Chapter 1

Introduction
1. Introduction

1.1 Overview

The basic human needs of food, shelter and fuel are often supplied by separate systems of land management. Building material and fuelwood are harvested from forests and food is produced from fields of herbaceous crops, fruit orchards and livestock grazing in pastures. However, this has not always been the case. When trees are mixed in the same land with food crops or pasture for domestic animals, the term agroforestry is used to describe the management system (Smith et al., 1996).

Rising population pressure and urbanisation, along with land degradation, soil salinisation, and global warming are causing insufficiency in food in large parts of Asia. A majority of the population in the developing countries is still dependent on natural resources, particularly on agro-based vocations, which have limited potential for income generation. In rural areas, where resource poor farmers do not find adequate means for their livelihood, young men tend to migrate to cities in search of employment, while women, children and older people prefer to stay back and look for other income generation opportunities such as collection of fodder, fuel and non-wood tree produce from forests, livestock management and cultivation of fruits and vegetables. Villagers living around small towns find it remunerative to maintain dairy animals or bring fuelwood from forests for retail selling. In such a situation, the natural resources which are otherwise meant for generating livelihood on a sustainable basis, are often used for destructive or consumptive purposes. This leads to ecological imbalance and environmental pollution. It has been reported that about 43 percent of the total energy consumed in the Third World by more than 2 million people, is met from biomass. This is equivalent to 22 million barrels of oil per day.

Development of wastelands can be a very effective programme for conserving the natural resources and to restore the ecological balance. However, it is difficult to take a direct approach of establishing greenery, where the local communities do not see any direct benefits immediately. In such a situation, it is advisable to promote various tree species which can generate cash income and hence, wastelands development can turn into a profitable venture. Although these species are grown to produce fruits and timber, it is possible to produce fodder and fuelwood by introducing other species in the interspace to meet basic needs of the local people.
Agroforestry or woody perennial-based mixed species production systems has the potential to arrest land degradation and improve site productivity through interactions among trees, soil, crops, and livestock, and thereby restore a part of the degraded lands. Agroforestry also has potential to improve rural livelihood and enhance integrated management of the natural resource base (Kumar, 2006).

In many countries, there has been greater recognition of the need for more sustainable agricultural practices. Tree-planting has been the means for many farmers to improve the sustainability of their cropping practices and to provide both timber and non-timber tree products. Despite such advantages, agroforestry as a land use option has not attracted much attention from the planners and extension communities. Conscious efforts on system management, policy adjustments and accurate knowledge are therefore imperative to promote agroforestry adoption by the farming community. As a first step, perfect knowledge of agroforestry practices can be very effective in developing countries.

Under this research, the potential of this sustainable production system has been evaluated for reducing food insecurity and preventing environmental degradation in Iran, with particular reference to the study undertaken and historical experiences in this field. The increase and decrease in production levels are specifically addressed using data from published sources. A limited amount of such data is also presented to demonstrate certain concepts and managerial interventions.

### 1.2 Concept and definition of agroforestry

Agroforestry is a new name for a set of old practices (Nair, 1993). Growing trees on farm land is an ancient art. Farmers have nurtured trees on their farms, pasture lands and around their homes. Therefore, neither the concept nor the practice of agroforestry is new (Sen et al. 2004). As a scientific discipline, the origin of agroforestry is fairly recent (Wojtkowski, 1998). Agroforestry is a symbiosis of tree growing, crop production and livestock raising where each component is beneficial to each other. It may be traditional and/or introduced (Bandyopadhyay, 2001). These definitions imply the following in an agroforestry system:

1. There are two or more species of plants/animals at least one of which is woody perennial;
2. There should be biological and economical interaction within the components;
3. The cycle of an agroforestry system is always more than one year (Mesele, 2002).

According to the definitions, agroforestry includes agriculture and forestry technologies to create more integrated, diverse, productive, profitable, healthy and sustainable land-use system. "Agroforestry is a collective name for land use systems and practices in which woody perennials are deliberately integrated with crops and/or animals on the same land management unit", as defined by the World Agroforestry Centre (ICRAF) in 1993.

