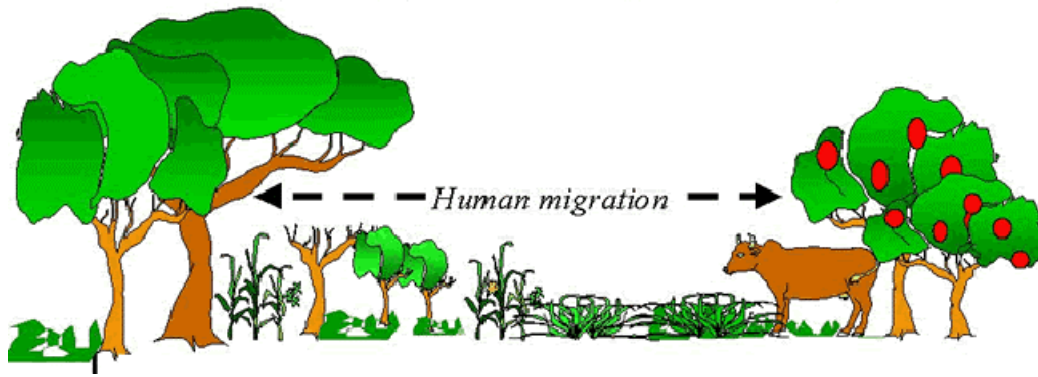

Agroforestry System Practiced in Nepal

(A term paper of Agroforestry, WME 706)



Submitted by
Manij Upadhyay
M.Sc. Forestry, Second Year
Roll No.-1 (One)

Submitted to
Mr. J.N. Yadava
Module Coordinator
SFB 709 Agroforestry



Tribhuvan University
Institute of Forestry
Office of The Dean
Pokhara
March 2009

Table of Contents

Abstracts	3
1. Introduction.....	3
2. Agroforestry Systems.....	3
3. Principles and Purpose of Agro-forestry System.....	4
3.1 Principles.....	4
3.2 Purpose.....	5
4. Why agroforestry In Nepal?.....	6
5. Types of Agroforestry System	7
6. Agroforestry System in Nepal	8
7. Agroforestry Models Practices in Nepal.....	9
7.1 Forest Based Agroforestry System	11
7.1.1 Shifting Cultivation.....	11
7.1.2 Taungya System.....	12
7.1.3 Hortisilviculture System.....	14
7.1.4 Silvipastoral System	14
7.1.5 Aquasilviculture	15
7.1.6 Sericulture	15
7.1.7 Apiculture	15
7.2 Farm Based Agroforestry System.....	15
7.2.1 Agrisilviculture System	15
7.2.2 Agrisilvihorticulture System.....	16
7.2.3 Alley Cropping (Hedgerow intercropping).....	16
7.2.4 Home Garden or Homesteads	17
7.2.5 Farm Forestry.....	18
7.2.6 Slope Agriculture Land Technology (SALT).....	19
8. Issues and Challenge in Agroforestry System Practiced in Nepal.....	22
8.1 Institutional	22
8.2 Socio-economic.....	22
8.3 Biological.....	22
9. Conclusions.....	23
10 References.....	24

Abstracts

This term paper entitled “Agroforestry system practiced in Nepal based on the literature survey and researcher own experiences. The paper focused on the existing agroforestry system of the country. Nepal subsistence farming has traditionally practiced many type of agroforestry. These are forest based agroforestry and farm based agroforestry. Shifting cultivation, Taungya cultivation, Silvopastoral system, Sericulture are forest based agroforestry system and Agrosilviculture, Home garden, Alley cropping, are farm based agroforestry system.

Key Words: Agroforestry System, Shifting Cultivation, Taungya Cultivation, Alley Cropping

1. Introduction

Agroforestry is an integrated approach of using the interactive benefits from combining trees and shrubs with crops and/or livestock ([Beetz, 2002](#)). It combines agricultural and forestry technologies to create more diverse, productive, profitable, healthy and sustainable land-use systems ([Yadava, 2009](#)).

In Agroforestry, woody perennials are deliberately integrated with crops and/or animals on the same land management unit. The integration can be either in a spatial mixture or in a temporal sequence. There are normally both ecological and economic interactions between woody and non-woody components in agroforestry" ([WAC, 2003](#)). Trees or shrubs are intentionally used within agricultural systems, or non-timber forest resources are cultured in forest settings. Knowledge, careful selection of species and good management of trees and crops are needed to optimize the production and positive effects within the system and to minimize negative competitive effects ([Nair, 1993](#)).

[Regmi \(2004\)](#) concluded that agroforestry is the science, art and practice that deals with the management and utilization of woody perennials in combination with other agricultural crops, animals, aquatic and/or other resources either zonally, mixed, simultaneously or sequentially for the twin purpose of conservation and socio-economic productivity.

2. Agroforestry Systems

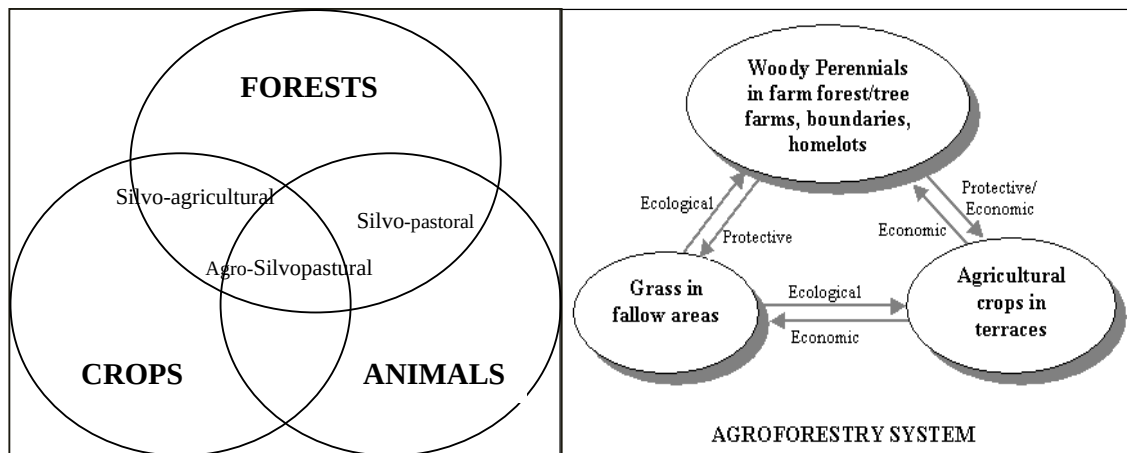
Agroforestry systems involve growing woody herbaceous species and perennials in association with food crops and livestock on the same piece of land. Agroforestry systems have been described extensively in several reports ([Nair, 1989](#)). They are known to increase

ecological diversity within a landscape unit and optimize the use of limited resources through the integration of complementary components.

Over the centuries, farmers have developed sustainable agroforestry system that produce crops, trees, livestock, fish and related resources. The widely accepted definition of an agroforestry system stresses two characteristics, common to all agroforestry systems that separate them from all other forms of land use.

- The deliberate growth of woody perennial on the same unit of land along with agricultural crops and /or animals, either in some form of spatial mixture or temporal sequence.
- A significant economic and/ or ecological interaction (Positive or negative) between the woody and other components of the systems.

Combe (1982) proposed twenty four agroforestry systems, based on three kinds of associated of trees (trees with crops, trees with pasture and trees with crops and pastures), two major factions of the tree components (production and Protection), two spatial arrangements of the tree (regular and irregular) and two types of temporal association (temporary and permanent). Combe's classification is incomplete, as it does not include silvofishery system and agro-ecological zones (Combe, 1982 cited in Amatya, 1994).



3. Principles and Purpose of Agro-forestry System

3.1 Principles

The basic principles of Agroforestry system are production, protection and ameliorative (Regmi, 2004). Agroforestry have capacity to produce crops and materials like food, wood and livestock etc. Agroforestry systems have ability to minimize the degradation of the farm.

