

# AGRIHORTICULTURE DEVELOPMENT IN NORTH EASTERN REGION

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## INTRODUCTION

Northeastern region of India comprises eight states namely Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Tripura and Sikkim. The total geographical area of the region is 2.62 lakh km<sup>2</sup>, which is about 8% of the country's total area. The physiography of the region is divided into three divisions namely Meghalaya plateau, northeastern hills & basin, and Brahmaputra valley. The NE hills and basin alone accounts for 65% of the total land area while the Brahmaputra valley and the Meghalaya plateau cover 22% and 13% of the area, respectively. The region still has more than 64% of the total geographical area under forest cover and continues to be a forest surplus region. Environmental degradation is quite active mainly due to traditional system of food production. Control efforts were not succeeded to desired scale. The climatic conditions and topography in different North East states varied from plain to high altitude thereby providing congenial altitudinal variations for the production of forest, cereal crops, vegetables, tropical, sub-tropical and temperate fruits. The economy of the states mainly depends on forest wealth, horticultural crops, agriculture and animal wealth.

The scientific management of land and water resources in hilly areas through appropriate vegetative measures becomes important for achieving long term conservation and production needs. Due to over-exploitation and improper management in hills, the forests are gradually disappearing and grasslands are converted into wastelands causing acute fodder and fuel scarcity and danger of soil and water erosion. Agrihorti system in North East region shall require special emphasis on the cultivation of indigenous trees, which have multiple economic and traditional importance in various applied fields such as nectar flora for bee keeping, sericulture, fibre and cottage industry, traditional medicines, wood carving, carpentry and several other aspects. Various species of trees like *Aesandra*, *Butyracea*, *Oleosa*, *Pyrus pashia*, *Rhododendron arboreum*, etc., have plenty of nectar for the bee keeping (Silas and Gaur, 1987).

**Land use systems:** Land use systems focused on the cropping system and agroforestry. Suitable location specific crop production technologies have been developed for tillage, seeding, weed control, water and fertilizer application and crop management for enhanced productivity. Land use systems have been developed for desert areas involving suitable trees, grasses and legumes. Land degradation is the biggest challenge affecting healthy environment and reducing the basic live support systems. Agroforestry is being viewed as a restoration agent, rehabilitation process, bio remediation, and mechanism to high input agriculture on fragile lands.

**Agri-Horti System:** In the region, the commonly preferred horticulture based agroforestry systems are agri-silviculture and silvi-horticulture. Agrihorti system in North Eastern region envisages growing of trees and woody perennial on terrace risers, terrace edges, field bunds in the field as intercrops, as alley cropping in the shape of the hedge row type of plantation, etc. The tree species grown in association with hilly crops in this region are: *Grevillea robusta*, *Albizia*

*lebbek, Malia azadarach, Alianthus excelsa, Moringa pterygosperma, Morus alba, Bauhinia purpurea, Grewia optiva, Populus xeriramericana, eucalyptus globules, etc.* Agriculture crops like peas, potato, cauliflower, mustard, etc., during winter season and maize, tomato, pepper, beans, etc., are grown in first few years during summer with following tree species in north eastern region. Toky *et al.* (1989) reported that the total above ground biomass in agrohorti silvicultural or agri horticultural system was around 48 t/ha and it was about two fold higher than agrisilvicultural systems. In fodder tress, significant percentage of annual production upto 48% was allocated in current twigs, while in horticultural trees, a major portion, upto 63% was partitioned in fruits.