There are normally both ecological and economic interactions between woody and non-woody components in agroforestry. This means that trees are deliberately used within agricultural systems. Knowledge, careful selection of species and good management of trees and crops are needed to maximise the production and positive effects of trees and to minimise negative competitive effects on crops. It needs to be emphasised that one concept is common in all the diverse agroforestry systems: the purposeful growing or deliberate retention of trees with crops and/or animals in interacting combinations for multiple products or benefits from the same management unit. This is the essence of agroforestry.

There are three additional attributes which, theoretically all agroforestry systems possess. These are:

1. **Productivity**: Most, if not all, agroforestry systems aim to maintain or increase production (of preferred commodities) as well as productivity (of the land). Agroforestry can improve productivity by increased output of tree products, improved yields of associated crops, reduction of cropping system inputs, and increased labour efficiency.

2. **Sustainability**: By conserving the production potential of the resource base mainly through the beneficial effects of woody perennials on soils, agroforestry can achieve and indefinitely maintain conservation and fertility goals. Although production is a very important consideration in agroforestry, it is the sustainability attribute that makes it different from other approaches towards land use. Sustainability is the key word in land-use parlance today and the cornerstone of agroforestry.
3. **Adoptability**: The word "adopt" here means "accept". The fact that agroforestry is a relatively new word for an old set of practices means that, in some cases, agroforestry has already been accepted by the farming community. However, the implication here is that improved or new agroforestry technologies that are introduced in new areas should also conform to local farming practices.

These attributes are so characteristic of agroforestry systems that they form the basis for evaluation of various agroforestry systems (Nair, 1993).

To achieve self-sufficiency of people and ecological balance, agroforestry can play a significant role. While selecting tree species and cropping systems, the following properties are considered:

**A. Multipurpose:** In terms of economic value, those tree species and cropping systems which yield multiple products such as fruits, flowers and leaves as food, fuelwood, wax, timber, fodder, medicinal extracts and many other uses.

**B. Companion growing:** The multistorey cropping system is the most effective use of resources. The species used should support the harmony of various plants in the entire system.

**C. Ecological improvement:** The tree species and cropping systems should enrich soil and improve soil balance; provide habitat and food for various animals; diversify ecosystems which can support and maintain healthy food chains; decrease temperature and increase moisture; improve water supply and recycling capacity.

**D. Special advantages:** The tree species should be fast growing, drought tolerant, and require less maintenance, etc.

**E. Culturally harmonising with the local society:** There are many species from abroad which are able to grow harmoniously in an area plant combination (Sungsumaran, 2000).

In agroforestry systems, there are three basic sets of elements or components that are managed by the land user, namely, the tree or woody perennial, the herb (agricultural crops including pasture species), and the animal. Occasionally, there may be other components also, such as fish, honey bees, etc. All agroforestry systems consist of at
least two of the three major groups of agroforestry components. In order for a land-use system to be designated as an agroforestry system, it must always have a woody perennial. In most agroforestry systems, the herbaceous species is also involved, the notable exceptions being apiculture and aquaculture with trees, and plantation-crop mixtures of two woody perennials such as coffee and rubber trees, or coffee, cacao, and tea under shade trees. Animals are only present in some agroforestry systems (Gholz, 1987).

The most obvious and easy-to-use criteria for classifying agroforestry systems are the spatial and temporal arrangement of components, the importance and role of components, the production aims or outputs from the system and social and economic features. They correspond to the structure, function (output), socio-economic nature, or ecological (environmental) spread. These characteristics also represent the main objective of a classification scheme. Therefore, agroforestry systems can be categorised according to the following sets of criteria (Table 1.1):

- **Structural basis**: refers to the composition of the components, including spatial arrangement of the woody component, vertical stratification of all the components and temporal arrangement of different components.

- **Functional basis**: refers to the major function or role of the system, usually furnished by the woody components (these can be of a service or protective nature, e.g. windbreak, shelterbelt, soil conservation).

- **Socio-economic basis**: refers to the level of inputs of management (low input, high input) or intensity or scale of management and commercial goals (subsistence, commercial, intermediate).

