

**STATUS PAPER**

## Hill horticulture – status, problems and strategies

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**ABSTRACT** The hilly areas constitute undulated terrains with a variety of agro-climatic conditions, low population density, very low per capita availability of land and practical difficulties in intensive cropping. For economic upliftment of the rural hilly community and environmental restoration, proper land use planning has to be done with different horticultural and plantation crops. Cultivation in these regions is carried out in fragmented and terrace fields. The farming system i.e. agriculture as well as horticulture is mainly dependent on composition of the soil, position of the field, slope aspects, presence/ absence of irrigation, density of the population and their literacy rates etc. In order to boost up the horticulture sector central and state governments are working through introduction of Horticulture Mission for North East and Himalayan (HMNEH) States is a part of Mission for Integrated Development of Horticulture (MIDH) scheme, being implemented for overall development of Horticulture in NE and Himalayan states. A complete package of supply coupled with marketing and processing facilities should be made available at subsidized prices to the farmers in the hilly areas. Crop diversification should be targeted with special emphasis on high value crops such as vegetables, vegetable seeds, orchids, spices and mushrooms with adequate marketing facilities.

**KEYWORDS** Horticulture, hills, mountains, floriculture, status, strategies

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### INTRODUCTION

The hilly areas constitute undulated terrains and they are mostly fertile and has a variety of agro-climatic conditions. Due to varied climatic conditions, these hills are suitable for tropical, sub-tropical and temperate horticulture. The rainfall is, by and large high in most of the hilly regions and fairly widespread. Though the soil and climate conditions are highly favourable for practically growing all types of horticultural crops, in reality the organised horticulture in these hilly regions is relatively scanty compared to the plains. Though cultivation is practiced in few pockets of these hilly regions, still a major portion of the hill tracts remains untapped.

In the hilly areas, undulating landscape constitutes the most fragile elements of the ecosystem and the traditional economy rests on the terraced cultivation with extremely limited feasibility for expansion and modernization. Consequently, low economic return remains the characteristic feature of the agrarian landscape in these regions. It is the common experience that the ecological conditions of the basin are more suited to fruit cultivation rather than cereal farming (Atkinson 1882). Along with fruit cultivation, tea garden practice and cultivation of seasonal vegetables will boost up the regional economy (Sati 2004).

The population density in these hilly regions is very low but the per capita availability of land in these regions is also low because vast portions of the land couldn't be covered with traditional agricultural crops presumably due to the practical difficulties experienced in the intensive cropping in such hilly terrains. For economic upliftment of the rural community inhabiting these hilly terrains, proper land use planning has to be done with different horticultural and plantation crops. In view of soil conservation and ecological points of view, it is also desirable to cover the hills with perennial vegetations (Ghosh 1985).

Horticultural practice in the hilly regions is of great importance not only for economic development but also for environmental restoration. In the entire Himalayan mountain system, from Jammu and Kashmir Himalaya to Assam Himalaya, the practice of horticulture is centuries old, which includes the availability of variety of fruits (Papola 1996). In most of the hilly areas, the practice of horticulture does not get to commercial level; only it is cultivated domestically. The climatic conditions range from sub-tropical (low-lying river valleys) to Alpine and cold (highly elevated regions) in the Himalayas and are suited for diverse fruit cultivation. Besides this, the variety of fruit cultivation in this basin ranges from mango-guava papaya, stone-nut, citrus to apple in the different elevations. Among the citrus fruit, lemon, elephant citrus, orange, malta, kinnow and others are prominent. Along with cultivated fruits, a variety of wild fruits were also found in the hilly forests. In addition to this, vegetable cultivation is also carried out on the slopes of the hilly basin at different altitudes where both indigenous tropical as well as temperate vegetables are cultivated to considerable extent. Among the flowering plants, orchids, tulips, anthuriums, gerberas etc. can be cultivated in these regions. Tuber and rhizomatous crops like potato, tapioca, sweet potato, dioscorea, colocassia, ginger and turmeric grow very well in these regions while the plantation crops like Arecanut, cocoa, tea, coffee and rubber were introduced on commercial scale in certain hilly regions of our country. As the current position stands, there are certain inhibiting factors, especially poor transportation and marketing, that hinders the rapid growth of the horticulture sector in these hilly regions.

### Historical background

Mountain agriculture/ horticulture is characterized by the internal variability with a multiplicity of highly localized and complex micro eco-system. It can be distinguished by complex and multiple farming system such as agriculture, animal husbandry, horticulture, pisciculture, agro and social forestry. Cultivation in these regions is carried out in fragmented and terrace fields. Although efforts to develop hill horticulture were initiated in early fifties, the systematic planned development programmes have evolved in the late sixties only.

Though our hills abound in the wild forms of temperate fruits like apple, pear, apricot and peach, yet their cultivation in India on a commercial scale is only of a recent origin. It was the keen eye of the European settlers and Western missionaries, who found immense potentialities of growing these fruits in our hill areas. They were convinced by the existence of the wild forms and inferior, indigenous varieties of these fruits

in abundance all over the hill ranges. They found that, the climatic conditions in these hills are congenial, and more or less akin to those in Europe. Since the local people were backward and steeped in poverty, they could provide cheap labour for work in the orchards and for the transport of fruits on their backs or on the mules, there being no vehicular traffic in the area in those days. These considerations tempted them to settle down in these hills and go for fruit growing.

It was around 1870 that these settlers and missionaries started cultivation of fruits in Kulu in the Punjab, Simla Hills (now comprising Himachal Pradesh), Kumaon Hills in Uttar Pradesh and Kashmir. The varieties of fruits planted in the orchards were imported from England, France and, later on from Japan.

