameters	System			DF	Type III	Mean square	F	Pr>F
	AHS	AS	AH					
TB	5.44	3.44	2.59	2	348.32	174.16	28.02	0.00
TC	2.44	1.60	1.16	2	15.41	7.7	8.24	0.00

Significance at the level of probability of 5 % ($P < 0.05$)
AGB= Above ground biomass BGB= Below ground biomass CB= Crop biomass TB= Total biomass TTB= Total tree biomass TC= Total carbon At middle altitudes, agroforestry system shows significantly difference in AGB, BGB TTB, TB and TC ($P>0.05$).

Total carbon storage were found maximum agri-horti-silviculture system (2.22 Mg ha^{-1}) followed by agri-silviculture system (1.53 Mg ha^{-1}) (Table 11.4).

TABLE 11.4: Comparison among agroforestry systems for AGB, BGB, TTB, CB, TB and TC (Mg C ha^{-1}) along middle altitudes of Tehri district, Uttarakhand (n=60)

Parameters	System			DF	Type III	Mean square	F	Pr>F
	AHS	AS	AH					
AGB	3.64	2.43	2.19	2	202.17	101.122	16.91	0.00
BGB	0.91	0.60	0.54	2	50.54	25.205	4.22	0.00
TTB	4.55	3.03	2.73	2	269.67	134.83	22.55	0.00
CB	0.39	0.37	0.56	2	5.049	2.524	9.97	0.00
TB	4.94	3.40	3.29	2	454.34	207.17	34.6	0.00
TC	2.22	1.53	1.48	2	204.45	93.22	15.57	0.00

Significance at the level of probability of 5% ($P < 0.05$)
AGB= above ground biomass BGB= below ground biomass CB= Crop biomass TB= Total biomass TTB= Total tree biomass TC= Total carbon Agroforestry system differed significantly in AGB, BGB TTB, TB and TC ($P \leq 0.05$) at upper altitudes.

Agri-horticulture system shows a maximum (1.64 Mg ha^{-1}) carbon stock followed by agri-silviculture system (1.3 Mg ha^{-1}) (Table 11.5).

TABLE 11.5: Comparison among agroforestry systems for AGB, BGB, TTB, CB, TB, and TC (Mg C ha-1) along upper altitudes of Tehri district, Uttarakhand (n=30)

Parameters	System			DF	Type III	Mean square	F	Pr>F
	AHS	AS	AH					
AGB	2.37	1.85	1.48	2	20.87	10.43	4.26	0
BGB	0.8	0.51	0.49	2	5.21	2.6	1.32	0
TTB	3.17	2.46	1.97	2	27.83	13.91	5.68	0
CB	0.46	0.42	0.42	2	0.03	0.01	0.13	0.87
TB	3.64	2.88	2.4	2	29.68	14.84	5.58	0
TBC	1.64	1.3	1.08	2	6.01	3.006	5.58	0

Significance at the level of probability of 5% ($P < 0.05$)
AGB= Above ground biomass BGB= Below ground biomass CB= Crop biomass TB= Total biomass TTB= Total tree biomass TC= Total carbon

The effect of interaction between altitudes and systems is depicted in table 11.6. crop biomass (CB) are significant differences between altitudes and agroforestry systems ($P \leq 0.05$), While CB showed non-significant differences with altitude and system. Biomass and carbon stock was found maximum in agri-horti-silivculture system followed by agri-silivculture system and minimum in agri-horticulture system. (Table 11.3, 11.4, 11.5).

TABLE 11.6: Analysis of variance for AGB, BGB TTB, CB, TB, and TC by altitudes, system and the interaction of both variables of Tehri district, Uttarakhand

Source	Stock	DF	Type III SS	Mean square	F	Pr>F
Altitude	AGB	2	136.54	68.27	19.35	0.00
	BGB	2	45.51	22.75	6.45	0.00
	TTB	2	182.066	91.033	25.817	0.000
	CB	2	0.451	0.226	2.696	0.069
	TB	2	198.887	99.443	27.047	0.000
	TC	2	40.275	20.137	27.047	0.000
System	AGB	2	88.26	44.13	12.51	0.00
	BGB	2	29.42	14.71	4.17	0.00
	TTB	2	117.697	58.848	16.689	0.000
	CB	2	0.451	0.226	2.696	0.069
	TB	2	165.417	82.708	22.495	0.000
	TC	2	33.497	16.788	22.495	0.000
System x Altitudes	AGB		12.66	3.16	0.89	0.00
	BGB		4.22	1.055	0.29	0.00
	TTB	4	16.887	4.222	1.197	0.312
	CB	4	2.321	0.580	6.934	0.000
	TB	4	25.577	6394	1.739	0.142
	TC	4	5.179	1.295	1.739	0.142

Significance at the level of probability of 5 % ($P \leq 0.05$); AGB= above ground biomass BGB= below ground biomass CB= Crop biomass TB= Total biomass TTB= Total tree biomass TC= Total carbon.