Ameliorative refer to ability of the system to maintain and/or improve the productive capacity of the land. The fundamental principles of agroforestry systems are ([Wikipedia, 2009](#));

- Agro-forestry Help eradicate hunger through basic systems of pro-poor food production in disadvantaged areas based on agroforestry methods of soil fertility replenishment and land regeneration;
- Reduce rural poverty through market-driven, locally led tree cultivation systems that generate income and build assets;
- Advance the health and nutrition of the rural poor through agroforestry systems;
- Conserve biodiversity through integrated conservation and development solutions based on agroforestry technologies, innovative institutions and better policies;
- Protect watershed services through agroforestry-based solutions that reward the poor for their provision;
- Enable the rural poor to adapt to climate change and to benefit from emerging carbon markets, through tree cultivation; and
- Build human and institutional capacity in agroforestry research and development

Most people agree that an agro-forestry system should cater to ([Seif el Din, 2008](#));

- Diversification of species per unit area;
- Permanent soil protection;
- Continuous restoration of soil fertility; and
- Control of weeds, pests, and diseases.

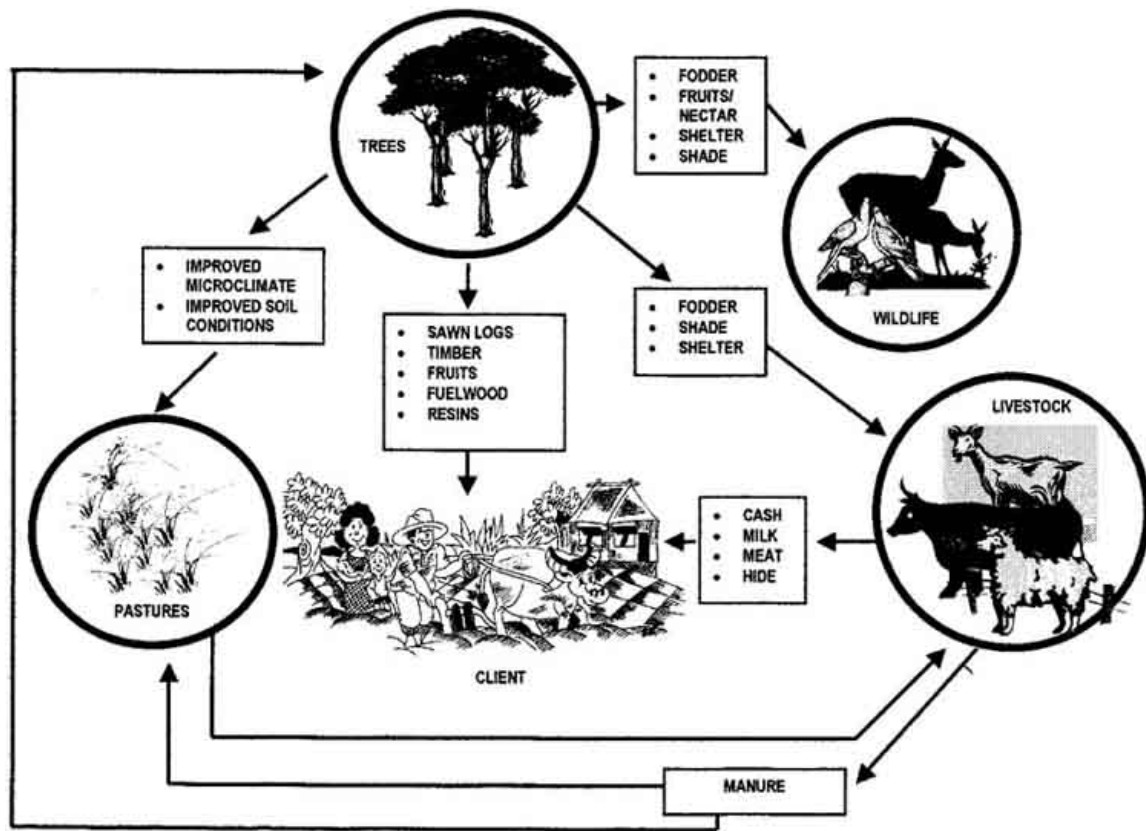
3.2 Purpose

Properly designed agroforestry systems protect crops and forage, increase their production, protect soil and water resources, conserve energy, improve ecosystem "richness", create additional wildlife habitat, and increase landscape diversity. They also provide additional farm or ranch products: timber, pulpwood, firewood, posts, fruit, nuts, and fodder to name a few. Agroforestry represents a collection of multipurpose practices that are enduring and help achieve a sustainable agriculture. These practices can form the major part of a "Resource Management System" for a particular field or treatment unit. The matrix below provides some examples of how practices might be combined into agroforestry systems in cropland and pasture/hay settings.

Potential Agriculture Problems				
Wind impacts (erosion, crop loss, inefficient water use)	Water erosion	Degraded or unbuffered stream/riparian areas	Limited crop diversity (lack of tree/wood products integrated with agricultural crops)	Fragmented wildlife habitat or low biodiversity of perennial plants
Sustainable Agroforestry Systems (A + B + C)				
A. Principal Tree/Shrub Practices:				
Windbreak/ Shelterbelt Establishment	Contour Buffer Strips (woody species) Tree/Shrub Establishment	Riparian Forest Buffer Filter Strip (woody species)	Alley Cropping Multistory Cropping	Tree/Shrub Establishment
B. Principal Agronomic Practices - Cropland Settings				
Conservation Crop Rotation	Conservation Crop Rotation	Streambank and Shoreline Protection	Conservation Crop Rotation	Conservation Crop Rotation
Residue Management	Stripcropping, Contour	Critical Area Planting	Residue Management	Residue Management
Cross Wind Stripcropping	Contour Farming	Use Exclusion		Use Exclusion
Herbaceous Wind Barrier	Residue Management	Nutrient and Waste Management		
Irrigation Water Management	Terrace			
C. Principal Grazing Management Practices - Pasture/Hay Settings				
Irrigation Water Management	Pasture and Hay Planting	Prescribed Grazing	Pasture and Hay Planting	Pasture and Hay Planting
Prescribed Grazing	Prescribed Grazing	Fencing	Prescribed Grazing	Prescribed Grazing
Fencing	Fencing	Pasture and Hay Planting	Fencing	Fencing
		Nutrient/Waste Management		
				Source: NRCS, 1996

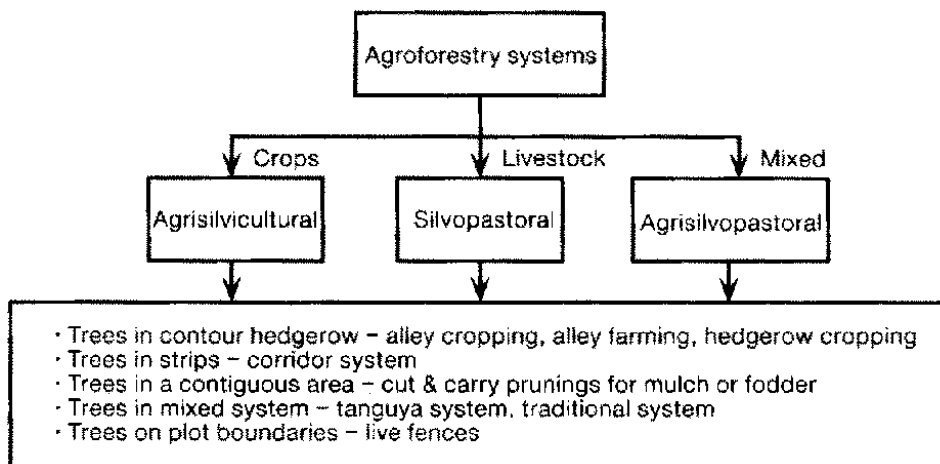
4. Why agroforestry In Nepal?