The State departments of agriculture in Punjab, Uttar Pradesh and Kashmir, got convinced of the success of the hill fruit industry, began to encourage and help the industry. The assistance given by them was in the form of importing and propagating fruit plants and supplying them to the fruit growers, spraying the orchards against San Jose Scale, and affording facilities for the marketing of the fruits.

Punjab Agriculture Department, in early thirties of the past century, launched very ambitious trials at Palampur with about 250 varieties of temperate fruits imported from the U.S.A., England, France, Italy and Palestine. The region being very rainy, the annual precipitation going as high as 116 inches, and the soil being a little too acidic, the trials were not very successful and the horticulture industry did not make much headway in this region. However, the later project of the Punjab Government with establishment of a Horticultural Research Station at Kulu in 1950, met with a spectacular success (Thapar 1960).

The Horticulture Department of the erstwhile Patiala State imported several thousand fruit plants of about 200 varieties from California, France and Italy. These plants were tried at nine different centres on elevations ranging from 2,000 to 9,000 feet above sea level. As a result of these trials, extending from 1938 to 1948, some promising varieties were selected and multiplied for distribution among fruit-growers at a cheap price. During the British Raj, Mahabaleshwar was the perfect summer getaway for the Bombay province and is located 120 km from Pune and 250 km from Mumbai. In the 1920s it was here that the English first introduced strawberries to India and now it has become a popular strawberry exporter.

Coffee production in India is dominated in the hill tracts of South Indian states, with the state of Karnataka accounting 53% followed by Kerala 28% and Tamil Nadu 11% of production of 8,200 tonnes. The first record of coffee growing in India is followed by the introduction of coffee beans from Yemen by



Baba Budan to the hills of Chikkamagaluru in 1670. Since then coffee plantations have become established in that region, extending south to Kodagu. Indian coffee is said to be the finest coffee grown in the shade rather than direct sunlight anywhere in the world. Almost 80 % of the country's coffee production is exported.

#### **Factors favouring development of horticulture**

The farming system i.e. agriculture as well as horticulture is mainly dependent on some factors *viz.* the composition of the soil, position of the field (its relative height above the mean sea level), slope aspects, presence/ absence of irrigation, density of the population and their literacy rates etc. (Sati 2004).

##### **(i) Land: altitude and slope**

The landscape of these hilly regions governs the relief, snow clad peaks, glaciers, deeply dissected topography, antecedent drainage and complex geological structure. Based on the altitude and slope, the hilly areas especially in the Himalayan zone are categorized as Himachal, Himadri, Alpine belt, Sub-alpine belt, Temperate belt, Sub-temperate and Sub-tropical belts. The altitudinal lapse rate of temperature bears seasonal influences in these regions. Altitude is one of the important factor controlling inter and inter-regional variation in the temperature distribution. The vertical distribution of height, as a function of temperature lapse rate, works as a temperature controlling phenomenon in these hilly areas.

##### **(ii) Climate: temperature and rainfall**

The climate in these hilly regions is highly manifested by the altitude of the hills. In these areas of complicated relief, the micro-climates are of higher significance. Thus the major factors determining the climate of these regions include altitude, relative relief, slope, direction of mountain ranges and their placement. In addition to these, the nature of vegetation, colour, texture and depth of soil along with the dimensions of the waterbodies further influence the micro-climatic conditions.

The rainfall varies considerably with the height and its quantity is dependent on the situation of the place to a greater extent *viz.* windward or lee ward of high ridges and peaks. In valley areas, there is a steady decrease in total amount of rainfall and is followed by further increase in correspondence with height. Cloud bursting was also reported in certain hilly areas which results in local-floods, damaging considerable portion of low-lying irrigated plots. The direction of relief also controls the climate in these areas, where the south facing slopes are relatively more sunny and get larger amount of rainfall.

##### **(iii) Soil: composition and texture**

The nature and characteristics of soil at different locations and situations would have developed as a result of interaction of soil genetic factors, climate, relief, vegetation, parental rock and time in addition to the human influences. The valley structures especially in the Himalayan regions generally consist of alluvial and diluvial materials. In certain valleys, broad terraces are formed through deposition of sediments forming parental side alluvial terraces while the structural terraces are formed through the process of mineral transformation, pedo-chemical reactions and rock disintegrations.

In general, the cultivable lands in the upper terraces (unirrigated lands) are of poor quality as they have less amount of organic matter and nitrogen while the lower basins are relatively fertile because the river valleys have thick cover of soil with high percentage of organic matter and nitrogen.

##### **(iv) Manpower: population, literacy, etc.**

Manpower constitutes one of the essential elements of the agriculture or horticulture. In general, the population density and their literacy rates are very low in these hilly regions compared to the plains which might be due to the absence of appropriate infrastructure facilities in these areas. The literacy and education stand in direct relation to other aspects of modern developed economic system. Literacy increases the consciousness and develops the sense on in ones surrounding physical and economic environment.

#### **Crops suitable for hilly areas**

Due to diverse agro-climatic zones available in the hilly terrains of our country, a large number of flora including fruits, vegetables, tuber crops, plantation, medicinal and aromatic crops, ornamental plants etc. are successfully grown under natural conditions. Many crops grown in these hilly regions have secured GI tags *viz.* Darjeeling tea (West Bengal), Kangra tea (Himachal Pradesh), Monsooned Malabar Coffee (Karnataka), Virupakshi and Sirumalai hill banana (Tamil Nadu), Mahabaleshwar Strawberry (Maharashtra), Coorg Green Cardomum and Orange (Karnataka), Appemidi Mango (Karnataka), Naga Mircha (Nagaland) etc.