- **Ecological basis**: refers to the environmental condition and ecological suitability of systems, based on the assumption that certain types of systems can be more appropriate for certain ecological conditions; i.e. there can be separate sets of agroforestry systems for arid and semi-arid lands, tropical highlands, lowland humid tropics, etc. (Nair, 1985).
Table 1.1: Major approaches to classification of agroforestry systems and practices

<table>
<thead>
<tr>
<th>Nature of components</th>
<th>Arrangement of components</th>
<th>Function (role and/or output of components, especially woody ones)</th>
<th>Grouping of systems (according to their spread and management)</th>
<th>Socio-economic and management level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agrisilviculture (crops and trees incl. shrubs/trees and trees)</td>
<td>In space (spatial) Mixed dense (e.g. hedges/edges)</td>
<td>Feed</td>
<td>Lowland humid tropics (above 1,200 m a.s.l., Malaysia)</td>
<td></td>
</tr>
<tr>
<td>Silvopastoral (pasture/animals and trees)</td>
<td>Mixed space (e.g. most systems of trees in pastures) Strip (width of strip to be more than one tree)</td>
<td>Feed</td>
<td>Highland humid tropics (above 1,200 m a.s.l., Malaysia)</td>
<td></td>
</tr>
<tr>
<td>Agrosilvopastoral (crops, pasture/animals, and trees)</td>
<td>Boundary fences on edges of plots/fields In time (temporal) * Coincident * Concomitant * Overlapping * Sequential (separate) * Interpolated</td>
<td>Windbreak Shelterbelt Soil conservation Moisture conservation Soil improvement Shade (for crop, animal and man)</td>
<td>Based on level of technology input Low input (marginal) Medium input High input Based on cost/benefit ratios Commercial Intermediate Subsistence</td>
<td></td>
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<tr>
<td>Others (multipurpose tree lots, aquaculture with trees, etc.)</td>
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</tbody>
</table>

Based on the nature and type of components involved, agroforestry system can be classified as agri-silvicultural (tree + crops), silvopastoral (tree + pasture and /or livestock) and agro-silvopastoral (all three types of components). This leads to a simple classification of agroforestry systems as depicted in Figure 1.1 (Nair, 1985).

Figure 1.1: Classification of agroforestry systems based on the type of components.

Agrisilviculture - crops (including shrubs/vines) and trees
Silvopastoral - pasture/animals and trees
Agrosilvopastoral - crops, pasture/animals and trees
Table 1.2 lists the most common agroforestry practices that constitute diverse agroforestry systems throughout the world and their main characteristics (Nair, 1991).