Nepal is developing country with average family size 3 -10 and average land less than 1 ha/family which is capable to produce food hardly to meet less than three months of the year (Garforth et al., 1999). For Every one hector of cultivated land needs 3 hector of forest land for the sustainable agricultural production, it is not possible to maintain this ration on the hills but agroforestry could be an option for encouraging planting of desirable tree species on farmlands. Country is mountainous/hill with limited arable land, Nepal's subsistence hill farming have traditionally practiced many types of agroforestry. So, beyond question, Agroforestry can greatly improve livelihood of mountainous region people of Nepal. The increasing population requires more food, fuel wood and timber materials. To fulfill these requirements, the concept and practice of agroforestry is needed (Donholm and Jodha, 1992).



Nepal is facing the problems of less production from agriculture field, Nepalese are highly dependent on forest, cultivation on marginal land and poor livestock breeds. Besides agriculture and forestry crop cultivation, livestock rearing is considered as one of the major components of mountain farming in Nepal. Thus development of agroforestry system has a great scope and is important to overcome these problems (Amatya, 1994).

5. Types of Agroforestry System



There are three principal types of agroforestry systems

(i) Agrisilvicultural: This system involves simultaneously growing crops and trees on the same piece of land. Some commonly used agrisilviculture systems include alley cropping and hedgerow cropping.

ii) Silvopastoral: This system involves raising livestock on improved pastures grown in association with trees. Some commonly used systems are alley farming and live fences.

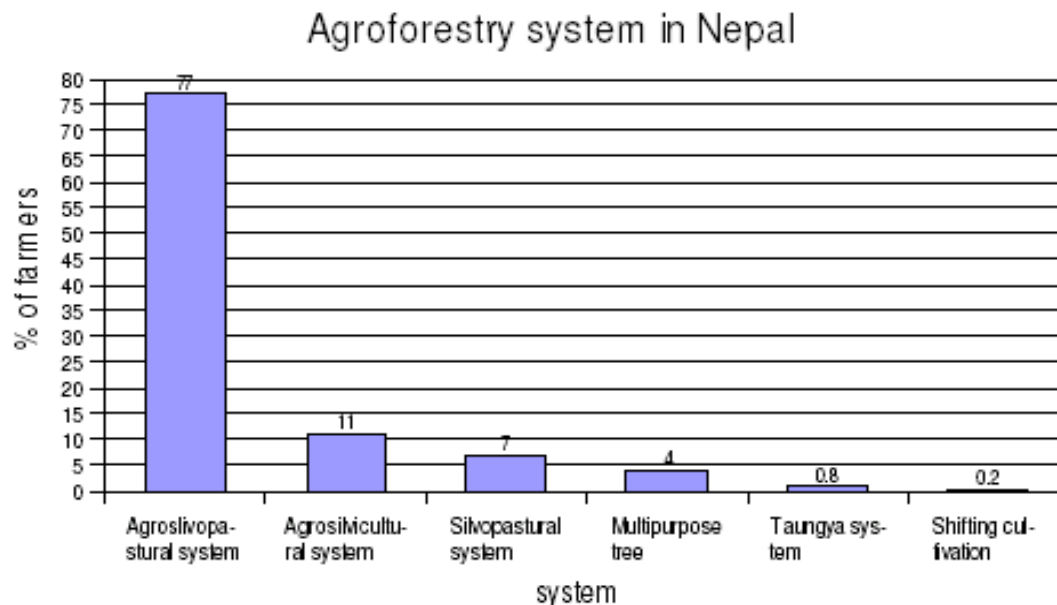
(iii) Agrisilvopastoral: This system involves a three-way mixture based on a combination of crops, trees and animals. Such a system requires skillful management, and can be sustainable even in harsh environments and fragile soils.

6. Agroforestry System in Nepal

Traditional agricultural activities to produce food, mostly cereals for human consumption, are still dominant in Nepal. Farmers practice mixed farming systems which rely to a marked extent on local resources. They try to grow multipurpose trees near their homesteads which would yield products such as fodder, fuel, bark and nuts. Forest land is an integral part of farming system, just as much as arable land and livestock. Farmers depend on forest products such as timber, poles, fuel, fodder, litter, compost, medicinal and food plants and Fruit for their livelihood.

Agroforestry, production of agricultural crops, fruits, livestock and timber/fuel wood from same land, is common practice in Nepal. Most adopted agroforestry system in Nepal is Agrosilvopastoral system which is adopted by 77% of farmer and followed by Agrosilviculture system, Silvopastoral system and Multipurpose tree (Yadav, 2005). Adaptation of system depends on the living standards, land, capital, and interest of the farmer. Generally, for commercialization, multipurpose tree production systems with some Non timber forest products having medicinal values are adopted. Major agroforestry system in Nepal are (Aryal and Pyakurel, 2007);

1. Multipurpose tree system:
2. Agrosilvicultural system
3. Agrosilvoanimal system
4. Silvopastoral system
5. Shifting cultivation
6. Taungya system



7. Agroforestry Models Practices in Nepal

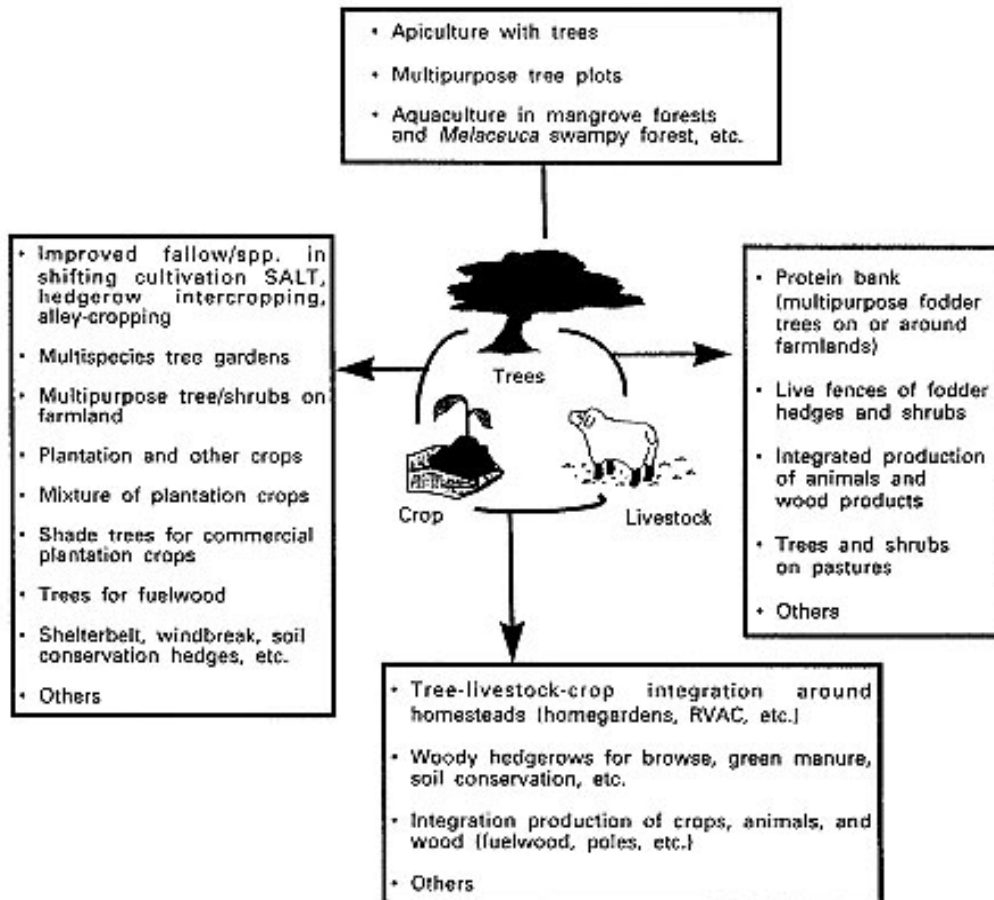
Agroforestry is a new term for old practice of growing assorted varieties of trees and shrubs in association with field crops. About two third of Nepal is occupied with steep slopes. Nepal has divided into five Physiographic zones, namely high Himalayas (> 4000m), High Mountain (2000-4000m), Middle Mountains (2000-3000m), Siwalik (120-2000m) and Terai region (60-300m).