It was observed that agri-horti-silviculture system yields higher biomass carbon stock than other agroforestry systems across the altitudes may be due to adequate management of trees under agroforestry systems of the atmospheric carbon capture and stored in the plant. It is indicated that the biomass carbon was decreased with increasing altitudes across systems. Similar results are also reported by (Kaur *et al*., 2000; Maikhuri *et al.*, 2000. Albert and Kandiji (2003) reported that carbon variability in plant biomass can be high within complex systems and productivity depends on several factors including the age, structure and the management of the system. Among agroforestry systems, biomass carbon stock followed the order agri-horti-silviculture>agri-silviculture> agri-horticulture. There was no significant difference between biomass carbon stock with altitudes and systems (Table 11.2). The main reason for higher carbon density in tree-based systems as exhibited by perennial components is attributed to the continuous accumulation of biomass in the woody component. Moreover, from the agriculture fields and grasses, almost all of the above-ground biomass carbon stock is removed annually.

5.1. Carbon Stock Contribution by Trees Species in Agroforestry Across Altitudes

Total thirty-eight agroforestry trees species were observed in different agroforestry systems of the district. Out of thirty-eight, *Grewia oppositifolia, Celtis australis, Melia azedirach, Quercus leucotrichophora, Ficus roxburghii, Myrica esculenta, Rhododendron arboretum, Citrus limon, Juglans regia* accumulated maximum biomass carbon stock in the district. Fig. 3 represents that among the dominant tree species *Quercus leucotrichophora* contributed maximum (15.11%) biomass carbon stock followed by *Ceitis australis* (6.94%), *Grewia oppositifolia* (6.45%) and the rest of the species contributes (49.34%).

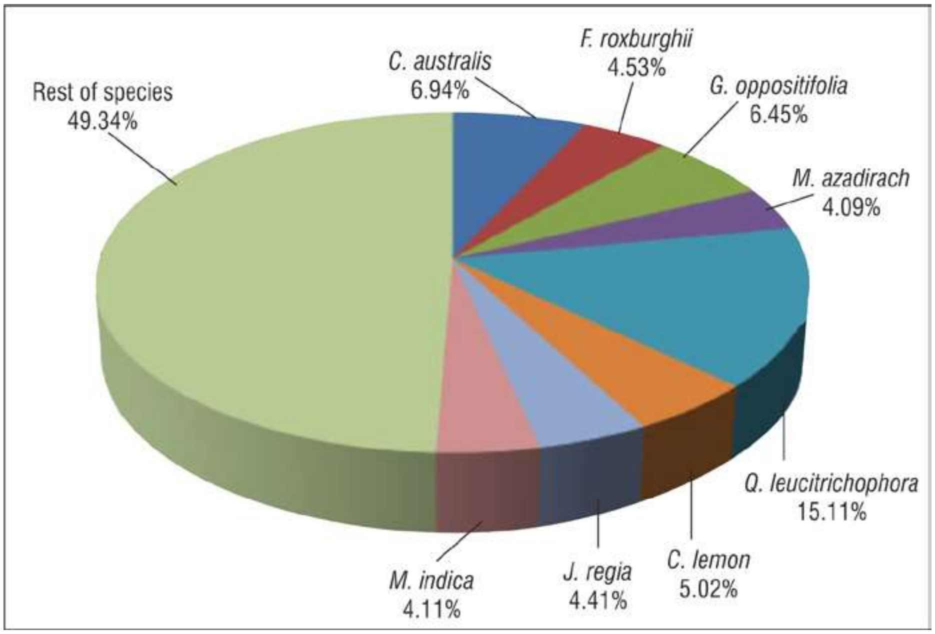

FIGURE 11.2: Carbon stock contributed by trees species in agroforestry of Tehri district

In the present study, *Quercus leucotrichophora* contributed maximum biomass than other tree species. Biomass in *Quercus leucotrichophora* was higher as reported by (Devi *et al.*, 2013; Sharma *et al*., 2010) for lower Western Himalaya. *Grewia opposoitifoila* contributed a maximum number oftrees but biomass contribution was lower than *Quercus leucotrichophora,* maybe due to continuous lopping off its branches for fuel and fodder during a lean period by local people, therefore, stunting and bushy growth of *Grewia* was noticed in agroforestry field. Kumar *et al.* (2012), reported that overexploitation of resources from traditional agroforestry trees reduces input biomass.