**Table 1.2: Major agroforestry practices and their main characteristics**

<table>
<thead>
<tr>
<th>Agroforestry practice</th>
<th>Brief description (arrangement of components)</th>
<th>Major groups of components</th>
<th>Agroecological adaptability</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Agrisylvicultural systems (crops + shrubs/vines/tree crops + and trees)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(1) Improved fallow</td>
<td>Woody species planted and left to grow during the fallow phase</td>
<td>w: fast-growing preferably leguminous; h: common agricultural crops</td>
<td>In shifting cultivation areas</td>
</tr>
<tr>
<td>(2) Taungya</td>
<td>Combined stand of woody and agricultural species during early stages of establishment of plantations</td>
<td>w: fast-growing, leguminous, that coppice vigorously; h: common agricultural crops</td>
<td>Subtropical to humid areas with high human population pressure and fragile (productive but easily degradable) soils</td>
</tr>
<tr>
<td>(3) Alley cropping (hedge-row intercropping)</td>
<td>Woody species in hedges; agricultural species in alleys between hedges; microcosmic or strip arrangement</td>
<td>h: common agricultural crops</td>
<td>Areas with fertile soils, good availability of labour, and high human population pressure</td>
</tr>
<tr>
<td>(4) Multilayer tree gardens</td>
<td>Multispecies, multilayer dense plant associations with no organized planting arrangements</td>
<td></td>
<td>In all ecological regions exp. in subtropical farming, also commonly integrated with animals</td>
</tr>
<tr>
<td>(5) Multipurpose trees on crop lands</td>
<td>Trees scattered haphazardly or according to some systematic patterns on bunds, terraces or plot/field boundaries</td>
<td>h: common agricultural crops</td>
<td>In humid lowlands or tropical humid/subhumid highlands (depending on the plantation crops concerned); usually in smallholder subsistence systems</td>
</tr>
<tr>
<td>(6) Plantation crop combinations</td>
<td>(i) Integrated multistory (mixed, dense) mixtures of plantation crops; (ii) Mixed species crops in alternate or other regular arrangement; (iii) Shade trees for plantation crops; shade trees scattered</td>
<td>w: plantation crops like coffee, cacao, coconut, etc. and fruit trees, esp. in (i); h: usually present in (iv), and to some extent in (ii); w: multipurpose trees and other fruit trees</td>
<td>In all ecological regions exp. in areas of high population density</td>
</tr>
<tr>
<td>(7) Homegardens</td>
<td>(iv) Intercropping with agricultural crops intimate; multistory combination of various trees and crops around homesteads</td>
<td>w: fruit trees predominant; also other woody species, vines, etc.</td>
<td>In regions of high land pressure</td>
</tr>
<tr>
<td>(8) Trees in soil conservation and reclamation</td>
<td>Trees on bunds, terraces, rainrails, etc. with or without grass strips; trees for soil reclamation</td>
<td>h: shade tolerant agricultural species</td>
<td>In wind-prone areas</td>
</tr>
<tr>
<td>(9) Shelterbelts and windbreaks, live hedges</td>
<td>Trees around farmland/plots</td>
<td>w: combination of tall-growing spreading types</td>
<td>In all ecological regions</td>
</tr>
<tr>
<td>(10) Fuelwood production</td>
<td>Interplanting fuelwood species on or around agricultural lands</td>
<td>h: agricultural crops of the locality</td>
<td>In all agricultural regions</td>
</tr>
<tr>
<td><strong>Silvopastoral systems (trees + pasture and/or animals)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(11) Trees on rangeland or pastures</td>
<td>Trees scattered irregularly or arranged according to some systematic pattern</td>
<td>w: multipurpose; of fodder value; f: present</td>
<td>Extensive grazing areas</td>
</tr>
<tr>
<td>(12) Protein banks</td>
<td>Production of protein-rich tree fodder on farm/rangelands for cut-and-carry fodder production</td>
<td>h: leguminous fodder trees</td>
<td>Usually in areas with high herbage: land ratio</td>
</tr>
<tr>
<td>(13) Plantation crops with pastures and animals</td>
<td>Example: cattle under coconuts in south-east Asia and the south Pacific</td>
<td>f: present</td>
<td>In areas with less pressure on plantation crops land</td>
</tr>
<tr>
<td><strong>Agrosylvopastoral systems (trees + crops + pasture/animals)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(14) Homegardens involving animals</td>
<td>Intimate, multistory combination of various trees and crops, and animals, around homesteads</td>
<td>w: fruit trees predominant; also other woody species</td>
<td>In all ecological regions with high density of human population</td>
</tr>
<tr>
<td>(15) Multipurpose woody hedges</td>
<td>Woody hedges for browse, mulch, green manure, soil conservation, etc.</td>
<td>a: present</td>
<td>Humid to subhumid areas with hilly and sloping terrain</td>
</tr>
<tr>
<td>(16) Agriculture with trees</td>
<td>Trees for honey production</td>
<td>w: fast-growing and coppicing fodder shrubs and trees</td>
<td>Depending on the feasibility of agriculture</td>
</tr>
<tr>
<td>(17) Aquiculture</td>
<td>Trees lining fish ponds, tree leaves being used as forage for fish</td>
<td>h: (similar to alley cropping and soil conservation)</td>
<td>Lowlands</td>
</tr>
<tr>
<td>(18) Multipurpose woodlots</td>
<td>For various purposes (wood, fodder, soil protection, soil reclamation, etc.)</td>
<td>w: multipurpose species; special location-specific species (other components may be present)</td>
<td>Various</td>
</tr>
</tbody>
</table>

Note: w = woody; h = herbaceous; f = fodder for grazing; and a = animals
1.3 Research objectives

The study provides insights into the contribution of agroforestry to the livelihoods of rural households in the form of traditional systems. The results of this study can help in redirecting, improving and strengthening the existing agroforestry programmes apart from providing certain guidelines for implementation of some agroforestry programmes in similar agro-climatic zones all over the country.