The agroforestry systems practiced by the Nepalese farmers differ in different physiographic zones. Depending on the agroecological zone many indigenous and exotics trees are now being used by framers, extension agencies and researchers. Based on altitude there are five physiographic zones in Nepal. Agroforestry system practiced in these zones in many cases differs, but in some cases overlap with each other. Apart from providing useful products, such as firewood, fodder, timber, fruits and bedding materials for livestock and leaf litter for compost making, trees on farmland also serve an important function of protecting the cultivated land from landslides and erosion. Although farmers have realized that keeping trees on farm, particularly maintaining taller tree species, as a traditional way, cause some losses in crop production, the benefits from tree products are more valuable than losses in cereal production. To minimize the losses, farmers have developed their own ways of managing trees and agricultural crops in different agroforestry systems.

Amatya (1994) highlighted the different agroforestry system with respect to physiographic zone of Nepal (see the table below).

S.N	Physiographic Zone	Agroforestry Practices	AF Trees Species
1	Terai and Siwalik	Home garden Planting trees among agricultural crops Intercropping with horticultural trees Taungya Silvofishery Silvopastoral System	<i>Albizia species</i> , <i>Artocarpus lakoocha</i> , <i>Dalbergia sisoo</i> , <i>Eucalyptus camalulensis</i> , <i>Ficus semecordata</i> , <i>Gliricidin sepicum</i> , <i>Leucaena lecocephala</i> , <i>Populus species</i> , <i>Susbania grandiflora</i>
2	Middle Mountain	Alley Cropping Home Garden	<i>Albizia species</i> , <i>Alnus nepalensis</i> , <i>Bauhinia species</i> , <i>Bassia butyracea</i> , <i>Erythrina arborescens</i> , <i>Ficus infectoria</i> , <i>Ficus neriifolia</i> , <i>Ficus semicordata</i> , <i>Garua pinnata</i> , <i>Litsea monopetala</i> , <i>Melia azaderach</i> , <i>Morus alba</i>
3.	High Mountain	Silvopastoral System	<i>Juglans regia</i> , <i>Populus species</i> , <i>Prunus cerasoides</i> , <i>Salix species</i> , <i>Sauraria nepalensis</i>

Combination of Trees, Crop and Livestock and Different Agroforestry Models



7.1 Forest Based Agroforestry System

7.1.1 Shifting Cultivation

Khoria kheti or bhasme (shifting cultivation) is the dominant land use practice in parts of more than 20 hill districts of Nepal; it is typically practiced on the most inaccessible and steep lands and it is the traditional farming system of several indigenous peoples, including Chepang, Magar, Sherpa, Rai, Limbu, Tamang and Gurung. These groups have been practicing shifting cultivation from generations, adapting it to local conditions and changing circumstances (Aryal and Kerkhoff, 2007).

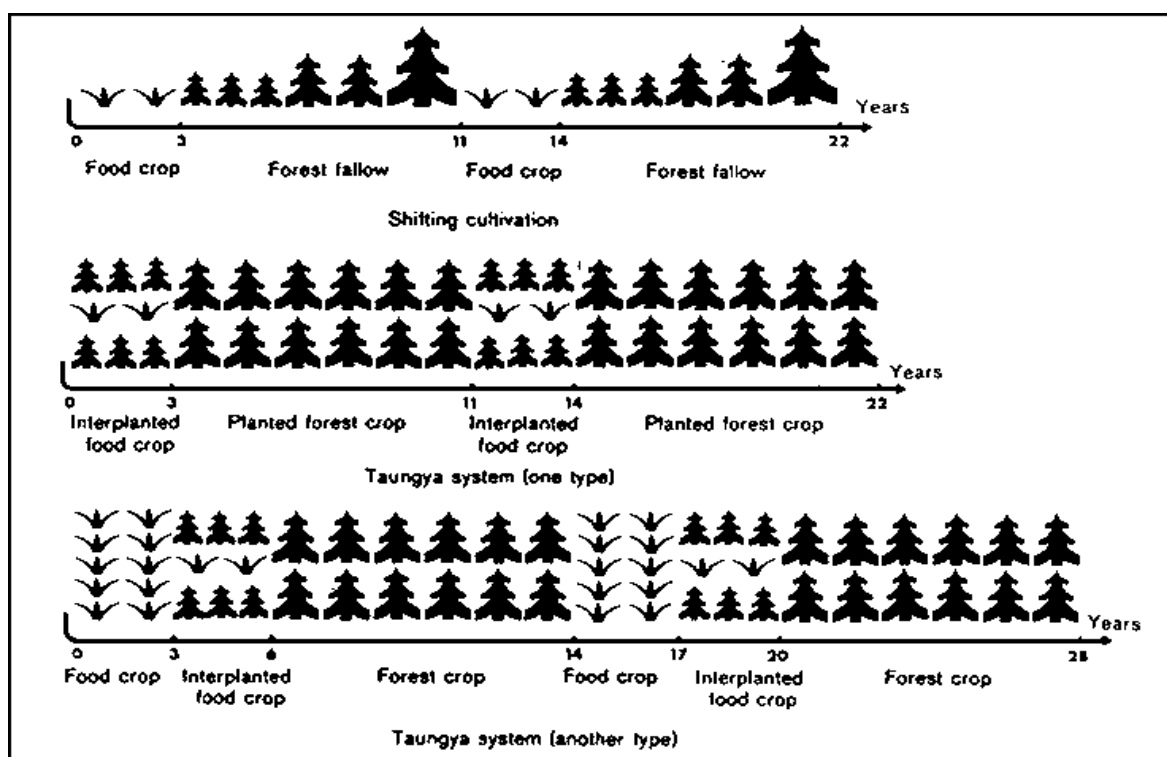
The land clearing technique ('slash and burn') is an integral part of the rotational cycle and makes nutrients and space available for growing crops. The crop growing phase lasts for 1-2 years; the 'forest fallow' phase for up to 12 years or even more (i.e. depend on population pressure and land availability). The fallow 'forests' provide other essential items for the farmers like firewood, timber, wild foods and medicines. It has been in use for centuries and still remains the dominant land use practice on about 30% of the arable land of the world (Gordon and Bentley, 1990).

Shifting cultivation involves an alternation between crops and long-term forest fallow. In a typical sequence, forest is cut and burnt to clear the land and provide ash as 'fertiliser' or 'lime' for the soil. Crop yields are typically high for the first few years but then fall on account of declining soil fertility or invasion of weeds or pests. The fields are then abandoned and the farmer clears another piece of forest. The abandoned field is left to fallow for several years or decades and thus has a chance to rebuild fertility before the farmer returns to it to start the process again.

In Nepal, this practice is locally known as Khoria Kheti and is a dominant farming practice in the hilly areas of Chitawan, Makawanpur, Tanahun, Gorkha, Lamjung, Nawalparasi and Dhading districts of Central and Western Region of Nepal. Khoria farming practice is also prevalent



in the Koshi watershed in Khotang and Bhojpur, some parts of Terathum and Pachthar. According to Regmi et.al., (2004), shifting cultivation practices is found extensively in the Num and sourrounded villages in Taplejung and Nalbu and surrounded villages in Sankhuwasabha. Shifting cultivation is commonly known as Bhasme in Taplejung and Sankhuwasabha districts. This practice is also prevalent in some remote areas of solukumbu district and along the side of Tamor River in Dhankuta district. According to Shroeder (1985), there is evidence of forest fallow slash and burn cultivation in the upper Arun River valley where at least ten years has passed between periods of cultivation. He also points out that at Pumdi – Bhumdi near Pokhara, some areas of Palpa and Rasuwa slash and burn was common prior to World War I and ended by about 1957. Besides, the practice of slash and burn is still a common practice in some areas of Jumla, Mugu and Kalikot in Far Western region of Nepal (cited in Singh and Adhikari 1993).