#### **Fruits**

Pome fruits (Apple, Pear); Stone fruits (Cherry, Plum, Peach, Apricot); Nuts (Almond, Chest-nut, Hazel-nut, Pecan-nut, Walnut); Berries (Strawberry, Rasp berry) Citrus (Sweet orange, Mandarin, Lime and lemons) Mango, Guava, Pomegranate, Papaya, Grape, Kiwi fruit, Other minor fruits (Litchi, Rambutan, Loquat, Durian, Mangosteen, Persimmon)

### Vegetables

Pot-herbs and Greens (Spinach, chard, fenugreek, *karam sag*, coriander, purslane and edible amaranthus; Salad Crops (lettuce, celery and beet); Cole Crops (cabbage, cauliflower, and kohlrabi); Root Crops (beet, carrot, turnip and radish); Bulb Crops (onion, leek and garlic); Potato, Peas and Beans; Solanaceous Fruits (tomato, egg plant and chillies); Cucurbits (cucumber, musk-melon, watermelon, pumpkin, squash, bitter ground, tinda, bottle gourd, ash gourd, sponge gourd and luffa); Perennial Crops (Asparagus, rhubarb, artichoke, Jerusalem artichoke and mint); Rhizomes (elephant ear, elephant foot and ginger); Other Crops (okra and sweet potato)

### Ornamentals

Annuals (Bulbous-tulips, narcissus, alstromeria from Himachal Pradesh, liliiums from Ooty, Sweet Williams, ferns too) limonium, statice, gomphrena, helichrysum) Biennials (Anthurium, Carnation, Gerbera); Perennials (Saffron, Orchid, Sweet Williams)

### Current scenario

Major hilly areas in our country are located in the Himalayas and this fall into two distinct geographical regions with wide variation in climate, land use and culture. Thus they can be broadly classified into (1) Western Himalayan region comprising of Jammu and Kashmir, Himachal Pradesh and Uttarakhand; and (2) Eastern Himalayan region comprising of Assam, Arunachal Pradesh, Manipur, Mizoram, Meghalaya, Nagaland, Tripura and Sikkim and Siliguri-Darjeeling districts of West Bengal. In addition to these, in the southern India we could find the (i) East coast hilly region stretched over Tamil Nadu, Andhra Pradesh and Orissa; and (ii) West Coast hilly region spreading from Kerala, Karnataka, Goa and Maharashtra.

#### (i) Western Himalayan Hill Region

Physically the Himalayas are classified as the lower hills with an elevation of 600-1250 m comprising the 'Shivaliks', Duns, Bhabar, and Tarai areas with tropical to temperate climates. The middle hills with elevations ranging from 1250-1850 m with temperate climate and higher hills of elevations from 1850-8000 m and above with arctic climate. Hill agriculture/horticulture though peculiar in many ways, is limited by low land to man ratio (Saxena 1988). Another major attribute of hill horticulture is that about 55 % of the cultivators are marginal to semi-medium farmers holding less than 4 ha. The medium and large farmers constitute only 8 % of the total farmers in the hilly regions (Jindal and Sharma 2004). Brief details on the cultivation in these areas are discussed hereunder.

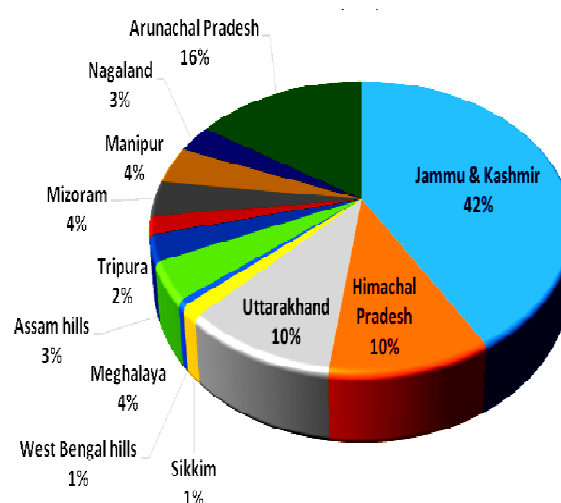


Fig 1 Share of geographical area of different states in Himalayan region

a. **High hills:** It is suitable for growing temperate or cold region fruits like apple, pear, cherry and walnut. Among these, cherry requires the coldest climate and is generally grown on elevations of 2000-3000 m. Next come apple, white pear and walnut, which are grown on lower altitudes in this zone. Besides altitude, the distance from the plains also determines the suitability of a place for the growing of these fruits. In the Kulu and Srinagar Valleys in the interior of the hills, apple is grown successfully even at an elevation of 1200 m, while in the Simla Hills which are nearer to the plains, it is not grown at elevations of less than 1800 m above sea level. In addition to these, the flowering Potted plants viz. Cyclamen, Primula, Begonia tuber hybrida, Primrose, Clivia, Tulip, Hyacinth, Daffodils; Foliage plants viz. Aucuba, Cupressus (golden), Rex begonia were cultivated.

b. **Middle hills:** This zone covers areas situated at elevations ranging from 900-1500 m above sea level. It is suitable for growing nuts and stone fruits like peach, plum, apricot and almond. These fruits require a somewhat warmer climate than the group of fruits grown in high hills, but a cooler region than citrus and mango. Peach, plum and apricot grow very successfully in this zone as well as in the lower portions of the high hills. The flowering potted plants viz. Flowering geranium, Hydrangea, pot mum, miniature roses, Hyacinth, daffodils and Foliage plants viz. Rubber plant, Philodendron, Araucaria, money plant, Syngonium, Aspidistra, Aglaonema etc. were grown here. The best results are obtained in areas which do not have excessive rainfall. Rainfall above 60 inches is considered excessive, the optimum being between 40 and 60 inches.