5.2. Carbon Stock Contribution by Crop in Agroforestry Across Altitudes

Forty crops species associated with agroforestry systems were observed in the district. Out of forty, maximum biomass carbon-containing crop species are *Solanum tuberosum* (4.49%), *Curcuma longa* (4.43%), *Tetricum estivum* (4.01%), *Ehinochloa frumentacea* (3.98%), *Amarnathus blitum* (3.78%), *Fagopyrum* *esculenta* (3.56%), *Eleusine coracana* (3.4%) and *Glycine max* (3.33%) and rest of the species contributes (55.74%) biomass carbon stock (Fig. 11.3).

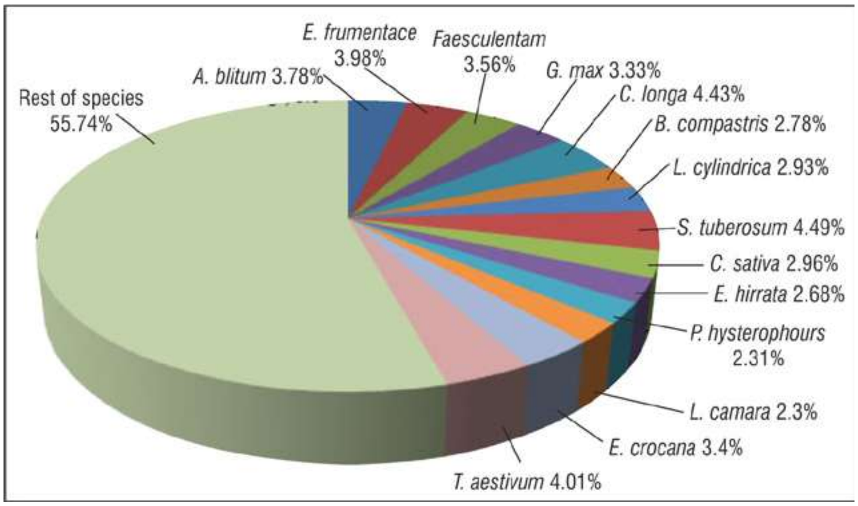

FIGURE 11.3: Carbon stock contributed by crops species in agroforestry systems of Tehri district

In the present study, *Solanum tuberosum* contributed maximum biomass as compared to other crop species. It may be attributed that *Solanum tuberosum* had maximum leaf area and dry weight as compared to other crop species. Due to the large leaf area, it is capable of absorption of maximum sunlight and maximum amount of CO_2 fixation (Lakitan, 2008).

6. Conclusion

Agri-horti-silviculture system found to have maximum biomass carbon stock at lower altitudes. Across the altitudes, farmers mostly adopted agri-horti-silviculture system. Considering biomass and carbon stock, lower altitude (286-1200 m) subtropical zone have more potential for carbon sequestration in agroforestry. *Grewia oppositifoila, Quercus leucotrichophora* and *Celtis australis* were dominant tree species which contributed more biomass carbon stock as compared to other species and are mostly adopted by the farmers in agroforestry. Therefore, these three species were considered suitable agroforestry tree species in the district. In the agroforestry systems, particularly agri-silviculture and agri-horti-silviculture land-use systems are playing an important role in the carbon storage the Tehri district of Uttarakhand. Hence these systems need to be promoted further for economic and environmental security. Due to the ban of green/live trees felling in the entire Indian Himalayan region, agroforestry systems can be a good source of earning significant carbon credit to the farmers therefore understanding and implementation of carbon sequestration will help to maintain climate change mitigation from agroforestry.

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CHAPTER 10

Traditional Practices in Forest Conservation: Experience from Indian Himalaya

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ABSTRACT

The involvement of local people and their knowledge/experience of resource values and management options have an important role to play for forest conservation. Simultaneously to conserve forest resources, the role of cultural and spiritual values becomes of prime importance. These community conserved sites of Garhwal Himalaya are very important from the conservation viewpoint of plant species diversity and dependence of the local inhabitants for their livelihood activities like collection of fuelwood, fodder, small timber, and NTFP. The Uttarakhand state, also called 'Dev Bhumi' or abode of Gods, is unique in this regard. The landscape in this state is dotted with many holy places of worship. These places are often of small to medium-sized with natural vegetation as a sacred grove of the deity. The present book chapter has given the status of some community-conserved forests sites from Garhwal Himalaya for its contribution in plant diversity conservation, regeneration of the tree species, ecosystem services/biodiversity value, and role of belief systems in conservation practices. Article 8 (j) of the Convention on Biological Diversity calls for respecting, preserving, and maintaining knowledge, innovations, and practices of indigenous and local communities

Chapter

Assessment of Biomass and Carbon Stock along Altitudes in Traditional Agroforestry System in Tehri District of Uttarakhand, India