**Table 1:** Cultivation practices in the NE states.

| State             | Total geogr-aphical. area (000'ha) | Cultiv-able land (000'ha) | % of geogra- phical area | Total crop area (000'ha) | Area sown more than once (000'ha) | Net sown area (000'ha) | % of cultiva- ble area used | Gross irrigated area (000'ha) | % of gross cropped area |
|-------------------|------------------------------------|---------------------------|--------------------------|--------------------------|-----------------------------------|------------------------|-----------------------------|-------------------------------|-------------------------|
| Arunachal Pradesh | 8374.3                             | 293                       | 3.50                     | 244                      | 59                                | 185                    | 63.14                       | 36                            | 14.75                   |
| Assam             | 7843.8                             | 3387                      | 43.18                    | 3938                     | 1158                              | 2780                   | 82.08                       | 572                           | 14.53                   |
| Manipur           | 2232.7                             | 164                       | 7.35                     | 182                      | 42                                | 140                    | 85.37                       | 75                            | 41.21                   |
| Meghalaya         | 2242.9                             | 1074                      | 47.88                    | 247                      | 41                                | 206                    | 19.18                       | 45                            | 18.22                   |
| Mizoram           | 2108.1                             | 445                       | 21.11                    | 109                      | 0                                 | 109                    | 24.49                       | 9                             | 8.26                    |
| Nagaland          | 1657.9                             | 626                       | 37.76                    | 228                      | 17                                | 211                    | 33.71                       | 72                            | 31.58                   |
| Tripura           | 1048.6                             | 310                       | 29.56                    | 426                      | 149                               | 277                    | 89.35                       | 60                            | 14.08                   |
| All NE            | 25508.3                            | 6299                      | 24.69                    | 5374                     | 1466                              | 3908                   | 62.04                       | 869                           | 16.17                   |
| All India         | 328726.3                           | 194680                    | 59.22                    | 186561                   | 44346                             | 142215                 | 73.05                       | 71510                         | 38.33                   |

Data Source: CMIE Report on Agriculture, 1998

**Table 2:** Trees used in agrihorti system.

| Fodder trees              | Local name | Timber and fuel wood trees  | Local name |
|---------------------------|------------|-----------------------------|------------|
| <i>Grewia optiva</i>      | Bhemal     | <i>Toona ciliata</i>        | Toon       |
| <i>Bauhinia variegata</i> | Kachnar    | <i>Pistacia integerrima</i> | Kekkar     |
| <i>Celtis australis</i>   | Khiriks    | <i>Ficus palmata</i>        | Angiri     |
| <i>Albizia chinensis</i>  | Ohi        | <i>Melia azedarach</i>      | Derek      |
| <i>Morus serrata</i>      | Kimar      | <i>Bombax ceiba</i>         | Simul      |
| <i>Ficus roxburghii</i>   | Timla      | <i>Prunus puddum</i>        | Pazzar     |

Fruit trees and crops are grown together in various ways. Depending upon the pattern and configuration, these companion crops are known as intercrops, under planting, hedge row planting or alley cropping. In intercropping, agricultural crops are normally grown between rows of fruit trees planted at a spacing of 5 to 7 meters apart. The agricultural crops provide seasonal revenue, while fruit trees are managed for 30-35 years giving regular returns of fruit and in some

cases fuel wood from pruned wood and fodder. Several kinds of crops are also under planted with the canopy of fruit trees providing shade. However, shade is not always desirable for agricultural crops such as maize, sorghum, groundnut, etc. Following are the crops, generally under planted in the orchards.

| <b>Types</b>          | <b>Crops</b>   |
|-----------------------|--|
| Cash crops            | Clove, pepper  |
| Spices and condiments | Turmeric, ginger, green chillies, betel and coriander.             |
| Fruit crops           | Papaya, banana, pineapple, passion fruit, phalsa as a filler crops |
| Tuber crops           | Sweet potato, colocasia, dioscorea, elephant foot yam              |
| Cereals               | Maize, Oat   |
| Pulses                | Cowpea, green gram, soybean, winged bean                           |
| Oil crops             | Groundnut  |
| Pasture               | Various species of palatable grasses and legumes                   |

Home gardens or homestead gardens or sometimes called Kandy garden are age old horticultural based agroforestry system. In the densely populated flood plains, rural communities depend on the groves developed around a cluster of houses or homestead for supply of fruits, fodder, fuel wood, medicinal plants, etc. Such home gardens helps in revealing the pressure on forest lands and slow down the degrading on natural resources.