c. **Lower hills/ sub-montane areas:** This zone comprises the tract extending from the foot of the hills up to an elevation of 900 m above sea level. It represents the meeting line of fruits of the low hills and the plains. Certain varieties of stone fruits grown in the low hills, as well as fruits of the plains such as citrus, mango, guava; loquat and litchi, can be grown in this zone. Grafted plants of mango are very susceptible to frost injury and, therefore, should be planted in places not subject to severe frosts, or, otherwise, the plants should be protected.

d. **Cold arid region/ Leh-Ladakh region:** In addition to the hot arid regions of Indo-Gangetic plains and peninsular India, a considerable part of cold arid regions were observed in western Himalayas mainly comprising Ladakh area of Jammu and Kashmir State and some parts of Lahul-Spiti sub-division in Himachal Pradesh. The major crops suited to this region include grapes (raisin type), prunes and drying varieties of Apricots. Minor crops such as seabuckthorn are also cultivated besides cultivation of apple, walnut, currants in certain areas of the region.

In Himachal Pradesh marigold, some cultivars of chrysanthemum, China aster and annual chrysanthemum are cultivated for loose flowers

#### I. High hills

*Flowering Potted plants:* Cyclamen, Primula, Begonia tuberhybrida, Primrose, Clivia, Tulip, Hyacinth, Daffodils

*Foliage:* Aucuba, Cupressus (golden), Rex begonia

#### II. Mid hills

*Flowering potted plants:* Flowering geranium, Hydrangea, pot mum, miniatureroses, Hyacinth, daffodils

*Foliage:* Rubber plant, Philodendron, Araucaria, money plant, Syngonium, Aspidistra, Aglaonema.

#### (ii) North Eastern Hill Region (NEHR)

The north eastern India of our country comprises of eight states, Arunachal, Assam, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura. The NEHR is bounded by four countries, like Bangladesh, Bhutan, China and Myanmar. The region occupies about 5.6 % of the total geographical area in our country. The varied climate, altitude, edaphic conditions etc. leads to enriched biodiversity in this region. A large number of horticultural crops are grown in the north eastern region, many of them were originated in this region like banana, mango, a large number citrus species, flowers, etc. Among the North eastern states, Assam occupies maximum share in fruit production and area followed by Arunachal Pradesh and Tripura. Similarly,

in vegetable production Assam occupies maximum in production and acreage under the crop (Sati 2004).

Production of horticulture crops ranging from fruits, vegetables, flowers, spices and plantations has shown vertical growth in the recent years with the intervention of high yielding varieties, improved production technologies and quality planting materials etc. The growing awareness and hype for organic produce has also boosted the North East economy as the region has natural advantages for organic cultivation (Borthakur and Nath 1992). North eastern region can also be accounted for protected cultivation of high value crops like colored capsicum, cherry tomatoes, strawberry and flower crops of exporting quality. It is encouraging to note that Anthurium of North East Region is being successfully marketed in European and Middle East Countries. However, lack of awareness of post harvest management practices and adequate marketing remains a setback.

In the past several decades, the nurseries of Kalimpong area were very much involved and buzzing with floricultural activities and developed their own techniques in tissue culture propagation of orchids and other related floricultural plants. Exports from these hills also started 5-6 decade back. For the unlimited scope in the present multi-million dollar floriculture industry, these hills are the natural habitat for innumerable plant species and thus much has been achieved till date by our floriculturists. However, this region still has enormous potential. With the global floricultural trend these hills have limitless scope for production of Gladioli cut flowers to cater to the demand of both the domestic as well as the export market. Cut flower started trade over three decades back. Today other cut flowers, besides Gladioli are anthuriums, Orchids particularly Cymbidiums, bulbous flowers of lilies, ornithogalum and other flowers like gerberas, carnations and greens like ferns are under production (Raj 2005).

The Darjeeling Hill area represents a unique geo-environmental perception with more or less uniform lithology, structure, climate, soil and vegetative covers. The principal economy of Darjeeling Hill Area depends on tea production, horticulture, agriculture and forestry. The major portions of the forests are today found at elevations of 2000 m and above. The area located in between 1000-2000 m is cleared either for tea plantation or cultivation. Darjeeling hills are also the natural home for countless orchid species like Cymbidiums, Vandas, Dendrobiums, Paphiopedilums, Lycaste, Odontoglossum, Phaius, Arundina etc. the list being endless.

#### (iii) East Coast Hill Region

The East Coast Hilly Region also popularly known as 'Eastern Ghats' are isolated hill ranges in Peninsular

India. They run from West Bengal state in the north, through Odisha and Andhra Pradesh to Tamil Nadu in the south passing some parts of Karnataka. They are eroded and cut through by the four major rivers of peninsular India, known as the Godavari, Mahanadi, Krishna, and Kaveri. They harbor primarily tropical moist deciduous vegetation, which represents species of high economic, timber, and medicinal potential. Eastern Ghats are highly significant in terms of its biodiversity (Singh 2013).

North of the Kaveri river are the highest Shevaroy hills, generally cooler and wetter than the surrounding plains and thus became the home of coffee plantations. Jackfruit, star apple, fig, lacota, water apple, oranges, guava and spices such as black pepper and cardamom are other crops raised in the coffee estate. Presence of National Orchidarium in the Yercaud hill station indicates the moderate humid subtropical climate.