Kundan K. Vikrant, Dhanpal S. Chauhan and Raza H. Rizvi

Abstract

Agroforestry represents an integration of agriculture and forestry to increase productivity and sustainability of farming systems and farm income. It has been recognized as carbon sinks due to the need of climate change mitigation. The objective of this study was to compare the carbon stock in living biomass between altitudes and agroforestry system in Tehri district, Uttarakhand. The system compared was: Agrihortisilviculture system (Trees, crops and fruits), Agrihorticulture system (Trees and Fruits) and Agrisilviculture system (Trees and crops.). 1350 sample plots were selected in three altitudes. Three altitudes were: Lower (286-1200 m), Middle (1200-2000 m) and Upper (2000-2800 m). Results indicated that carbon was influenced by the altitudes. Carbon stock in the lower altitude (286-1200 m) was higher compared to the middle and upper altitudes. Agrihortisilviculture system contained maximum carbon stock compare than other system. It is concluded that agroforestry systems are playing an important role in the biodiversity conservation, soil enrichment and carbon storage in Tehri district of Uttarakhand.

Keywords: Agroforestry system, Climate change, Altitudes, Carbon storage

1. Introduction

The third IPCC Assessment Report on climate change (IPCC 2000) contains an endorsement of the potential for agroforestry to contribute to increase in carbon stock in agriculture lands. Agroforestry can both sequester carbon and produce a range of economic, environmental, and socioeconomic benefits. Trees in agroforestry farms improve soil fertility through control of erosion, maintenance of soil organic matter and physical properties, increase N, help in extraction of nutrients from deep soil horizons, and promotion of more closed nutrients cycling. Agroforestry is an ideal option to increase productivity of wasteland, increase tree cover outside the forest and reduce human pressure on forests under different agro-ecological regions, and is thus a viable option to prevent and mitigate climate change effect [1]. Most, if not all, agroforestry systems have the potential to sequester carbon for a short period, say 6–8 yrs. [2]. With adequate management of trees under agroforestry systems,

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A Study of Oak Dominant Forest in Garhwal Himalaya Relation to Different Aspects and Altitudes, Uttarakhand.

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Abstract

A study was carried out to investigate the plant diversity and composition in an Oak Forest of Garhwal Himalaya. Three altitudinal zones in both north facing and south facing aspects were explored for plant quantitative study. In all studied aspects and altitudes, a total of 23 tree species with 14 families, 29 shrubs with 16 families and 37 herbs species with 20 families were recorded. The proportion of species, family and genus in all altitudes was found greater for herb and shrub layer as compare to tree layer. Comparing both the aspects, north aspect showed higher tree species,family and genus while south aspect was richer in terms of shrub and herb layer of vegetation.

Keywords: altitude, north aspect, south aspect, species, family, genus

Introduction

The Indian subcontinent is a region of moderate to very high biodiversity including twoof the global hot spot of vascular plant endemism in the Western Ghats and the Eastern Himalaya[1]. The plant diversity is found extremely rich from the valley regions to the highly elevated alpine meadows[2]. Biodiversity is used variously for fodder, fuel wood, timber, leaf litter, construction, industrial raw material and several non-timber forest produce[3]. The Garhwal Himalaya is one of the hot spots of biodiversity situated in the western part of Central Himalaya. The unusually wide altitudinal ranges make it interesting for studies[4,5]. Forest diversity is the main source of livelihood of the people living in Uttarakhand. In Uttarakhand, composition of forest is diverse varies from place to place because of varying topography such as plains, foothills and upper mountains[6]. Substantial amountof work has been carried out at regional and local levels in various parts of Indian Himalayan region (IHR),

Pages: 221-227

Ecosystem and Environmental Pollution

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Noise Pollution Sources, Effects and Controlling Techniques

Shashank Srivastav[1]; Deepak Kholiya[1]; Laxman Singh Kandari[2]

The word noise is derived by the Latin word nausea meaning unpleasant sound, which causes discomfort. Noise may be defined as the wrong sound in the wrong place at the wrong time. Thus, the noise is itself pollution, which means the unpleasant sound, produced in the atmosphere leading to discomfort or the health hazards.

Noise pollution, also known as environmental noise or sound pollution, is the propagation of noise with ranging impacts on the activity of human or animal life, most of them harmful to a degree. The source of outdoor noise worldwide is mainly caused by machines, transport, and propagation systems. Poor urban planning may give rise to noise disintegration or pollution, side-by-side industrial and residential buildings can result in noise pollution in the residential areas. Some of the main sources of noise in residential areas include loud music, transportation (traffic, rail, airplanes, etc.), lawn care maintenance, construction, electrical generators, explosions, and people.

Atmospheric pollution is not the only type of contamination that is harming living beings on the planet. According to the World Health Organization (WHO), it is one of the most dangerous environmental threats to health and according to the European Environment Agency (EEA); noise is responsible for 16,600 premature deaths and more than 72,000 hospitalizations every year in Europe alone.