7.1.2 Taungya System

Taung-hill, Ya-cultivation, the taungya system is defined as a method of establishing a forest crop in temporary association with agricultural crops. It is a method of raising forest plantations in which cultivators are allowed to raise agricultural crops for initial periods of a few years and in return they are made to raise forest plantations. Agricultural cropping is usually confined to the period by which the canopy of the forest crop starts closing. In fact, the taungya system is

an extension of shifting cultivation ([Dwivedi, 1992](#)). In this system, inter cropping is allowed to the farmers for initial 2 years in public land of large scale forest conservation. *Eucalyptus camaldulensis* was planted in 2*3m spacing (10000 ha).

In Nepal the taungya system was started sometimes in 1972 at tamagadhi area of Bara district ([Amatya, 1994](#)). This area was originally covered with forests consisting mainly Sal, Asna and its associates. The area was encroached on by migrants from the hills. In an effort to save the remaining forest and to engage the migrants in forest activities, the taungya system was practiced in that area. Now this system is practicing in the Tamagadhi of Bara district and Sagarnath Forest Development Project of Sarlahi. In the Tamagadhi, land are allocated for the poor and land less people and they generally live inside the forest area, whereas Sagarnath cultivators live outside the forest area.

Major functions of the system are to supply fuelwood, poles, small timber for local consumption to reduce fire hazards and to transfer of weeding costs to the agricultural sector ([Sharma, 2006](#)).

Types of Taungya System

- **Departmental Taungya:** Agriculture plantation is raised by Forest department; not practiced in Nepal
- **Village Taungya:** land is provided for the poor people to raise agricultural crops on the basis of certain agreement. No cost is taken from the villagers. This system is practiced by Sagarnath Forest Development Project.
- **Leased Taungya:** The plantation land is given on lease to persons or industries. In Sagarnath plantation land is given to the industries for the cultivation of Non-timber forest products. Project collects tax NRs 1250/ha. for the three years.

Limitations of Taungya Systems

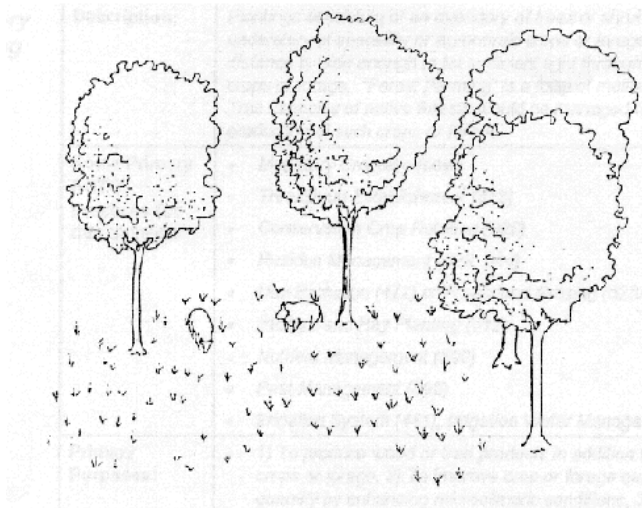
- ☞ It does not provide security of land tenure
- ☞ It does not provide long term employment or the opportunity for permanent settlement.
- ☞ Sometimes the cultivators did not leave the area and the area had to be allotted for agriculture.

7.1.3 Hortisilviculture System

Hortisilviculture system defined as land management system in which trees are simultaneously management with fruit trees and vegetable production (Yadava, 2009). This system is a common feature as a home garden with fruit trees orchard as a windbreak. For example Sissoo+ Mango, Eucalyptus + Litchi etc. In eastern Nepal planting cardamom with *Alnus* and tea with *Albezzia*, Bombox as a understory is commercially cultivating practices.

7.1.4 Silvopastoral System

Tree and pasture combinations are called *silvopastoral agroforestry*. Silvopastures combine livestock grazing on forage crops or pastures within actively managed tree or shrub crops. Cattle, sheep and goats are the most common livestock incorporated into silvopasture systems and they may be deployed entirely within a private farm/woodlot silvopasture or through collaborative arrangements between forest licensees and livestock producers on public lands (Wikipedia, 2009).



Trees are planted in single or multiple rows, and livestock graze between them. Although both the trees and the livestock must be managed for production, some systems emphasize one over the other. Usually, in the early years of establishment, crops or hay are harvested from the planting. Grazing generally begins after two or three years, when the trees are large

enough that the livestock can't damage them. In other instances, tree tubes and electric fencing protect the young trees, and grazing begins immediately (Attrra, 20009).

Agro-silvo-pastoral land use patterns, which includes growing of :

- Fast-growing fodder shrubs and trees in crop land and pastures;
- Pastures under plantation crops and
- Pastures in forest tree plantations

There are several examples of such land use patterns in the region and in Himalayan areas of Nepal as well (Tewari, 1995).

7.1.5 Aquasilviculture

This is a system where trees are used in conjunction with fish farming. This system is currently gaining momentum in terai/inner terai parts of the country where different tree species and fruits trees are being planted along the embankment of the ponds. Banana, pineapple, papaya also planted as a intercropping at the embankment. In some areas, duck and pigs are also included (Regmi, 2004).

7.1.6 Sericulture

Sericulture is today a well recognized practice combining silviculture, agriculture, horticulture and cottage industry. The main trees raised are *Morus alba* and *Terminalia arjuna*. The Silk Worm (*Bombyx mori*) is raised on the leaves of these trees. It plays an important role in socioeconomic development of rural poor. There are varieties of mulberry. The important varieties are L146, RSS 175, RSS 135, S 54, TR 10, K 2, etc (Yadava, 2007).

7.1.7 Apiculture

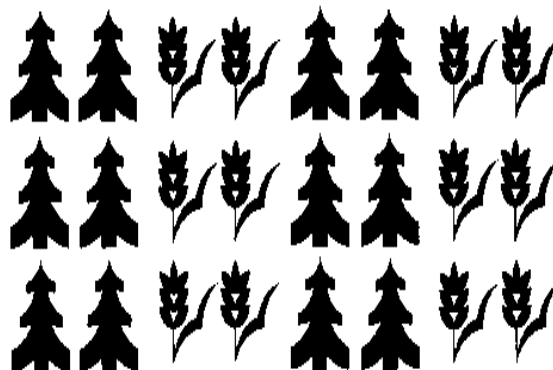
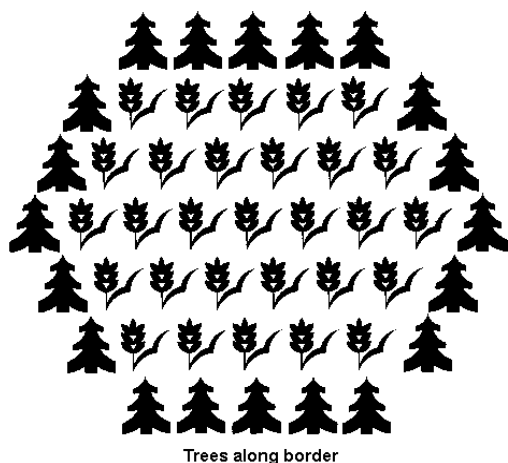
Two important non-timber products in our forests are honey and beeswax. Several species of bees are found in our country, e.g., *Apis indica*, *Apis dorsata*, etc. Some forest areas can be used for beekeeping. Knowledge of the nectar and pollen source plant in the area is necessary before initiating a beekeeping program. Several tree species, e.g., *Acacia species*, *Tilia species*, *Litchi*, *Prosopis chilensis*, *Eucalyptus*, *Mahogani*, *Robinia pseudocacia* and other flowering species are supposed to beekeeping. Forest areas should be developed as good which bloom at different period. Some forest areas should be selected for apiary site for benefit effect of bees in pollens (Yadava, 2007).