Araku valley is a famous hill station located in the Vishakhapatnam district of Andhra Pradesh inhabited by different tribes. It is popular for its famous coffee plantations, though started recently as a non-traditional area for coffee cultivation. India's first tribal growers' organic coffee brand was launched in the Araku Valley in 2007. The premium organic "Araku Emerald" brand of coffee sells globally. Thousands of tribals in the Agency area are engaged in coffee cultivation as farm hands or small farmers. Likewise, in Odisha we have Daringibadi, widely known as "Kashmir of Odisha" is a hill station gifted with natural bounties including pine jungles, coffee gardens and beautiful valleys.

#### (iv) West Coast Hill Region

The West Coast hills / Western Ghats extend from the Satpura range in the north, go south past Maharashtra, Goa, through Karnataka and into Kerala and Tamil Nadu. The narrow valleys of these ghats are naturally fertile as they receive silt and nutrients drained-off from the hill slopes. Recent decades have witnessed submersion of certain areas under river valley projects, damage by uphill mining of certain areas, shortage of organic manures in the form of leaf manures. At the same time there were positive signs such as improvement in the yields through high yielding varieties, chemical fertilizers, pesticides and modern irrigation facilities. However, there is an increasing doubt as to whether we can sustain these improved yields through intensive horticulture on a long term basis. Because, the use of chemical fertilizers alone will deplete the micronutrients in the soil, pest and pathogens may develop resistance to the available chemicals and the exhaustion of genetic variability of indigenous races of crops may limit us in tackling new diseases or pests. These fears are not hypothetical but are based on the current happenings where for example, the productivity of arecanut orchards in

Uttara Kannada with good availability of leaf manure is substantially higher than those in the Dakshina Kannada which have very little organic manure. Also, the pepper crop in many parts of Karnataka has been totally destroyed by a fungal disease (Gadgil 1984).

The warm, humid climate of the Western Ghats is conducive to plant growth all year round. A vast collection of grasses, herbs, shrubs and trees grow in the varied ecosystems of the region. Some have been commercially used-even over-exploited. Others have their commercial or ornamental value yet to be discovered. This region is thickly populated and famous for exotic food crops, spices, herbs and medicinal plants. Arecanut, Jack fruit, bread fruit and mango have been the traditional horticultural crops of Western Ghats while coconut has been cultivated on the coastal plains. In the forests of Western Ghats, there are natural plantations of centuries-old Appemidi mango trees in the valleys of the Aghanashini, Kumudvati, Kali, Varada, Bedthi and Sharavathi rivers in Uttara Kannada and Shimoga districts. The trees are also found in places like Chittoor and Khanapur in Belgaum and parts of Chikmagaloor district. Though Pepper and cardamom were cultivated to a limited extent, but collected mostly from the forests on a very large scale. The hill horticulture scenario has been revolutionized over the past century though large scale introduction of tea, coffee, black pepper, vanilla, nutmeg, cloves, all spice, cardamom, rubber, cashew and more recently, cocoa plantations. These tree crops are environmentally more desirable replacement of natural forest compared to the cultivation of millets and tapioca.

Coffee production in India is dominated in the hill tracts of South Indian states under monsoon rainfall conditions, and hence termed as "Indian monsooned coffee". Among different coffee growing states, Karnataka accounts for 53% followed by Kerala 28% and Tamil Nadu 11% of production of 8,200 tonnes. Indian coffee is said to be the finest coffee grown in the shade rather than direct sunlight anywhere in the world. There are approximately 250,000 coffee growers in India; 98% of them are small growers and almost 80% of the country's coffee production is exported.

In the hilly areas of Kodagu, Hassan and Chikmagalur, Coorg orange was cultivated as a secondary crop in coffee plantations for more than 150 years. The hilly terrain with well-drained soil and heavy rainfall in the region of cultivation gave unique characteristics of this variety leading to allocation of geographical indication (GI) tag in 2006.

The Nilgiris district, known as "The Queen of Hills" is situated at an elevation of 900-2636 metres above MSL. The climate is temperate to sub-tropical. About 60% of the cultivable land falls under the slope ranging from 10%-33%. Nilgiris being a horticulture

district, the entire economy depends on horticultural crops like potato, cabbage, tea, coffee, spices and fruits (Fyson 1975).

Hill bananas (AAB, two ecotypes Virupakshi and Sirumalai) are grown at a height of 2000 to 5000 feet with well distributed annual rainfall of 1250-1500 mm in the lower Palaini, Sirumalai and Kolli hills. Hill bananas, unique to the state of Tamil Nadu are perennial in nature, and are cultivated along with coffee and pepper as a multitier system. They are well known for their special flavour and long shelf life. Hill bananas are highly susceptible to Banana bunchy top virus (BBTV) which has been the sole cause for reduction in Hill banana cultivation from 18,000 ha in 1970s to a mere 2,000 ha at present.

The commercial cultivation of kokum is concentrated in western ghat region especially only in southern part of Konkan region of Maharashtra state and Goa state. After realizing the importance of existing kokum trees in the region, Government of Maharashtra started encouraging the farmers of the region to grow kokum by planting kokum orchard in systematic manner under employment guarantee scheme (Braganza et al. 2012).

Mahabaleshwar is one of the hill station located in the Western Ghats range under the state Maharashtra. Due to the red soil / mud and other favorable climatic factors in Mahabaleshwar and Panchgani, strawberry, raspberry, mulberry, gooseberry and blueberries are grown in abundance. Mahabaleshwar strawberry contributes to about 85 percent of the total strawberry production in our country. The Britisher's brought these strawberry plantations from Australia and planted in Panchgani and Mahabaleshwar and today these strawberries etc. are exported to various countries. It has also received the geographical indication (GI) tag in 2010.