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Editor

Dr. Alok Sagar Gautam is an Assistant Professor & Scientist at H.N.B. Garhwal University (A Central University), Uttarakhand. Earlier, he worked in Instrumentation & Observational Techniques Division, Indian Institute of Tropical Meteorology, Pune. He is currently working on physical and chemical characteristics of aerosols/cloud dynamics with Science and Engineering Board (SERB) and Department of Science and Technology (DST) funded research projects which will help to understand the extreme weather events i.e. cloud burst events in Himalayan region. He took part in South Pole Antarctica Expedition on a research project. He has published some very good scientific papers in peer reviewed International/Nationals journals. He has also organized/participated in many scientific International/Nationals conferences, seminars, workshops. As a result of his very good research work, Dr. Gautam has been awarded Junior Associate at International Centre for Theoretical Physics (ICTP) Italy, Young Scientist Award by Uttarakhand State council for Science & Technology (UCOST), Young Scientist of the Year 2018 by International Academy of Science and Research (ISAR) Kolkata and "Promising Indian" by Promising Indian Society New Delhi.

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ADVANCEMENT IN BASIC AND APPLIED SCIENCES
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Advancement in BASIC AND APPLIED SCIENCES

Dr. Alok Sagar Gautam & Dr. Tushar Kandari

About the Book

Development of science and technology depends on the way of its application in the right direction. The present manuscript will surely attract the readers because of its interdisciplinary nature which covers atmospheric science, material science, computer science, remote sensing, environmental science, mathematical science, health and agricultural science. Some of the key findings of the book are study of various atmospheric factors i.e. climate change due to various pollutants and the aerosol content in the environment, the radioactivity level and the dose absorption level along with its correlation to the aerosols. The results discussed in the chapters were experimentally performed using the latest technology to get some impactful results. The chapters in the book shows a high impact over the society as it covers the hot and burning topic such as atmospheric and environmental science which deals with the factors responsible for the climate change and our environment. As we all know, learning is a never ending process to explore new horizons in science and technology, therefore this book somewhere reflects the above lines and is a small step towards advancement of science.

Contents

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- Influence of Geophysical and Neotechtonic Activities on Radon Concentration and Surface Flux Rate in Kumaun Himalaya, India
- CCN Variation in Different Events at High Altitude Western Himalaya Observatory: Preliminary Results
- A Review on Effects of Radon, Thoron and their Daughter Products on Human Beings in Uttarakhand Himalayan Region
- A Brief Review of Atmospheric Aerosols
- Indoor Air Pollutants and Associated Health Hazards: A Review

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Characterization and Morphological Analysis of Airborne Pm_{10} and $Pm_{2.5}$ in Srinagar Garhwal

Alok Sagar Gautam, Nidhi Gairola, Sanjeev Kumar, Rajendra Singh Negi, Karan Singh, Santosh Rawat, Don Bishwas, Surendra Pratap Singh

Introduction

The particles in the atmosphere are a complex mixture of organic and inorganic species that play a very crucial role in cloud formation, distribution of solar radiation and cloud droplet nucleating ability, acidification, dry deposition and precipitation that support life in planet (Ramanathan et al.,2009 and Tiwari et al., 2009). The source of such atmospheric particles are mainly natural as well as anthropogenic activities such as dust, sea spray, volcanic emission, industrial power plant, combustion of solid fuel for domestic use and exponential growth in the vehicle (Datta et al., 2011 and D'Almeida 1991). Based on recent research, it is observed that the airborne particulate matter (PM) is a complex mixture of various chemical varieties (Colbeck et al., 2010). There are some recent observations of particulate matters (PMs) in Alaknanda valley carried out (Gautam et al., 2018) to understand the loading of such particulate matters (PMs) particles at higher altitude area along with metrological parameters and their chemical characteristics. Generally, the aerosol can be reached in high altitude area by valley breeze activity in the central Himalayan re-

About Editor

Dr. Priyadarshini Agnihotri is working as Head of Geography department in Arihant College, Indore. She is also a very active environmentalist and a social worker. She has done M.A. (Geography), M.Phil and PhD (Geography) from Barkatulla University , Bhopal. She has also pursued B.Ed from Barkatulla University, Bhopal and M.Ed from IASE UNIVERSITY Rajasthan.

Dr. Priyadarshini Agnihotri is author of two books
1) Physical Geography 2) Regional Geography. In addition to this, she has edited over 8 books.

She is recipient of the awards
1. "Young Geographer's Award in 1994 by the Institute of Indian Geo.
2. Received Confederations of Education Excellence Teacher's Award-2015 (CCE), Delhi under the category of Research/Papers/Book published.
3. "Wama Shakti metro Woman Award" by Rajasthan Patrika in educational and chamber of commerce on the auspicious occasion of Women day 2016.
4. Awarded by Secretary of State for Central Panchayati Raj. for remarkable achievements in research work.
5. Received "International Award for Pioneer Researches 2018 9th International conference LNCTS Indore by Research Foundation of India.

