SOIL AND WATER CONSERVATION THROUGH HORTICULTURAL INTERVENSION IN HILLY AREAS

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INTRODUCTION

Land, which is the most precious heritage and the physical base of biomass production of life supporting systems, is finite. In this natural non-renewable endowment, the share of our country is fixed at about 329 million ha. It is not only inelastic but also heterogeneous in different parts and regions of the country with a definite set up, capabilities, suitability for different land resources. Conservation of land resources can promote sound land use to match with the land capabilities or suitability and to initiate correct land resources, development/suitability in the country.

A close look at the present health of the soil and water resources reveals their wanton misuse and degraded environment. About 173 million ha covering slightly half of the country are threatened by various types of degradation like salinity, alkalinity, water logging, ravenous and gullied lands, areas under ravages of shifting cultivation, desertification, etc. About 800 ha of arable land are being lost annually due to ingress of ravines. There are specific problems of land degradation due to open-cast mining operations, using good productive land for brick kilns, coastal erosion and seawater ingress, excessive erosion and land slides in the crumbling hill areas. Our forests and grass lands have been over exploited. Frequent occurrences of floods and droughts in different parts of the country are evidence of improper land use in the catchments and inadequate conservation and use of rain water. The problem of land degradation has brought us face to face with the ever increasing depletion of the productivity and the basic land stock through nutrient deficiencies on the one hand and the ever growing demand for food, fodder, fibre, fuel, land based industrial raw materials and many non-farm land uses on the other hand.

SCENARIO OF NORTHEASTERN REGION

The north eastern region comprising of states of Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Tripura and Sikkim is endowed with wide variety of flora and fauna. Degradation of land and water resources is a serious problem in this region. The adverse biotic impact has resulted in degradation of forests and this trend has been highlighted in many recent reports. Fast paced and multi-faceted development and ever increasing population have created tremendous pressure on land to provide basic requirement essential for survival. To meet these requirements, the limited natural resources are being over-exploited resulting in widespread eco-system degradation. The northeastern region is highly susceptible to acute soil erosion problems due to its undulating topography and high intensity rainfall. The primitive cultivation practices like *jhum* and *bun* further enhances these degenerative trends and rampant deforestation, wild fires, extensive grazing, unscientific mining and quarrying, etc., are adversely affecting the overall ecological condition of the region. Control efforts have not succeeded to desired scale. The authors strongly feel for the need of review and re-orientation of the planning process and programmes particularly for conservation and maintenance of natural resources such as soil, water, plants and animals. 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 and sub-tropical and temperate fruits. The economy of the states mainly depends on forest wealth, horticultural crops, agriculture and animal wealth. All these four components together contribute to the preservation of eco-system, soil conversation and healthy environment. The technical measures for conservation and development essentially are:

a) Tree planting and reforestation
b) Water harvesting
c) Terrace and other engineering structures
d) Agronomic, grassland and pastures development and other socio-economic measures for conservation and management of the soil.

It is evident that combating the degradation of our natural resources especially soil, water and vegetation and investing in their conservation for future generation will be a major practical task promoting sustainable development and nature protection. The application of modern techniques and development of new methodologies to cope with the widespread problem of soil degradation has become imperative to protect cultivable and uncultivable lands from the ravages of erosion, enhance and restore soil productivity, reverse degradative trends and restore degraded soil.

WHY SOIL AND WATER CONSERVATION

Land and water are natural resources that are essential for the existence of life and are the two variable factors for which management has become most essential. Land provides food, fuel, fodder and shelter besides supporting secondary and other economic life supporting system. However there has been a continuous depletion of land resources and the quality of land is deteriorating due to various factors like soil erosion caused mainly due to shifting cultivation, high rainfall, large scale deforestation, reckless mining activities, overgrazing, general mismanagement, etc. Such soil erosion leads to degradation of soils' physical property and loss of plant nutrients

It takes nature 600-1000 years to build 2.5 cm of top soil but get displaced in a year only due to misuse. It has been reported that 6000 million tones of productive soil are lost every year from about 80 million hectare of cultivated land alone in India. It has also been proved that soil lost from unprotected land is about 120 tonnes /ha/yr and may go as high as 300 tonnes /ha/yr. Thus, a part from depletion of fertile soil erosion results in the loss of run-off water, plant nutrients and micro flora, siltation of reservoirs and riverbeds thereby adversely affecting irrigation and power potential, causing floods in plain and valley which damage crops, animals, habitation, communication, etc. But most of them adversely affect agricultural production, forest productivity and availability of water both for irrigation and drinking besides bringing about a disturbance in the soil and water balance

PROBLEMS RELATED TO SOIL EROSION

Normal erosion is a continuous process where soil is regenerated by natural means at the same rate as it is removed. But when protective vegetation is disturbed by cultivation, grazing or burning, the natural balance is upset and soil becomes exposed to most serious causes of erosion, i.e., water and wind. Under these conditions the soil can be washed away at a faster rate than it can regenerate resulting in a net loss of soil. It causes exposure of bed rocks and silting of rivers and dams. The main cause of soil degradation in the region is as follows.