7.2 Farm Based Agroforestry System

7.2.1 Agrisilviculture System

Agrisilviculture systems include those combinations of agriculture and forest crop where agricultural components predominate over the forestry components. These systems are primarily used for managing lands classified as agricultural lands. Importance agrisilviculture systems may includes;



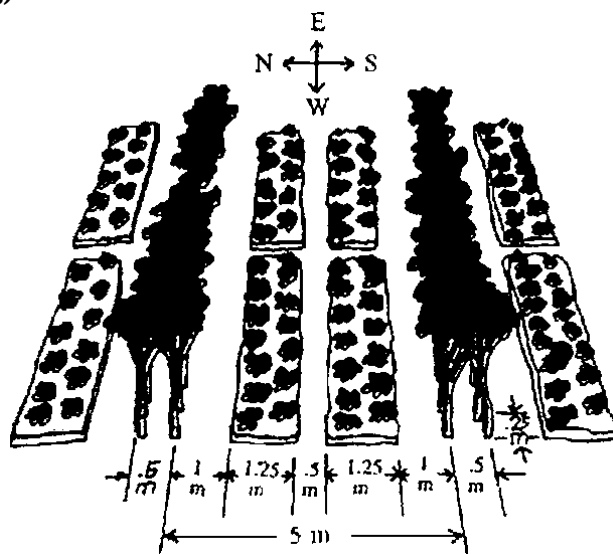
- Growing of multipurpose trees on farm lands
- Homestead plantations and home gardens
- Trees with plantation crops
- Multipurpose trees with horticulture crops
- Alley cropping or hedgerow cropping

7.2.2 Agrisilviculture System

As the term suggests, this incorporates agriculture, forest and fruit trees. The trees, both fruit and forest, may be planted in rows. Those species should be selected which can be spaced to all intercropping. The varieties which do not grow tall are preferred. It is assured that the canopy would close after about 15 years. Some of the fruit trees selected for this type of cultivation are mango, apple, citrus, litchi, guava, banana, coconut and pineapple. The agricultural crops are raised for about 10 to 15 years in between the rows of trees. Cereals, vegetables, pulses and spices may be raised (Regmi, 2004).

7.2.3 Alley Cropping (Hedgerow intercropping)

Alley cropping, 'sun systems, or Intercropping is a strategy used by farmers to combat soil erosion. In this method, several crops are planted together in strips or alleys between trees and shrubs. This design provides shade (reducing water loss from evaporation), ensures retention of soil moisture, and can also produce fruit, fuel wood, fodder, or trimmings to be made into mulch (Wikipedia, 2009).



Several species, such as *Leucaena leucocephala*, *Sesbania grandiflora*, *Gliricidia sepium*, *Casia siamea*, etc are used in this system. These species are usually planted at a spacing of 50 cm in rows spaced at 4, 5 and 6m apart.

In between the rows of trees, agricultural crops such as maize, jowar, pulses, oilseeds, etc are grown. The trees are often pruned and lopped. The fodder obtained from these trees is either used as green manure in the field or as fodder for animals. *Leucaena leucocephala* is often pruned at the height of 1.0 m and maintained as a hedge in the field. Alley cropping and hedgerow cultivation is very useful for sloping land (Dwivedi, 1992).

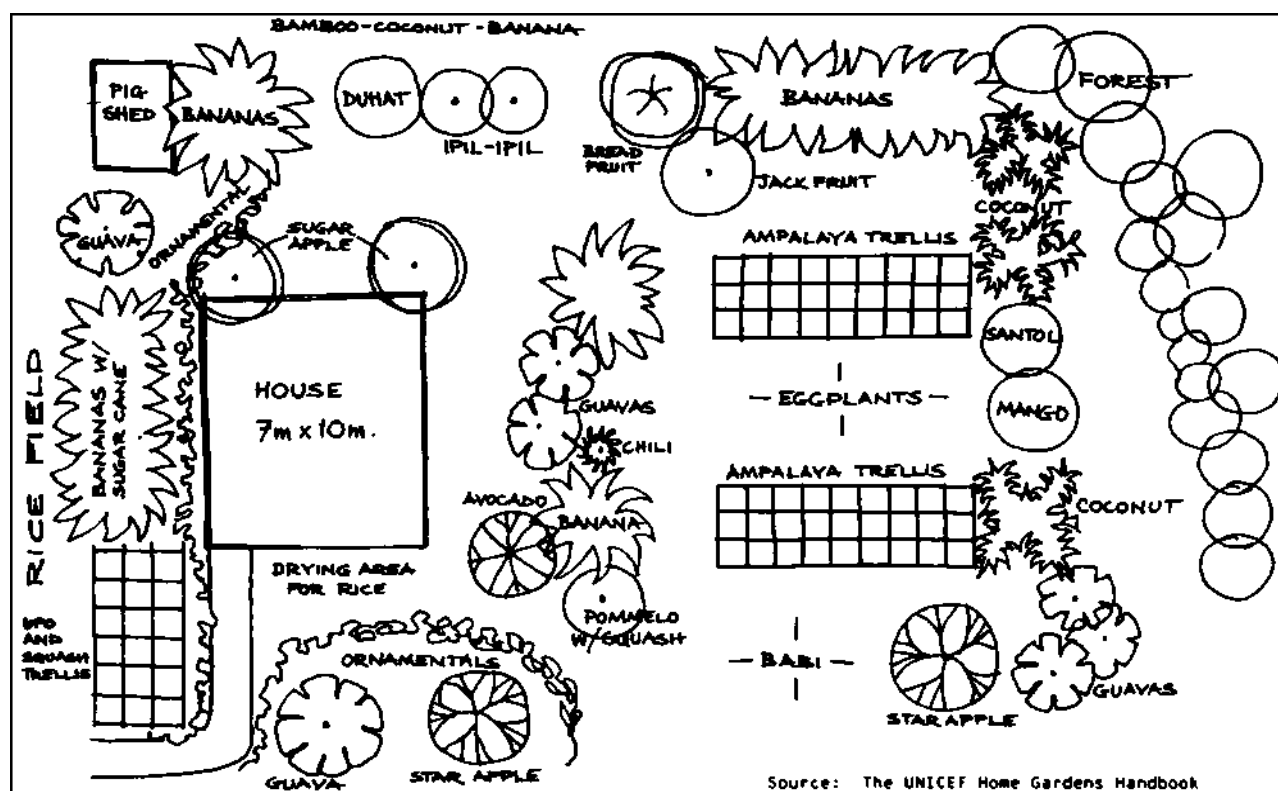
Plantings are placed at intervals across a field or unit that, depending on purpose, are perpendicular to the prevailing troublesome winds, on the contour, or at multiples of the widest field equipment width. The products derived from the trees or shrubs or the protected or climatically influenced zones of these plantings achieve desired purposes. Trees or shrubs planted along the edges of "alleys" may consist of one to many rows to insure adequate density of branches, stems and leaves (NRCS, 1996).

7.2.4 Home Garden or Homesteads

A characteristic feature of the landscape in many countries in the region is the existence of tree groves around houses or homesteads, or on raised land in the midst of rice fields. In the densely populated flood plains, rural communities depend on homestead groves for timber, fuel, fruit, fodder and medicinal plants.

In some countries, these homestead groves supply the forest product needs of as much as 90 percent of the rural population. Home gardens also help relieve pressure on forest lands, thus slowing degradation of natural resources (Tewari, 1995).

Home gardens are traditional Agrisilviculture system where trees and shrubs are integrated with vegetables and grass species. Although, growing a mixture of fruit & fodder species, and vegetables can be seen in nearly majority of the households, only a small number of households have managed a particular home garden- called Bageincha in Nepali. Productive and protective multipurpose tree species comprise the upper layer of the home garden. The subsequent layers are composed of the shrubby and medium height species of papaya, banana, litchi and ground level vegetables and grass species. Establishment of home garden with multiple species of plant in the Hill is vital as moisture is the limiting factor in crop production system. Kitchen wastewater is



efficiently used to raise the seedlings and other crops grown in home gardens, which is particularly important during the long dry spells. Home gardens normally supply the households' kitchen needs and number of green leafy vegetables, spices, and pulses like pigeon pea, black gram, beans and horse gram and oil seeds, such as groundnut.