Dr Priyadarshini Agnihotri has a rich experience of around 25 years in Industry/Research/ Academy. Apart from this she is a very active member of Institute of Indian Geographers(IIG) and Rajasthan Geographers Association(RGA).She has also published more than 40 papers in various national and international journals and magazines.

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Editors

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Dr. Priyadarshini Agnihotri

Dr. Sandhya Bageria

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Alok Sagar Gautam,

Abstract: - The Himalayas have a profound effect on climate of Indian sub continent. Local impacts on climate are significant throughout the Himalayas. Climate and weather are interrelated processes in which atmospheric aerosols play important role which take place on a global and regional scale. Aerosols affects the weather and environment in a number of ways including through changes in average temperature, rainfalls and climate extreme, change in atmospheric aerosol and ground level ozone concentrations, change in nutritional quality of foods and change in sea level. The presence of particulate matter (PM), inhalable particles in both diameter PM2.5 and PM10 triggered chronic disease which is alarmed for human being. In the present study, four weather parameters viz. temperature, wind speed, wind direction and relative humidity have been studied with respect to three hourly intervals over the year 2016 for Srinagar (Garhwal)

INNOVATIVE AGRICULTURE AND BOTANY

EDITORS

KRISHAN KUMAR SINGH

SHIV PRATAP SINGH

ABOUT THE EDITORS

Dr. Krishan Kumar Singh was born on July 15, 1985 at Etawah Dist. of Uttar Pradesh. He did his B.Sc. (Agriculture) from (Doon P.G. College of Agriculture Science & Technology, Dehradun) H.N.B. Garhwal University, Uttarakhand in 2006; He completed his M.Sc. (Horticulture) from H.N.B. Garhwal University in 2009. He done his Ph.D. on Macro-Propagation of Phalsa (*Grewia asiatica*) from the H.N.B. Garhwal University in 2016. He received UGC Ph.D. Central University Fellowship from 2011 to 2015.

He has great interest in Micro and Macro-Propagation of Horticulture crops. He has published more than 43 research papers and 5 Review papers in National/International Journals; attended 10 workshops and presented papers in many conferences. He received Best paper presentation award in International conference, Kota (Rajasthan). He also published 5 chapters in different books. He is a life member of HortFlora Research Spectrum International journals.

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INNOVATIVE AGRICULTURE AND BOTANY

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Contents

Opportunities for Cultivation and Processing of Economically Important Medicinal and Aromatic Plants in Uttarakhand

Santosh Singh[1], R.S. Negi[1], Kh. Naseeruddin Shah[2] and Vivek Singh[2]
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Abstract

The Himalayas have an enormous prosperity of medicinal plants with traditional medicinal knowledge. Medicinal plants have played an important role of primary health care system among the local people of Himalayan region. The present paper focuses about the economical importance of different medicinal and aromatic plants used in the Uttarakhand Himalayan region. Uttarakhand is a hill state in the Indian Himalayan region. Due to its unique geographical location and different climatic conditions, it has rich biodiversity and variety of plant species. In Uttarakhand, enough possibilities exist for their processing of medicinal and aromatic plants. This may built a network of rural enterprise, thereby increasing the employment and income for the rural peoples of the state.
Keywords: Medicinal, Aromatic Plants, Cultivation, Uttarakhand.

INTRODUCTION

Medicinal and aromatic plants play a very important role in the human health. In the world, herbalism flourishes as the method of rehabilitation of choice in many European and Asian continents (Al Quran, 2005). It is estimated that traditional knowledge, mostly plant based, medicinal treatment systems continue to provide health care to more than three-quarters of world's population of the earth (Prakash, 2015). Mostly plant based medicinal system is used in developing countries. The reliance of majority of the population on these systems, is because of, the arranged remedies have been historical acceptance and easily availability, economical less expensive and highly effective (Azaizeh *et al.,* 2003). The peoples of different developed countries, were increased the use of plant based medicine for self-medication, that indicated the increasing the medicinal plant imports by these countries. Thus, there are evidences of positive attitudes towards herbal drugs and preparations. Mostly the medicinal and some aromatic plants are collected from the forests in the different forms like, fruits, roots, seeds, leaves, corms, tubers, rhizome and flowers (Edwards 1996). The collection of these medicinal and aromatic plants from the forest is very tricky and troublesome work. The cost of collection is raises significantly and the price of raw materials and their preparations (Jaiyati *et al.,* 2016). The collection of these medicinal and aromatic plants from the forestsare not rewardingour requirements. In order to ensure the continuous supply of the medicinal and aromatic plants of standard quality, it is necessary to cultivate these plants in a systemic way for meeting the demands.