#### **Different agrihorticulture system in NE region**

- Agroforestry is an age-old practice in the states of north eastern region. Out of the various agrforestry practices, tribes of the region adopt a combination of pineapple and black pepper with arecanut, plum with potato or cole crops, indigofera with large cardamom and schima with ginger or turmeric. These are the most productive horticulture based agroforestry systems.
- Borthakur *et al.* (1979) have demonstrated the model of an ideal agroforestry system as an alternative to 'Jhumming' or shifting cultivation in north eastern hill region. In the alternative model, lower 1/3<sup>rd</sup> area of hilly slope is terraced and utilized for raising field crops keeping farmers requirements in view. Crops like rice, maize, ragi, mustard, sasamum, black gram and root crops like ginger, turmeric, etc., may be grown on such terraces. Usually, these terraces are stabilized by few mechanical measures and planting with fodder grasses or legume on risers. Fodder grasses and legumes suitable for terraces risers are stylosanthes (4.73 t/ha dry matter yield). The middle 1/3<sup>rd</sup> of the hill slopes are used for forest including fuel, fodder, plantation. Citrus fruits such as lemon could be intercropped with cowpea, garden pea, French bean and sweet potato in agri-horti system. Even lemon and pineapple were found to grow together. The average net income realized from one hectare farming was the highest in three-tier system followed by in complete terracing, in puertorican terraces and in Jhum cultivation.
- The above system may be coupled with runoff harvesting and recycling and other biological components may be added. There is great scope of pisci-culture, dairying, bee keeping and cut flowers industries, which will further increases the income of the marginal farmers through agro-based industries.
- In agroforestry systems from land management point of view, the combination of the broad-leaved trees and pineapple, oranges with large cardamom, arecanut, black peeper and pineapple on slopes wherever the soil, climate is suitable would not only supplement the income from orchard but also help in the conservation of sol and runoff.
- In Meghalaya (Anonymous, 1987), growing ginger in mandarin orchards has been highly profitable than in mandarin grown with rice, soybean, groundnut and turmeric. According

to another study by Dhyani and Chauhan (1989), pineapple with black pepper and arecanut resulted in highest net return after six years of plantation of tress than arecanut with black pepper. In the temperate and sub alpine zone of Himalayas, plum with potato/cabbage gave a high net return. In subtropical hills, the combination of Schima with large cardamom could give a high net return from large cardamom alone.

- The results of an investigation conducted in eastern parts of Himalayas (Anonymous, 1988), indicated that the high net return was obtained when guava (*Psidium guajava*) is grown with ginger. No adverse effect of intercrops on the growth of guava were observed.

| Treatment         | Crop yield (q/ha) | Net return (Rs./ha) |
|-------------------|-------------------|---------------------|
| Guava + groundnut | 14.4              | Medium              |
| Guava+ soybean    | 14.5              | Low                 |
| Guava+ rice       | 19.5              | Low                 |
| Guava + ginger    | 92.8              | High                |
| Guava+ turmeric   | 106.9             | Medium              |

- The performances of *Alnus nepalensis* and *Symingtonia populnea* were tested on hill slopes by Anonymous (1990). When raised with pineapple stylos, guinea grass, setaria and *Bracharia mutica*, Preliminary results indicated that *Alnus nepalensis* - pineapple-*Stylosanthus hamata* silvihorti-pastoral land use performed the best, sofar with stylo (dry) yielding 6.5 t/ha/year. The yield of guinea grass, Setaria and Bracharia were 4.1, 2.8 and 2.2 t/ha/year, respectively. The performance of *Alnus* was comparately better as compared to other species. Soil fertility improvement was also maximum due to intercropping of Stylo.
- Dhyani and Chauhan (1989) studied the performance of ginger, turmeric and colocasia under natural shade of *Pinus khasya* on 40% slope in Khasi hills (Meghalaya). All the three plantation crops gave high yields in partial shade as a compared to open condition and complete shade of *P. khasya*.

| Crops     | Partial shade | Complete shade | Open |
|-----------|---------------|----------------|------|
| Colocasia | 187           | 112            | 129  |
| Ginger    | 94            | 50             | 66   |
| Turmeric  | 90            | 57             | 58   |