- **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. In this system farmers burn the cleared vegetation and cultivate plots of land in the virgin forest until the yields of the crops fall below subsistence level. At this point the farmers abandon the land to natural fallow and move to a new site. When the original area is considered to have recovered fertility, the cultivators return to repeat the process, until once again the fertility of the land is apparently exhausted. As a result of population explosion, demand for food and fuel increased and land availability for agriculture has reduced. As a result, the jhum cycle of 10-15 years is reduced to 3-5 years. Earlier when jhum cycle was long the abandoned land got sufficient time for regeneration of forest but now due to reduced jhum cycle land does not get

time for regeneration of vegetation. 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 loss 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 in tact as well as to meet the fodder, food, fuel requirements, etc., in these states. The calendar of shifting cultivation system is given in Table 1.

Table 1: 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 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 drilling 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**

The entire resource degradation process in the region is closely linked up with the land use system. Forestry is the most dominant land use system in the region followed by agriculture, horticulture, animal husbandry and non-agricultural uses (urbanization, commercial establishment, etc.). Evaluation of some of the land use systems practices in the region indicates that most of them are hazardous to resources and are not conducive to the aims of permanent agricultural systems with sustainable production. 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 2). Vegetable crops grown on the slope without proper soil and water conservation measures also resulted in this type of soil loss.

Table 2: Soil erosion on hill slopes

Sl.No.	Land use/practice	Soil loss (t/ha/yr.)	Reference
1	"Bun" system for raising tuber crops	40-50	Singh(1970)
2	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. 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 recoding the highest rainfall in the 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 distributed to whole year has come 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 or shifting cultivation in northeast region has increased the problem of land degradation. The involvement of such a large area in shifting has caused large scale deforestation, soil erosion, loss of productivity, ecological imbalance and land degradation. The growing population pressure has resulted in misuse of land resource and national options for high value plantation crops have severely affected the tropical forests. Estimates have revealed that nearly 88.3 million tonnes of soil is lost annually as a result of shifting cultivation in NEH region. The degraded land as can not be put to any productive use.

SOIL AND WATER CONSERVATION MEASURES

The water conservation is inseparable from soil conservation. It is the application of all measures necessary to conserve the whole complex of land and water resources. The maximum benefit of a variety can be derived only after maintaining a high fertility level. Therefore, soil and water conservation measures should be primary objective of research programmes. There are two approaches that have been used to reclaim degraded soils and intensify agriculture production system, i.e., engineering approaches and ecological approaches. Mechanical soil and water conservation measures are required for controlling soil erosion, retaining maximum rainfall within the slope and safe disposal of excess run off from the top to the foot hills. These structures are used in case of extreme soil degradation, where other approaches are not possible or slow. The measures useful in controlling are discussed below.

Contour bunds: Bunds are either mechanical or vegetative barrier created across the slope. The purpose is to divert the excess run-off during rain to the waterways and to retain eroded soil. These bunds on steep slopes are created by way of excavating parabolic channels (0.3 m top and 0.2 m deep) on contours and keeping the dug out soil in form of a bund at the lower edge of the channel. These bunds require care in maintenance during first 2 years. Our experience showed that vegetative barrier alone will not serve the purpose on steep slopes. The vertical interval of these bunds may vary from 0.5 to 5 m depending on the land use, soil depth and slope of the land.

Bench terrace: Bench terraces are flat beds constructed across the hill slope; spaces between two contours are leveled by cut and fill method. In micro-watershed involving steep slopes, experiences showed that only at foot hills few benches may be constructed to produce food crops through intensive cropping. The vertical interval of such terraces should not increase more than one meter. Such measures can be adopted where the soil depth is more than 1.0 m.

In case the entire hill slope is to be converted into benches, the construction should start from foot hill.

Half moon terrace: These are level circular beds having 1 to 1.5 m diameter cut into half moon shape on the hill slopes. These beds are used for planting and maintaining sapling of fruits and fodder trees in horticulture/agro-forestry land uses.