Uttarakhand is the place of temples, holly rivers and importantly place of gods. The god blasé his grace to give the plenty of miracle medicinal plants and also aromatic plants (Gaur, 1999). Large number of economically important medical and aromatic plant has been not exploited; someone exploited ruthlessly, as a result of many species has been extinct or are at the verge of extinction. Over the several years, different medical species are shrinking and there is growing concern to preserve them for mankind (Anthwala *et*

Knowledge and Adoption Behavior of Farmers using Biofertilizers in District Pauri Garhwal, Uttarakhand

Santosh Singh and R.S. Negi
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Abstract

Indian agriculture has undergone the deep change since the green revolution period. The major thrust of the green revolution as to ensure maximizing food grain production through package of practices, viz., ensuring assured irrigation and application of higher doses of chemical fertilizers to tap the potential of high yielding varieties. Biofertilizers are safer to soil health as well as for ecosystem. They are inherently less harmful and do not have any residual effect. Thus, the present paper is an attempt to evaluate the knowledge level and adoption behavior of farmers using biofertilizers in Pauri Garhwal District Uttarakhand, with the sample of 80 farmers. The result indicates that there are significant association with education and knowledge of respondents and selected biofertilizer practices in case of all the four selected crops. The overall reason concludes that education and size of holdings land were significantly associated with the adoption of bioferfilizer in respect of related crops.

Keywords: Bioferfilizer, Uses, Farmer, Uttarakhand.

INTRODUCTION

Agriculture production depends on availability and use of quality and quantity of farm inputs. The chemical fertilizer is supported to be an essential input for boosting up agricultural production (Kumar, 2014). It had played an important role in growing agriculture production in the country. However, the incessant use of chemical fertilizers had depreciated soil fertility, destroyed soil microbial activity and bothered environmental balance and ecological reliability. (Hiremath, 2011; Srinivas and Bhalekar, 2013). The biofertilizers are believed to be the potential substitute to chemical fertilizer in improvement of soil fertility for sustainble crop production (Balamurugan and Normon, 2001). Biofertilizers are tacit to be of great significance as complement or supplement to chemical fertilizers because of significant changes in crop production system, reasonable cost and environmental friendly (Nigade *et al.,* 2017). They are helpful for proliferation and survival of beneficial micro-organisms in the soil. They are affordable to farmers because of low cost and economically they are very significant in making available plant nutrients like nitrogen and phosphorous (Pathak *et al*., 2016 and Bodake *et al*., 2009)

Biofertilizer is a technological innovation that has the possible to increase crop yield, reduce agricultural and environmental sustainability and efforts production cost and improve soil situation. A Bio-fertilizer is a substance, which contains living microorganisms, when applied to seed, plant surfaces or soil, colonizes the rhizosphere or the interior of the plant and promotes growth by increasing the supply or availability of primary nutrients to the host plant (Kumar, 2004; Patel and Vyas, 2014). The bio-fertilizers are alternative to chemical fertilizer in improvement of soil for sustainable crop production. With the view to popularizing biofertilizers,

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Original Research Article

Women's Empowerment and MGNREGA: Exploratory Study in Pauri Garhwal District, Uttarakhand, India

Santosh Singh*, R. S. Negi and Rekha Dhanai

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A B S T R A C T

This paper is an attempt to investigate the level of economic empowerment gained by women engaged in Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) within the in the district of Pauri Garhwal, Uttarakhand. The key objective of the MGNREGA is to provide social security to rural households by guaranteeing one hundred days of paid employment in publicly works every financial year. Based on nine variables (education, land ownership, ownership of other assets, control over income contributed by a woman to her family, control over the income of the family, savings, access to credit, social participation, cash income earned from income generating activities, the research compared the magnitude of women's empowerment before and after getting involved in MGNREGA. The findings suggest that whereas MGNREGA is an indispensable dive to making sure economic empowerment to rural women; however, the scheme has not been enforced properly within the district women and men not obtaining 100 days of employment, irregular mode of payment, very slow progress and poor quality in public works.

Keywords

Frequency, Women's empowerment, MGNREGA, Pauri Garhwal, Uttarakhand

Introduction

There is huge literature on problems concerning about rural women's empowerment through the prevalent community works programme of India. National Employment Guarantee Act, 2005, first started in 200 districts since 2 February 2006 and renamed after the Father of the Nation as Mahatma Gandhi National Rural Employment Act (MGNREGA) since 02 October 2009 on his birth anniversary (Dutta *et al.,* 2012; Negi *et al.,* 2015; Liu and Barret, 2013; Narayanan and Das, 2014; also Bhattacharyya and Vauquline, 2013; Roy and Singh 2010 and Dhaka *et al.,* 2015). Underscoring the human rights notion of right to work the act guarantees one hundred days of paid employment in unskilled works to poor rural households among the every financial year aimed toward granting social security (dutta *et al.,* 2012). Apart from this basic objective, the other objectives of the act are the creation of durable assets and strengthening the livelihood resources based on the rural poor, generation of productive assets, protection of environment, empowerment of rural women, reduction of rural-urban migration and fostering social equity. However, after a decade of performance, evidence suggests that MGNREGA has been suffering from massive funding cuts apace with corruption and issues associated with poor implementation (Fraser, 2015; Jayati, 2015: Ruwali, 2014).