- In Manipuri valley, agri-silvi-horti agroforestry system is highly remunerative and preferred by the farmers. Among the tribal farmers, crops like paddy, mustard, sugarcane, soybean, beans, vegetables (mainly pumpkin or potato), walnut, cherry, banana, guava, etc., are grown. In this region, forest tree species are grown to produce wood and leaves for fodder in combination with high income horticultural crops like pineapple. In a study at Langoi Hill, Lamphelpat, pineapple was grown with *Eucalyptus tetricornis*, *E. citridora*, *Leucaena leucocephala* and *Parkia roxburghii*. This study shows that the tree do not have any shade effect on the yield o pineapple. Pineapple with *Parkia roxburghii* agroforestry system gave the highest yield of pineapple (Anonymous, 1990).
- Agrihorti systems can be used to improve economic condition of the farmers. In the North East region, peach based agri-horti systems were evaluated on class II lands. Both annual and companion crops were grown. The net returns double when turmeric was grown with peach. Mixed cropping is preferred over pure crops in rainfed condition as

risk of failure of crop is minimized. If annual crop fails, tree crop can provide some income.

- In Sikkim, among the tree species grown with large cardamom, *Alnus napalensis* is the predominant. This shade trees is important as it also reserves as major source of fuel, fodder and timber to the farming communities. From tree cardamom combination about 140 kg dry capsule yield of the spice alone can be obtained, which gives high returns with minimum inputs.
- Mandarin (*Citrus reticulata*) is another commercial fruit crop in Sikkim. Mandarin orchards are intensively intercropped with many spices of cereals, pulses and vegetable crops. Ginger is the most remunerative intercrop in Sikkim. Singh and Pradhan (1989) observed that various intercrops with mandarin can yield 609 kg/ha (Ginger), 149 kg/ha (black gram and rice bean).
- In high hills of Sikkim (temperate zone), apple is intercropped with potato, barely, radish, cabbage and turnip. Due to poor productivity of apple orchard, farmers mostly rely on returns obtained from intercrops.

### Challenges in Agrihorticulture Development

- **Shifting cultivation:** It is known as jhuming and regarded as the step in transition from food gathering or hunting to food production. This traditional practice is still predominant in this region. As a result of population explosion, increase in demand for food and fuel arised. As a result, the jhum cycle of 10-15 years is reduced to 3 years. Indiscriminate felling of trees on the hill slopes brought an undesirable eco-imbalance. Further, the hill tops are the main source of water; deforestation of this hill top led to the elimination of water source. This in fact, ended in the losses of top soil. Coupled with this, deforestation drastically reduced the retentive capacity of the soil. Erosion of soil in the catchment area resulted in silting of the reservoirs and streams leading to unprecedented floods. Hence, this situation needs to be tackled on top priority to keep the ecological imbalance checked as well as to meet the fodder, food, fuel requirements, etc., in these states. The calendar of shifting cultivation system is given in Table 3.

**Table 3:** Soil erosion calendar of shifting cultivation system.

| Month            | Agricultural operation   | Erosion problem  | Soil erosion (t/ha) |      |
|------------------|--|--|---------------------|------|
|                  |  |  | Min                 | Max  |
| January to April | Selection of plot, forest cutting, burning and cleaning of hill slopes of burnt pieces continues and sowing begins | Displacement of loose soil materials to down hills and rolling down of earthworm casting, soil erosion as above and wash due to rains. | 0.0                 | 22.4 |
| May              | Sowing/weeding   | Heavy soil wash, faint rilling at foot hills on silt deposits  | 0.2                 | 61.9 |
| June             | Weeding  | Heavy wash of soil aggregates  | 0.2                 | 45.4 |
| July             | Weeding/harvesting begins  | Heavy wash of soil aggregates, crop root exposed, farm soil visible  | 1.8                 | 21.9 |
| August           | Harvesting and occasional weeding  | Soil wash continues  | 1.0                 | 29.6 |
| September        | Harvesting   | Moss appears, soil erosion slows down  | 0.1                 | 13.8 |
| October          | Harvesting   | Soil erosion appreciably reduced   | 0.0                 | 2.7  |
| November         | Harvesting   | No erosion, moss turns blackish  | 0.0                 | 0.0  |

|          |   |                 |     |       |
|----------|---|-----------------|-----|-------|
| December | Harvesting/threshing/carry harvest back to home | No erosion      | 0.0 | 0.0   |
| Year     | Cropping with zero tillage on steep slope       | Heavy soil wash | 3.3 | 201.4 |

- **Unscientific land use on hill slopes:** Horticultural crops grown on the hill slopes without proper soil and water conservation resulted in soil erosion. The soil erosion varied with the extent of disturbances caused to the soil surface. Colocasia, tapioca, sweet potato, turmeric and ginger are the crops, which resulted in movement of soil to the foot hills during the process of harvesting (Table 3). Vegetable crops grown on the slope without proper soil and water conservation measures also resulted in this type of soil loss.