The Western Ghats are home to 250 orchid species, of which 100 are endemic. There are 71 species of Impatiens, some species of palms, 150 species of grasses and other plants of ornamental value. A host of introduced plant species, including Hibiscus, Lantana and Capsicum have naturalized in this region. The government focuses attention on commercial floriculture by identifying centers where particular plants can thrive (such as orchids in Kerala), and promotes the industry through generous subsidies (Raj 2005).

#### **Role of government agencies**

In order to boost up the horticulture sector in these non-traditional hilly areas, the central government as well as the state governments are working hard through introduction of various missions and schemes. Some of these are discussed here under:

Horticulture Mission for North East and Himalayan (HMNEH) States is a part of Mission for Integrated Development of Horticulture (MIDH) scheme, being implemented for overall development of Horticulture in NE and Himalayan states. The mission covers all NE States including Sikkim and three Himalayan states of Jammu and Kashmir, Himachal Pradesh and Uttarakhand. The mission addresses entire spectrum of horticulture from production to consumption through backward and forward linkages.

Through implementation of the Technology Mission (a project under Ministry of agriculture, Govt. of India) on horticultural crops in the north eastern region, the government has made a significant contribution in the field of area expansion, crop production, productivity, marketing, value addition and post harvest management. Special mention may be made like introduction and cultivation of tissue culture banana plants, improved varieties of apple, kiwi and other temperate fruits in higher elevation, commercial cultivation of flowers like orchids, anthurium, roses, gerbera, liliun etc.

In Jammu and Kashmir, the state government is promoting the hill horticulture through introduction of schemes such as (i) Rural appraisal for livelihood systems; (ii) Seed and Planting Material Production Drive; (iii) Rashtriya Kisan Vikas Yojna; and (iv) Tribal Sub-Plan etc.

Agriculture and Organic Farming Group (AOFG) India is a network of community based grassroot level development organizations, farmers associations, farmer federations, farmer limiteds and rural NGOs. They work with small and marginal farmer collectives and indigenous communities in the rain-fed, mountain slope farming and shifting cultivation areas.

*Role of the Indian Council of Agricultural Research.* A great fillip to the development of the fruit industry in the Kumaon Hills was given by the Indian Council of Agricultural Research. The Council financed a big scheme of research on various aspects of the temperate fruit industry at Chaubattia in Almora District. The scheme remained operative from 1934 to 1955, and greatly helped in the expansion of the area under temperate fruits and the planting of orchards on the right lines. Also, ICAR has established certain research institutes for horticultural development in the hilly areas viz. (i) National research centre for Orchids, Sikkim (ii) Central Potato Research Institute (CPRI), Shimla, Himachal Pradesh (iii) Central Institute of Temperate Horticulture (CITH), Srinagar, J and K (iv) Vivekananda Parvatiya Krishi Anusandhan Sansathan (VPKAS), Almora, Uttarakhand (v) ICAR Research Complex for North East Hilly Region, Barapani, Meghalaya.

### Success stories of horticulture in hilly regions

With the implementation of various schemes and missions offered by the state as well as central governments, the small and marginal farmers in these hilly regions could make their life sustainable and are moving towards profitability. Some of the success stories from the progressive farmers of the hilly regions are as follows:

Shri. Abelson Marbaniang, popularly known as Bah Ion hails from a non-descript village in Mawreng under Mawphlang Community and Rural Development Block. He started his farming as an ordinary vegetable grower but gradually diversified to floriculture. Today, he is one of the most successful growers of flowers and fruit plants in the East Khasi Hills District.

Laitjem village and its surrounding are climatically suited for Pea cultivation and most of the households cultivate Pea extensively. With the implementation of HMNEH Scheme from the office of the District Horticulture Officer, East Khasi Hills, Shillong ten farmers were identified for cultivation of Pea hybrid (Azad) in a cluster mode where the farmers were supported with necessary inputs and technical guidance. Inputs like seeds, pest and pathogen Chemical, Sprayers, Organic manure have been distributed to the above farmers. The area is now well known for pea cultivation and considered as a "Model Village for Pea cultivation"

Strawberry cultivation in Gousoo village is an example for healthy transformation under Horticulture Mission, a small area of 1/8th acre of land was brought under cultivation of strawberry in a village called Gousoo on the outskirts of Srinagar city. With the assistance of Horticulture Mission and continuous guidance of the department Shri Abdul Ahad Mir has emerged as a leading strawberry grower who earned National and State awards. Farmers in the vicinity have also started harvesting the benefits of diversification and as such it has contributed for the upliftment of the economy in that area. Gousoo is now called a strawberry village.

In the Meghalaya, the directorate of horticulture has taken up two projects on floriculture. (1) The Rose Pilot project which was initially started at Dewlieh Departmental Farm in Ri-Bhoi district at an area of 0.5 ha has been a success with a production of 2500 cut flowers per day. Today, Rose, Liliun and Anthurium cultivation has also been extended to farmer's field in village clusters through self-help groups and individual farmers. (2) The Anthurium project at Samgong Horticulture farm is a tourist spot for farmers, high power dignitaries and the common people. This is because of the success of the project taken under the cultivation of the flower. The excellent marketing of anthurium as cut flower gives a phenomenal impact to

the farmers which encouraged them to go for commercial group cultivation.