Grassed waterways: These are channels laid out preferably on natural drainage lines in the watershed. As far as possible, natural courses should be used without much disturbances for draining out the excess water. At appropriate locations, stilling basin (water pools) should be created with land use of earthen and boulder pitched bunds for temporary detention of run-off water. This structure will also serve the purpose of energy dissipation of flowing run-off water.

Water harvesting ponds: Dug out cum embankment type of water harvesting structure can be used for creating seasonal and perennial ponds at the foot of the micro-watershed for irrigation and fish farming purposes. The above soil and waster conservation measures can be created with the use of local resources. On hill slopes, soil and water conservation measures may be followed with horticulture land use system. Other steps required are:

Contour bund at 1.0 m to 5 m. vertical interval in all the land uses with common grassed waterways.

Bench terraces towards the foot hills for growing vegetable crops (Vertical interval should not increase over 1.0 m.)

Half-moons terrace (1 to 1.5 m dia.) for fruit crops.

Water storage at appropriate location for irrigation/fish purposes.

WATERSHED BASED LAND USE SYSTEM

Watershed management is the development and management of the watershed resources in such a manner so as to achieve optimum production, which can be sustained without causing deterioration in the resources base or disturbing the ecological balance.

Principles of watershed management

Our research experiences proved that with the watershed based concept, it is possible to manage the hill slopes effectively while utilizing local natural resources. A high priority within watershed management practices has to be given to water conservation and water harvesting so that the farmer is attracted to the high yield enabled by increased water availability. Land has to be developed to receive the rainwater in such a way so as to utilize the maximum for plant growth and lead the rest into storage either surface water storage or ground water storage for later use by man and animals. The daily needs of the people for food, fuel, fibre, fodder and employment have to be adequately met before any other goals of watershed management.

DEVELOPMENT OF HORTICULTURAL LAND USES

In this system mixed horticultural crops including fruit, vegetable, root crops, etc., may be grown under the best management practices to keep the soil covered. The horticultural crop residue, i.e., stubble, leaves, etc., not only reduce the soil erosion but also serve as a mulching material and add organic matter to the soil. The rotation of annual horticultural crops in between the perennial trees is done to increase cropping intensity as well as maintain soil fertility, etc. Bunds, half moon terraces and grassed waterways are the major soil and water conservation measures required for land development. However, if vegetable crops are to be grown, then only bench terraces may be required on foot hills at a vertical interval of 0.5 to 0.75 m. The different horticultural land uses are to be formulated in the following pattern:

1. Agri-horticulture

In this system the 2/3 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 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.

1) Fruit trees in half-moon terraces (triangular system of planting) on contour
2) On the contour bunds the pineapple in two rows should be planted at closer distance, which helps in soil erosion from contour area.
3) 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.
4) Ginger and turmeric can be grown in the interspace area in the contours.

2. Agri-horti-silvi -pastoral (model land use)

In this system the middle 1/3 area of the hills is taken for the cultivation of horticultural crops and upper 1/3 area and lower 1/3 area are being cultivated for establishment of economic forest plant's 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 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 contour is utilized for the cultivation of rhizomatous crops. After that 3-4 terraces may be completely utilized for the pure vegetable cultivation. 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 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 in half moon terraces or in contour bunds.
2) If the slope is below than 25.30^{o} 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. Horti-silvi-pastoral system

The horti-silvi-pastoral system has great potential to provide a sustainable land use system, which would maintain an acceptable level of production of fruits, vegetables, fuel wood, timber, fodder, etc., and at the same time, conserve the basic resources (mainly soil) on which production depends. This system was found economically viable and socially acceptable alternative to *jhuming* in this region.

6. Multi-tier horticultural system

1. Horti-horti three-tier system: areca nut + black pepper +ginger/ turmeric/pineapple/Assam lemon
2. Silvi-horti-three tier system: MPT + black pepper + ginger/turmeric/pineapple
3. Silvi-horti-two tier system (Parkia and pineapple or subabool and pineapple)

a) Alder based farming system of Nagaland (alder and vegetables like potato, cole crops or alder and cereals like maize, rice, etc.)
b) Alder based large cardamom system of Sikkim
c) MPT + Assam lemon

7. Multi-tier system for plantation crop

Tea plantations in the region including Sikkim and Darjeeling play major role in the economy and employment generation. It has been established that tea and coffee plantations require sparse shade and *Albegia, Dalbergia, Accasia* have been used as the major tree species for the purpose, which in general formed a two-tier system of silvi-horticulture. Recently, black pepper has been introduced in some of the plantation for making the system more profitable.