**Table 4:** Soil erosion on hill slopes.

| Land use/practice                    | Soil loss (t/ha/yr.) | Reference    |
|--------------------------------------|----------------------|--------------|
| "Bun" system for raising tuber crops | 40-50                |              |
| Pineapple along the slope            | 24-62.6              | Ghosh (1976) |

- **Over exploitation of forest:** Exploitation of forest indiscriminately increases the soil erosion on hills and flood in down stream areas, thus forests wealth decreases. Fuel shortage becomes acute. This again means further encroachment of forest land resulting in more denudation, environmental degradation and loss of biological components of soil and vegetation. Thus a vicious circle may crop up. Even excessive grazing by cattle may also damage forest. The best example is Cherrapunji in Meghalaya, which has been famous till recently for recording the highest rainfall in world. The place is suffering from acute scarcity of drinking water. With an average rainfall of over 1150 cm or more one would expect Cherrapunji to be clothed in lush green forest. But what one sees now is a desertified barren bed along the slope. Heavy deforestation for augmenting fuel/fire need and harsh climate of 1150 cm of annual rainfall coming down in 4-5 months during monsoon.
- **Land degradation:** The extent of land degradation that follows use of forest areas for agriculture is largely determined by the level of management. Apart from soil loss that accompanies land clearing and early stages of plantations, there is also severe nutrient loss. The practice of jhuming cultivation in North East region has (increased) the problem of land degradation. The involvement of such a large area in shifting cultivation has caused large scale deforestation, soil erosion, loss of productivity, ecological imbalance and land degradation. Rapid population pressure has resulted in misuse of land resource and rational options for high value plantation crops have severely affected the tropical forests.

### Strategies for Agrihorticulture Development in NE Region

- 1) **Agri-horticulture:** In this system the 2/3<sup>rd</sup> of the area (upper side) is covered under horticultural crops for which half moon terraces and contour bunds are prepared on the hill slope and 1/3<sup>rd</sup> of the area towards down side is used for the cultivation of cereals, oil crops, etc., on the bench terraces. In this land use pattern, the following crops may be grown after the land preparation.

- ◆ Fruit trees in half-moon terraces (Triangular system of planting) on contour
- ◆ On the contour bunds the pineapple in two rows should be planted at closer distance, which helps in soil erosion from contour area.
- ◆ The interspaces in the contour are utilized for the cultivation of the vegetables. The legume vegetables like bean, cowpea, guar, pea and good over crop like sweet potato should be cultivated.
- ◆ Ginger and turmeric can be grown in the interspace area in the contours.

In medium deep soil areas (LCC II to IV) receiving annual rainfall of more than 750mm, agri-horticultural systems consisting of a fruit tree intercropped with annual arable crop is recommended. Land treatment for collection of runoff and water harvesting techniques to provide supplemental irrigation during the summer months are critical to the success of this practice (Katyal *et al.*, 1994). Apart from prudent use of stored soil moisture, the water needs of fruit trees have to be effectively modulated by pruning. Custard apple and also pomegranate and aonla are other fruit crops suitable for this system.

**2) Agri-horti-silvi -pastoral (model land use):** In this system the middle 1/3<sup>rd</sup> area of the hills is taken for the cultivation of horticultural crops and upper 1/3<sup>rd</sup> area and lower 1/3<sup>rd</sup> area are being cultivated for establishment of economic forest plant plantation with fodder and cereals, millets etc. respectively. The middle portion is converted under contours and the fruit plants are planted in half moon terraces on the contours. The contour bund is utilized for pineapple planting. The two or three separate blocks of each fruit crop may be made so that cultural operations may become easier. The vegetables, root crops, rhizomatous crops, etc., are cultivated in the interspaces of the contour. The lower one or two contours may be used for pure vegetable cultivation.