In Jammu and Kashmir state, a significant improvement in production and productivity was observed with the implementation of Horticulture Mission and resulted in changing the financial scenario of the farming community. Besides economic upliftment of the farmers, Horticulture Mission has directly and indirectly contributed for social reforms.

Sri Haradhan Das, from Chotosurma village of Dhalai, Tripura has been transformed from the stage of food insecurity to self-sufficiency and significant level of economic upliftment through multiple cropping system approach assisted by Horticulture Technology Mission (HTM) Programme.

Mrs. Subbalakshmi from Nanjanad, Tamil Nadu owns a limiting land of 18 cents and was struggling for survival. She was being approached by the field functionaries of National Horticulture Mission (NHM) and was asked to take up floriculture through erection of Hi-tech Poly green house. She responded positively and now she is doing floriculture perfectly and realizing tangible monthly income regularly.

### Issues and strategies relating to climate change

Horticultural crops are adapted to a wide range of climatic conditions, produce higher biomass per unit area as compared to field crops, are more remunerative for replacing subsistence farming and thus may aid in alleviating poverty in difficult agro- ecosystems as rain fed, dry land and hilly areas. Increase in demand for horticultural produce due to greater health awareness, rising income, export demand and increasing population poses the challenge for further increasing the production and productivity of horticultural crops. The issue of climate change and climate variations has resulted in more uncertainties and risks in this already high capital intensive system. This has resulted in further aggravating the constraints on horticulture production system. Major challenges before us is to have sustainability, higher levels of production, competitiveness to stay in market, regular production, land, water and more importantly threat of climate change. In order to meet the above challenges we need innovations for improving horticultural crops production in changed scenario (Lal and Tandon 2015).

Climate change results in erratic rainfall pattern, heat waves, more warm spells and crop failures. However, climate change may have some beneficial effect to a limited extent. The vulnerability of horticulture depends on both expected regional climate change and that sector's ability to adapt to the change. The projected or anticipated increase in temperature, variability in precipitation pattern and increase in frequency of extreme weather events such as heat, cold waves, frost days, drought and floods would severely

affect the production of horticultural crops. These stresses at different crop development phases in varying intensities would ultimately determine productivity and quality.

Indian climate is dominated by monsoon, responsible for most of the regions precipitation, poses excess and limited water stress conditions. Fruit crops being sensitive and succulents are generally more sensitive to environmental extremes. High or low temperatures and water stress are the main cause of low yields. Under climate change scenarios the impact of these stresses would be compounded. The horticultural crops having C3 photosynthetic metabolism have shown beneficial effects due to elevated carbon dioxide. In perennial, crops like mango and guava, temperature is reported to have influence on flowering. The percentage of hermaphrodite flowers is more in late emerging panicles, which coincided with higher temperatures. The rise in temperature will influence the survival and distribution of pest populations. It also increases nutrient mineralization in soils that will decrease fertilizer use efficiency. Increase in temperatures at fruit maturity stage results in fruit cracking, burning and premature ripening of certain fruits.

Many slow growing fruit crops require heavy investment on establishment of orchards. Changing the existing varieties would be difficult and very costly under the impact of climate change. In Kullu district of Himachal Pradesh, farmers have shifted from apple cultivation to either pomegranate cultivation or to vegetable growing. While, in Shimla district at relatively higher altitudes orchards have been replaced from high chilling requiring apple cultivars (Royal Delicious) to low chilling requiring cultivars and other fruit crops as pear, plum and kiwi etc. In mid hills the trend is altogether shifting from apple cultivation to vegetable cultivation due to erratic weather conditions and reducing chilling hours. It is corroborated by declining trend in snowfall and apple productivity in Himachal Pradesh and Jammu and Kashmir. Thus in replanting orchards and in new plantations during these years, selection of low chilling types may be advisable. This is an example of impending impact of climate change. Hence, under such circumstances, we would have to identify varieties and regions suitable for production of quality fruits (Lal and Tandon 2015).

With global warming production areas for specific crops and/or time of planting could be changed. For many horticultural crops areas have been defined for different fruit crops and creating new infrastructures in new areas would not be an easy task. Thus, climate change and CO<sub>2</sub> are likely to alter important interactions between horticultural plants and pollinators, insect-pests, diseases and weeds etc. Keeping in view the nature of crop, its sensitivity

levels and the agro-ecological regions in hilly regions, the crop based adaptation strategies need to be developed, integrating all available options to sustain productivity. To prepare ourselves for climate change and for formulating a sound action plan we must identify the gaps in information, prioritize researchable areas, and formulate concrete policies.

#### **Constraints for hill horticulture**

The cultivation in the undulated hilly areas is fraught with lots of constraints and some of them include:

- The hilly soils are marginal in fertility in most cases. Though they are sometimes rich in organic matters, but they are poor sources of the major nutrients like N, P and K. Also, they are shallow in depth with presence of hardpans in the upper horizons, thus can't provide a good base to the crop plants. Often, these soils are acidic and damaging to the crop plants.
- Owing to their undulating topography, the soils in these hilly areas were highly susceptible for erosion, especially due to the wrong cultivation practices such as *Jhuming*.
- The operational holdings in these areas were very small and thus the mechanization of horticulture has become a distant reality. This creates the need for high human energy inputs and drudgery.
- Low crop yields due to non-availability of the seed material of the high yielding varieties (HYV), along with other inputs such as fertilizers and pesticides.
- Due to higher dependence on the monsoon rainfall, only limited number of crops can be cultivated here and the crop diversification is of great need.
- Major bottleneck in the development of horticulture and its processing sector in this areas is the lack of proper transport and communication facilities.
- The farmers in these hilly regions follow primitive and traditional cultivation practices as the farmers are not well informed of the modern techniques of farming and production.