While the overall success and failure of this scheme has been widely researched upon in different states as well as India as a whole (Bhattacharyya and Vauquline, 2013; *Singh et al.,* 2015&2017; Dutta *et al.,* 2012; Fraser, 2015; Liu and Barret, 2013). The present study takes a broader view of empowerment and defines it both as a process and as an outcome that alters the position of women both, inside and outside their households in respect of their economic empowerment gained by women engaged in Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) in the district of Pauri Garhwal, Uttarakhand.

Materials and Methods

The study is based on primary data. Primary data has been collected either from the beneficiaries as a part of the survey conducted individually or as a part of focus groups. For this, a household survey schedule was conducted to collect information among these beneficiaries. Prior to conducting this research however, consents were taken from the participants regarding their participation.

For collection of data from the sample households, a well-structured questionnaire. 150 beneficiaries to understand the impact of the scheme in terms of the socio-economic status of the households after the implementation of MGNREGA, through purposely-random sampling. This data was collected from five-gram panchayats (GPs) of Kaljikhal block. The collected data were analysed using simple statistical analysis like calculation of percentage, frequency have been worked out and presented in tabular format to determine the empowerment of women's employment under MGNREGA in the district Pauri Garhwal, Uttarakhand.

Results and Discussion

Table 1 illustrates the variables and their categorisation. This Table presents that the variables education, land ownership, ownership of other assets, control over own income, control over income of the family, saving, social participation, credit creation and cash income earned from income generating activities are different before and after implementation of the MGNREGA. The awareness of women working under MGNREGA are presented in Table 2 100 percent are aware about the programme of MGNREGA, 90.00 percent reported well aware about the number of days of works in a year. 64.00 percent also well aware about the per day wage. Job Card (JC) should be issued within 15 days of application 58.63 percent women's are aware. About 55.33 percent beneficiaries were aware about the employment that will be given within 15 days of application for work; about 46.00 percent are aware about unemployment allowance as per the Act. Again only 37.33 percent of the respondents know about the worksite facilities, 23.33 percent know about social audit system whereas a 16.67 percent beneficiary knows about Right to Information (RTI).

Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA), is an imperative step for guarantee economic empowerment of rural women the findings suggest that in the block Kaljikhal, These calculations signal that women involvement in income generating activities in MGNREGA contributed for enhancement in the scale of women's empowerment.

Table.1 Determine of Empowerment

Variable	Category	Observed Frequency	
		Before MGNREGA	**After MGNREGA**
Education	Illiterate	23	18
	Primary School	40	36
	Middle School	56	48
	High School	28	38
	College Education	3	10
Land Ownership	Land Ownership	146	146
	No Land	4	4
Ownership of other assets	No Assets	95	85
	Joint Ownership	39	46
	Sole Ownership of Other Assets	16	19
Control over own income	No Control	133	125
	Partial Control	11	11
	Full Control	06	14
Control over Income of Family	No Control	141	135
	Partial Control	02	06
	Full Control	07	09
Savings	No Savings	139	122
	Up to 25% of Earnings	09	25
	up to 50% of Earnings	02	03
Access to Credit	Yes	0	140
	No	150	10
Social Participation	Yes	12	148
	No	138	02
Cash Income earned from Income Generating Activities (`/month)	` 0- 5,000	140	35
	`5,001-10,000	07	106
	` > 10,000	03	09

Source: Primary Data

Table.2 Awareness level of the Beneficiaries under MGNREGA

S. No.	Awareness for the basic guideline	Aware		No Aware		Ranks
		Frequency	**%**	**Frequency**	**%**	
1	Awareness about MGNREGA	150	100	-	-	I
2	Job Card should be issued within 15 days of application	88	58.63	62	41.33	IV
3	Employment will be given within 15 days of application for work	83	55.33	67	44.67	V
4	Number of days of works in a year	135	90.00	15	10.00	II
5	Unemployment allowance as per the Act	69	46.00	81	54.00	VI
6	Per day Wage	96	64.00	54	36.00	III
7	Worksite facilities	56	37.33	94	62.67	VII
8	Social audit	35	23.33	115	76.67	VIII
9	Right to Information (RTI) Act	25	16.67	125	83.33	IX

Clearly, these analyses indicate that involvement of women in MGNREGA led to empowerment of rural women in the realms of education, savings, and access to credit, social participation and cash income earned through income generating activities. These findings stand resonance to a number of earlier studies (Bhattacharyya, 2016; Fraser, 2015 amd Roy and Singh).

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