**3) Mixed horticultural land use:** If the farmer is interested to grow only different horticultural crops in the land available with him the whole jhum land may be divided in the following pattern for developing mixed horticultural land use.

- a) 2/3<sup>rd</sup> area from top towards lower hillside is converted into contour and 3-4 fruit blocks can be developed, i.e., banana block, orange block, lemon block, papaya block. The lower 3/4<sup>th</sup> contour is utilized for the cultivation of rhizomatous crops. After that 3-4 terraces may be completely utilized for the pure vegetable cultivation.
- b) The contour bunds are utilized for the planting of pineapple.

**4) Horticultural land use (with fruit crops only):** The land use under pure horticultural orcharding system also has high potentiality in the region. In case more area (jhum land) is available at a place in the selected site and the owners are too interested for growing of fruit trees collectively as co-operative farming type in order to bring their large area under horticulture then pure orcharding can be done and land use pattern may be developed accordingly, keeping in view about the soil and water conservation aspects. This system of cultivating the land will be highly profitable in the long run and area will be developed as fruit growing belt.

The water and soil management practices are to be followed in a systematic manner so that the soil loss can be checked to a considerable stage. The following practices (management) are to be adopted while considering this land use.

- 1) The fruit plants like orange, banana, etc., are to be planted either half moon terraces or in contour bunds.

- 2) If the slope is below than 25.30° the intercropping is to be practiced for getting the subsidiary income to the farmers and the four rows planting of pineapple after 10 rows of fruit trees across the slope will be advisable in order to check the soil erosion.
- 3) The legume vegetable should be considered for the cultivation as intercrop so that soil fertility may be enhanced.
- 4) If planting is done only in half moon terraces the chopping of weeds in interspace areas is advisable and the filler crops should be taken.

**5) Selection of crops and varieties:** Suitability of crops depends upon the altitude, soil and climatic conditions. Say, as an example, Manipur state can roughly be divided into three land zones, viz.

- i) High hills: 900-2000 m above MSL (apple, peach, pear, plum, apricot, potato, cabbage, cauliflower, radish, beans, etc.)
- ii) Mid hills: Below 500 m (citrus, banana, pineapple, papaya, guava, ginger, turmeric, chilli, brinjal, tomato, bean, sweet potato, tapioca, colocasia, etc.)
- iii) Foot hills: Bordering areas of hills (jack fruit, areca nut, black pepper etc.)

Vast areas of the hills are suitable for cultivation of tropical, sub-tropical and temperate fruits.

|                             |   |
|-----------------------------|---|
| Tropical                    | Cashewnut, banana, papaya   |
| Sub-tropical fruits         | Pineapple, citrus, guava, banana, gooseberry, etc.  |
| Temperate                   | Apple, Peach, pear and plum   |
| Spices                      | Chilli, turmeric, ginger, garlic  |
| Vegetables                  | Tomato, chillies, brinjal, potato, radish, pea, colocasia, okra, pumpkin, bottle gourd, cucumber, carrot, cabbage, cauliflower, knol khol, French bean, winged bean, dolichos bean. |
| Tuber crops                 | Tapioca, sweet potato   |
| Tree vegetables             | Tree bean, tree tomato and drum stick   |
| Suitable grasses for risers | <i>Stylosanthes guyanensis</i> , <i>Stylosanthes hamata</i> and Thinnapier, NB-21.  |

**6) Crop planning and production technology:** The lower one-third area should be terraced and utilised for growing vegetable/spices or tuber crops. While planning crops, it should be necessary to keep in mind the requirement of farmers. Two crops round the year can be grown even under rainfed conditions. High yielding varieties of crops should be introduced.

Usually the terrace risers have to be protected by growing some fodder grasses, so that apart from protecting the risers from erosion, it provides a subsidiary source of income to the farmers. Upper, the mid-one third area should be utilised for fruit crops and the remaining upper one-third under the reserve forest (fodder or fuel trees). The plants should be planted in half moon terraces.

## CONCLUSION

Agri-horti system of land use with subsidiary source of income through livestock rearing provides most favourable indication in favour of adopting mixed land use system as an alternative

to shifting cultivation on steep hill sides. Such a system will certainly be technologically feasible, sociologically acceptable, ecologically sound and economically viable.

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