#### **Measures to improve Hill Horticulture**

- In north eastern hill areas where jhum or shifting cultivation is a problem, an alternative must be thought off as the legislative ban alone can't prevent it.
- As the hill areas have huge potential for horticulture, a complete package of supply if inputs (quality seeds, standardized saplings, fertilizers and pesticides) coupled with marketing and processing facilities should be made available at subsidized prices to the farmers.
- Proper research backup should be organized in the fields of horticulture and forestry.



- Need to strengthen the storage and cold storage facilities for the horticultural produce along with transport and communication network.
- In the hilly areas, crop diversification should be targeted with special emphasis on high value crops such as vegetables, vegetable seeds, orchids, spices and mushrooms with adequate marketing facilities.
- Women in the hilly areas should be trained in handling and preservation of fruits and vegetables for home use and for use in the small scale industries as raw materials.
- Since the ground water irrigation often leads to iron toxicity in the hilly regions, we should emphasize on surface irrigation and where the surface water potential is low, it should be on conservation of rain water.
- Cultivation of export potential crops such as tea, coffee and cocoa should be promoted in hilly areas with abundant rainfall, red-loamy and acid soils.
- Other subsidiary occupations such as apiculture, sericulture, fisheries, piggeries etc. should be promoted in these hilly areas with appropriate technical and financial support.
- Medicinal and aromatic crops suited to these hilly areas should be developed by researchers as these crops fetch high revenue in internal as well as external markets.

#### **Future scope**

It has been estimated that the mighty Himalayas, with a length of some 1,500 miles and breadth of about 150 miles, are capable of accommodating some 400 million fruit trees or about four million acres of orchards, without violently disturbing the present acreage under forests and farm crops.

There is a considerable area which at present is lying barren, and where nothing but grass grows during the monsoon season. Such areas are known as ghasnis or grasslands. They can be converted into fruit orchards, and still provide the same amount of grass, if not more, as the orchards will then be under sod. Most of these lands are the property of villagers, and fruit-growing there can be developed on a cooperative basis.

Due to the small size of the terraces and the stony nature of the soil in the hills, the yield from farm crops like wheat, barley and paddy is much lower than that in the plains. On the other hand, the hills are suitable for growing such fruit trees as cannot be grown in the plains. For a proper land utilization, therefore, it is advisable that more and more area in the hills is diverted to fruits for which there is an unlimited demand in the plains. The requirements of food grains of the hill areas could be met by importing them from the plains. It will be a poor crop economy to try to make the hill areas self sufficient in food grains.

There are millions of wild trees of pear, apricot, peach, plum and apple, growing on the edges of fields, roadsides, and on wastelands. All these trees can be converted into trees of selected commercial varieties by top-working. This will result in the increase of the number of fruit trees and enhanced production of fruits without involving any fresh planting

The principal temperate fruit, apple, has a storage period varying from one to four months at ordinary room temperature. It can, therefore, be sent to distant markets in the country and also to foreign countries. There is no fear of overproduction of the fruit and its price becoming unremunerative, as its production will remain restricted to hilly areas.

Increased production of fruits will bring in its wake the development of the fruit preservation industry. This will enable a proper utilization of the low-grade and culled fruits by conversion into jams, jellies, etc. A flourishing canning industry will also develop to take care of perishable fruits like pear, peach, apricot, cherry and plum. Instead of importing fruit products from foreign countries, as is the case at present, a sizable export trade of the canned and preserved fruit could be built up. It is thus obvious that the prosperity of the hill people lies in the exploitation of the potentialities of fruit-growing in these areas. A well-planned programme of horticultural research and development can bring these dormant possibilities to life in a short period.

Most of these hilly regions accommodate tribes who have vast information about the indigenous technical knowledge (ITK) especially with regard to medicinal plants and their uses. It is very important that we should tap the knowledge along with providing protection, royalty and ownership rights to their traditional knowledge. Three broad approaches to protect traditional knowledge have been developed. The first emphasizes protecting traditional knowledge as a form of cultural heritage. The second looks at protection of traditional knowledge as a collective human right. The third, taken by the WTO and WIPO, investigates the use of existing or novel sui generis measures to protect traditional knowledge.

#### **CONCLUSION**

In working out the horticultural farming in the hilly regions, the role of climate under influence of altitude, the nature and aspect of terrain seems to be the most unifying. Fruit and vegetable productivity is directly related with the meteorological conditions of the area. In the same altitudinal belt, windward and leeward sides offer suitable conditions for different types of fruit trees and vegetable along with herbs and tea garden. Besides climate, cultural factors are no less important. In the upper valleys, relatively low pressure (human and animal) of population also appears to be

co-related with the area under horticulture. There are a number of wild trees, shrubs and herbs, which supplement the nourishment of people in the hills. The knowledge of their uses and productive potential is declining. Reasons for this decline are many including absence of market, lack of tested technology/methods for cultivation and value addition, and weak public policies promoting uses of wild edibles.

Horticulture is a much recent land use change, which has succeeded in selected sub regions, particularly Himachal Pradesh and Kashmir in the west. A change from traditional food crop cultivation to agro-horticultural systems succeeded largely because of economic incentives and monetary profits to the farmers, which were ensured through government subsidy, and market demands. Horticultural development in central and north-eastern region is so far not as conspicuous as in the western Himalaya. Environmental and social costs of horticultural development are now being increasingly realized. Horticultural land use expansion often involves encroachment on forestland. Demands for packing the marketable produce becomes a pressing factor for unsustainable harvests from the forestland.

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