In Nepal, Home garden system is a common feature in hills as well as in the Terai. This is mostly developed in those villages which have exhausted their nearby accessible forest resource a long time ago.

7.2.5 Farm Forestry

The farm forestry is one of the mostly used agroforestry system in Nepal. It is practicing in private land e.g. block plantation, planting of terrace risers on upland rainfed or lowland irrigated areas, planting on farm non arable areas(gullies or streamside), multipurpose tree planting in agricultural fields, fruit orchard (multilayer arrangement), inter cropping and home gardens. Primary functions of the technology are to provide basic needs of fodder, fuelwood, small timber, fruits; water erosion control and waste land utilization.

7.2.6 Slope Agriculture Land Technology (SALT)

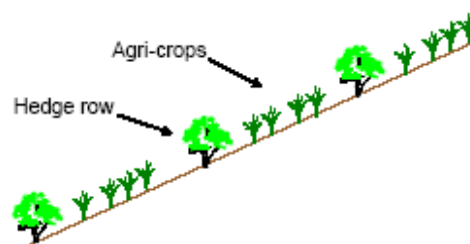
SALT is a package technology on soil conservation and food production, integrating different soil conservation measures in just one setting. Basically, SALT is a method of growing field and permanent crops in 3-meter to 5-meter-wide bands between contoured rows of nitrogen fixing trees. The nitrogen fixing trees are thickly planted in double rows to make hedgerows. When a hedge is 1.5 to 2 meters tall, it is cut down to about 75 centimeters and the cuttings (tops) are placed in alley-ways to serve as organic fertilizers. There are several forms of SALT, and a farmer may wish to use the SALT system in several variations (ARLDFES, 1997).

SALT 2 (*Simple Agro-Livestock Land Technology*) is a small livestock-based agroforestry preferably dairy goats with a land use of 40% for agriculture, 20% for forestry and 40% for livestock.

SALT 3 (*Sustainable Agroforest Land Technology*) is a cropping system in which a farmer can incorporate food production, fruit production, and forest trees that can be marketed. The farmer first develops a conventional SALT project to produce food for his family and possibly food for livestock. On another area of land he can plant fruit trees such as rambutan, durian, and lanzones between the contour lines. The plants in the hedgerows will be cut and piled around the fruit trees for fertilizer and soil conservation purposes. A small forest of about one hectare will be developed in which trees of different species may be grown for firewood and charcoal for short-range production.

SALT 4 (*Small Agrofruit Livelihood Technology*) is based on half-a-hectare of sloping land with 2/3 devoted to fruit trees and 1/3 intended for food crops. Hedgerows of different nitrogen-fixing trees and shrubs (*Flemingia macrophylla*, *Desmodium rensonii*, and *Gliricidia sepium*, etc.) are planted along the contours of the farm (Waston, 1995).

In Nepal this technology has been developed by ICIMOD in Godabary, near Mugling and in HKH and other hills. In this technology, cultivation is done in hill slope without losing the soil and increase the production to stop the shifting cultivation practice (Yadava, 2007). It is found to be a promoting farming system in slope agricultural land. It is primarily designed for soil erosion control. Legumes hedge rows are planted along the contour line at the spacing of 4-5m depending on the land characteristics



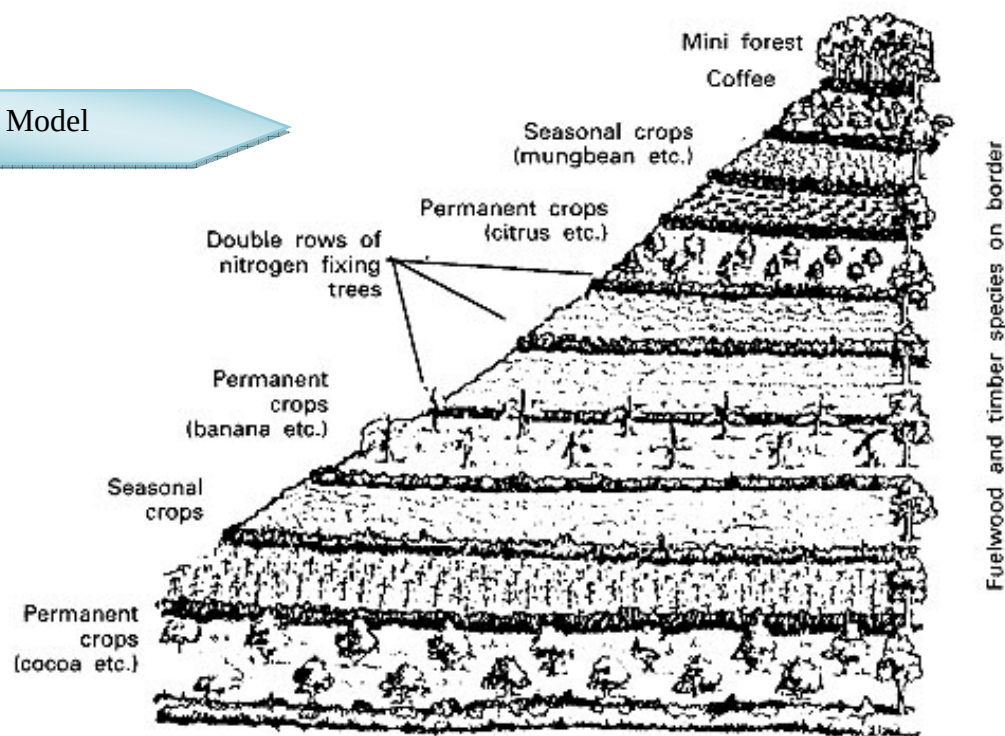
particularly slope angle. After a long time, a natural terracing is formed by trapping eroded soil by the hedge rows (Sharma, 2006).

It has been suggested that poplars with 5m spacing between the hedges would yield up to 64 tonnes biomass/ha, if suitable varieties were used. The use of legumes such as *Medicago sativa*, *Trifolium repens*, *Desmodium inforum*, *Stylosanthes gutanensis*, etc could produce an additional 8 tonnes DM/ha of foliage annually (Amatya et al, 1993 cited in Sharma, 2006).

Sloppy land Cultivation



SALT Model



All the above agroforestry systems of Nepal are given in one table by Yadava (2009) which is given in the table below.

Major System	Sub-Systems/ Practice	Nepal Examples
1. Agri-silvicultural System	1. Improved fallow land	Outer Terai, inner Terai and some parts in mid-hills
	2. Taungya system	Tamagarhi, Sagarnath, Murtiya, Banke, Kapilvastu, but now not in operation.
	3. Tree garden	Usually associated with fruits tree mixed with fodder, firewood, and timber species- Outer Terai, Inner Terai and in middle hills.
	4. Multipurpose trees and shrubs on farmlands	Several forms of plantations e.g. Single row, multiple row on field, on one side or all sides etc. Eucalyptus, Sissoo, Ipil ipil, Melia, Bauhinia, etc on bunds in Terai, Inner Terai and mid hills of Nepal.
	5. Hedgerow or alley cropping	Small scale practice in Terai, Inner Terai and Hills
	6. Tree crops and plantation crops	Plantation of multipurpose tree such a Mango, Lichi, Guava, Albizia, Terminalia, Luecaena, Melia, Sisoo in agri-crops in Orchard, Tea, Coffee in tea garden and in private land, Turmaric, Zinger in Terai and Hills
	7. Homestead garden plantation	Homestead AF in which trees of different species eg Mango, Lichi, Guava, Sissoo, Melia, Moringa, Bamboo etc. around the garden, well, house, tanks, path to supply fruit, fodder, fuel and timber in Terai, Hills and Inner Terai.
	8. Shelterbelt windbreaks	Plantation around Orchard, around farm, canal banks, roadsides etc.
2. Silvi-Pastoral System	9. Cut and carry fodder and forage production	Plantation in fallow, gaps in community forestry, sloppy lands in hills.
	10. Live fence	Several trees and shrubs planted around the boundary of field –eg Ipil, Kutmiro, Litsia, Melia, Bauhinia, Ficus for fodder and Justicia, Jatropha, Pyracantha, Rubus ellipticus, etc for live hedge in hills and some area in Terai.
	11. Tree and shrub in pasture land	
3. Agri-silvipastoral systems	12. Woody hedges for mulch, garden manure, soil conservation	Practiced only in watershed area in hills and small practiced in private land in hills only.
	13. Home garden	This system is common in almost all area.
4. Others systems	14. Multipurpose wood lots	Practiced in area where acute shortage of fuel wood and small timber in hills, terai and Inner Terai.
	15. Aquaculture/ Agrisilvi-fisheary	It is being tried in Sunsari, Morong, and where fish ponds are constructed in Terai and Inner Terai of Nepal.
	16. Shifting Cultivation	Common in mid hills of Nepal.
	17. Agriculture with sericulture, apiculture etc	Practiced in some parts of Terai, Inner Terai and midhills