For two-tier system

- Tree spp.(*Albegia*) + tea or coffee plantation
- Tree spp. (*Dalbergia*) + tea or coffee plantation
- Tree spp. (*Acasia*) + tea or coffee plantation

For three-tier system:

- Tree spp. (*Albegia*) + black pepper + tea or coffee plantation
- Tree spp. (*Dalbergia*) + black pepper + tea or coffee plantation
- Tree spp. (*Acasia*) + black pepper + tea or coffee plantation

8. Homestead gardening

A number of horticultural crops like guava, citrus, orange, banana, peach, pear, drum stick, etc., are grown with under story crops such as tapioca, colocasia, sweet potato, cucurbits, ginger, turmeric, beans, root crops, leafy vegetables, etc., having variations in their combinations from house to house depending upon area available, site condition, climate and choice of individual family. They are mainly grown for home consumption and surplus if any sold in the local market.

Home gardening of temperate/subtropical zone

Peach, pear, plum, apple, other indigenous fruits + cole crops, radish, carrot, turnip, pea and other indigenous vegetables.

Home gardening of tropical/subtropical zone

Citrus, guava, jack fruit, mango, coconut, areca nut papaya, pine apple, low chilling peach, pear and other indigenous minor fruits + okra, solanaceous vegetables, cucurbits, tapioca, ginger, turmeric, colocasia, sweet potato, black pepper and other indigenous vegetables along with water bodies (pokhari).

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 4 land zones viz.

i) High hills: 900-2000m 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 (jackfruit, areca nut, black pepper etc.)

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

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	*Stylosanthes guyanansis*, *Stylosanthes hamata* and Thinnapier, NB-21.

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 utilized 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.

Other methods of efforts to check degradation

In the second half of 20th century protection efforts for forest resources and the wild life have been brought to the notice through several activities in whole country like 'Chipako Movement in UP/UA', 'Silent Valley Movement' in Kerala, 'Thingtam' in Mizoram, etc. The rich variety of vegetation in the Mawsymai sacred grove, near Cherrapunjee (or Sohra, as it is locally known), stands out as a vivid reminder of what the area was once like.

Effective traditional methods

Most of the agricultural activities in the region contribute considerably towards land and water degradation. Bench terrace cultivation in certain areas of Nagaland, Sikkim and Manipur, bamboo drip irrigation in Jowai district of Meghalaya, efficient water management system of Apatani plateau of Arunachal Pradesh, 'Zabo farming system' of Nagaland, high altitude farming of Buddhist Monpas of Kameng district of Arunachal Pradesh are examples of excellent management of biophysical resources based on local skill.

FUTURE OUTLOOK

1. Formulation of suitable combination of various land uses for optimum utilization of land, water and natural energy sources.
2. Selection of suitable fruit trees, vegetable trees, fodder and fuel trees with suitable root system desirable for binding the soil.
3. Rehabilitation of jhum lands with horticultural crops.
4. Selection of locally available fodder trees.
5. Reforestation of the degraded lands.
6. Water harvesting and development of water area by utilizing run off water have to be perfected.

7. Development of suitable technologies for watershed management to be used in mini watershed.

CONCLUSION

The deep-rooted traditional agricultural techniques cannot be washed away overnight. They can, however, be spontaneously modified to minimize the ecological ill effects. Jhum is an ancient method of cultivation wherein a patch of forestland is cut and burnt down to be cultivated. Bun is different in the sense that the slashed biomass is not burnt but ploughed in for organic content. These methods were relevant when the population pressure was less and the land was re-harnessed after 30 odd years. Today, the population pressure is such that cultivators come back to used land after three or five years. This is not sustainable, and that is why they do not get proper agricultural yield.

For sustainable farming, agri-horti-silvi-pastoral system is one of the best land-use systems with adequate advantage of soil and water conservation. It has been proved that such a system can reduce soil erosion from 42 tonne/ha to 1.5 tonne/ha, besides providing for rainwater harvesting. This water can be harnessed both for pisciculture as well as irrigation.

The commercial agriculture and the Green Revolution could not touch the NE. This was mainly due to the region's inaccessibility. Keeping this in mind, we should refocus our strategy and make it two pronged. One, augment food production through intensive high-input agriculture in the valley land and, two, convert rest of the areas into organic farming zones.

Within the next decade and a half, the NE will not only be self-sufficient but will also be food surplus. For this, rainwater needs to be harvested. That may bring in more area under settled cultivation. To usher in a revolutionary change, all NE agriculturists should protect present resources and judiciously utilise the natural ones.

Studies on alternative farming system to shifting cultivation indicate that agriculture with bench terrace and contour bunds as conservation base can provide stable alternate to switch over from shifting to permanent agriculture system provided maintenance of conservation measure is properly done. Agro-horti system of land use with subsidiary source of income through live stock 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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