8. Issues and Challenge in Agroforestry System Practiced in Nepal

There are several land use issues which pose challenges for an agroforestry system. One such issue is shifting cultivation. In the high mountains of Nepal this system is extensively practiced. Although shifting cultivation provides a livelihood for many rural/ tribal people, it is a wasteful and inefficient system (Amatya, 1994). These issues and challenges can be categorized into;

8.1 Institutional

- Fears arising largely from the Forest Department that the land could be alienated once the farmers raise trees on their farm land.
- The system is difficult to operate as it demands multidisciplinary approach for solving a problem. Foresters, Agriculturists, Livestock scientist, Horticulturist, Social scientist need to sit down together and bring out the solution. This is also one constrain in case of Nepal.

8.2 Socio-economic

- In general the farm size holdings are small for afforestation plots and that there is no income incentive for tree planting as there is little possibility of a timber market in the hills.
- Requirement of more labor inputs, which may cause scarcity at times in the farm activities
- Competition between food and tree crops, which could cause aggregate yield to be lower than those of single crop
- Longer period required for trees to grow to maturity and acquire an economic value.
- Resistance by framers to displace food crops with tree, especially were land is scarce. and
- The fact that agroforestry is more complex, less well understood and more difficult to apply, compared to single-crop farms.

8.3 Biological

- Increase competition
- Potential for accelerated nutrient loss

- Mechanical damage for cultivation and harvest
- Damage to tree and crop component from livestock
- Allelopathy
- Potential for increased erosion in the hilly area
- Habitat or alternative hosts for pests

9. Conclusions

Agroforestry is simply the use of trees in farming systems. Different types of agroforestry system existed in different parts of the world. Agrosilviculture, Silvopastoral, Hortisilviculture, Silvo-fishery, Apiculture and Sericulture are the most common agroforestry system practiced in Nepal. Taungya cultivation is practiced for large scale plantation in Terai, where as the Shifting cultivation is practiced by the landless poor people of tribal communities in the hilly area. Alley cropping and SALT are mostly concentrated with soil conservation and productivity enhancement. These practiced are especially focused in the hilly area. Institutionalization, holistic approach and coordination, and research are the key for the sustainable practiced of agroforestry in the future.

10 References

- Amatya S.M., 1994.** Agroforestry Systems and Practice in Nepal. Forest Research and Survey Centre. Ministry of Forest and Soil Conservation, Babar Mahal, Kathmendu, Nepal.
- ARLDFES, 1997.** Sloping Agricultural Land Technology (SALT-1): A guide on how to farm your hilly land without losing your soil. Asian Rural Life Development Foundation Editorial Staff, 1997. *How to Series (1)*, Kinuskusan, Bansalan, Davao del Sur. Assessed on <http://www.pcarrd.dost.gov.ph/cin/AFIN/technologies%20-%20salt1.htm>
- Aryal A. and Pyakurel A., 2007.** Ecological impact of Agroforestry System in Nepal. M.Sc. Forest Ecology and management, ALU, Freiburg.
- Aryal K.P., Kerkhoff E.E., 2007.** The right to practice shifting cultivation as a traditional occupation in Nepal: A case study to apply ILO Conventions Nos. 111 (Employment and Occupation) and 169 (Indigenous and Tribal Peoples). Kathmandu: ILO Nepal.
- ATTRA 2009.** Agroforestry Review. Accessed in <http://www.attra.ncat.org/attra-pub/PDF/agrofor.pdf> on 23 March 2009
- Beetz A., 2002.** Agroforestry Overview. Assessed in HTML <http://www.attra.ncat.org/attra-pub/agroforestry.html> 24 March 2009.
- Brady N.C. 1999.** The nature and properties of soils. Tenth edition, Hall of India Private limited, New Delhi.
- Denholm J. and Jodha N.S., 1992.** Agroforestry as an Option for Mountain Agricultural Development. In: Jodha, N.S., Baskota, M. and Pratap, T. (Eds.) Sustainable Mountain Agriculture, Vol. 2. Center for Integrated Mountain Development (ICIMOD), Nepal.
- Dwivedi A.P., 1992.** Agroforestry Principles and Practices. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi, India.
- Garforth C.J., Mall Y.B., Neupane R.P., and Pandit B.H., 1999.** Socioeconomic Factors and Agroforestry Improvements in the Hills of Nepal. Mountain Research and Development 19 (3).
- Gordon J.C. and Bentley W.R., 1990.** A Handbook on the Management of Agroforestry Research. Winrock International, USA.
- Nair P. K. R., 1993.** An Introduction to Agroforestry. Kluwer Academic Publishers. Dordrecht, Netherlands
- NRCS, 1996.** An introduction to using tree and shrub practices in sustained agricultural systems. Agroforestry for Farms and Ranches: Agroforestry Technical Note No. 1, July 1, 1996. Assessed in [www.nrcs.usda.gov ECS/forest/technote.html](http://www.nrcs.usda.gov/ECS/forest/technote.html) March 15 2009.
- Regmi B.R., 2004.** Agroforestry Lecture Notes. Institute of Forestry, Pokhara, Nepal.

- Seif el Din A.G., 2008.** Agro-forestry research for the humid tropics” International Development Research Centre, Nairobi, Kenya. Assessed In <http://www.unu.edu/unupress/unupbooks/80364e/80364E05.htm> 24 March 26, 2009.
- Sharma S.P., 2006.** Agroforestry Practices in Nepal *assessed in* <http://www.springerlink.com/index/H02L68Q044183133.pdf> on 20 March 2009
- Sing S.P., 1994.** A Handbook of Agroforestry. Agrotech Publishing Academy.
- Singh A. and Adhikari S., 1999.** Agroforestry for sustainable development in Nepal. Proceedings of National Workshop(17-18, 1997), IOF/ ITTO, Pokhara Nepal.
- Tewari D.N., 1995.** Agroforestry for Increased Productivity, Sustainability and Poverty Alleviation. International Book Distributors, 9/3 Rajpur Road, Dehra Dun-248001, India.
- WAC 2003.** World Agroforestry Center. Assessed in <http://www.worldagroforestrycentre.org/>. on March 30 2009.
- Watson H.R., 1995.** The Development of Sloping Agricultural Land Technology (Salt) in the Philippines. Food & fertilizer technology center. Mindanao Baptist Rural Life Center (MBRLC) Kinuskusan, Bansalan, Davao del Sur, Philippines. Accessed on <http://www.agnet.org/library/eb/400a/eb400a.pdf>
- Wikipedia, 2009.** What are the general Principles of Agroforestry. Assessed in (http://wiki.answers.com/Q/What_are_the_general_principles_of_agroforestry) on March 24 2009.
- Yadav B., 2005.** Bird’s diversity in different landscapes of Nepal. Department of National park and wildlife conservation, Government of Nepal.
- Yadava J.N., 2009.** A Lecture Note on Agroforestry For Master Degree. Institute of Forestry, Office of the Dean, Pokhara, Nepal.