The objectives of this study were:

1. To study the different agroforestry systems prevailing in Iran and the objectives of establishing these systems.
2. To study the role of different agroforestry systems in soil and water conservation and some other environmental improvements.
3. To study the impact of different agroforestry systems on food security, supply of various products for home consumption such as fodder and fuelwood, income and employment generation.
4. To identify the participation of rural families in this sustainable land use system and particularly women whose rights over the land are not secure.
5. To identify various models, methods and strategies adopted for implementation of different agroforestry systems in other regions and to suggest the methods which are more effective for sustainable development.
6. To assess the socio-economic values of the traditional systems, compare it with modern agroforestry systems in the world and recommend sustainable systems of agroforestry for socio-economic development of rural population in Iran.

1.4 Research hypothesis

Based on the general field observations, the following hypothesis were developed for testing under the proposed study:

1. Agroforestry as a land use option has not attracted much attention from the planners and extension community in developing countries;
2. Different methods and strategies of agroforestry have been adopted by different climates, areas, cultures and Government supports;
3. Agroforestry is able to earn many direct and indirect benefits i.e. soil and water conservation, combat desertification, low input use and ecological security;
4. Agroforestry systems benefit a large number of villagers by enhancing employment opportunities, supply of fodder, fuel, timber and various products for home consumption;
5. There are several problems in involving rural families to participate in agroforestry schemes and it is possible to develop a strategy to enhance people’s participation;
6. Agroforestry can help to make agriculture permanently sustainable on a site;
7. Normally, there are both ecological and economic interactions between the woody and the non-woody components in agroforestry;

1.5 The need and scope of agroforestry in Iran

Since decades, food insecurity and poverty have been affecting the livelihoods of the rural poor and posing major challenges to sustainable development of many developing countries of Asia. Indeed, over the last four decades, due to the degradation in climatic and environmental conditions, land and soil, and increasing population pressure on limited resources, agricultural production in the developing countries, particularly those in the drylands has seldom matched the needs of the people. Most countries of the region also lack capital resources for making suitable investments for reclaiming degraded lands.

Some analysts have shown that many Asian countries may not be able to feed their projected populations in the 21st century. On the one hand, there is less land per person in Asia today than in other parts of the world, and on the other, productive land is progressively being displaced by urbanisation. According to FAO, the rate of population growth has been more than food production trends in the past decade and there are about 800 million people in the developing world who suffer from hunger and most of this is in Asia (Kumar, 2006).

Agroforestry, in the true sense, has been realised as the need of the day. It is not confined to regional, geographical or agro-climatic boundaries.

Due to increase in population of human and cattle, there is increasing demand for food as well as fodder, particularly in developing countries like Iran. Every year, farmers must make an attempt to feed 81 million more people irrespective of weather conditions. It is important to note that there will be 19% decline in crop land per head by the end of this century due to population explosion.
In general, there is acute shortage of food and fodder in developing countries. Asia has the smallest area of “potentially arable land” (672 million ha compared with 681 million ha in South America and 734 million ha in Africa) and the highest population. Out of this, 590 million ha (83%) is already under cultivation (Rai, 2001). Therefore, there is some scope to increase food production by increasing the area under cultivation. Hence, food production is to be increased from the land already under cultivation or from land not conventionally considered arable. A management system therefore needs to be developed which is capable of producing food from marginal agricultural land and maintaining and improving the quality of the producing environment.

In Iran also, a similar situation with regard to food, fodder, fuel and fibre exists. There is a global crisis of energy and efforts are being made to find out some alternative source of energy. We may have sufficient food but do not have fuel to cook. Fuelwood is one of the established sources to meet the energy requirement. At present, we are utilising 60-80 million tons of dry cowdung, equivalent to 300-400 million tons of freshly collected manure (Rai, 2001).

Nowadays, several agroforestry technologies have been developed that have immense potential to address these problems and provide options for improving livelihoods and enhancing environmental conservation. The main limitation, however, has been the delivery of these technologies. There is a need to select potential agroforestry technologies for diverse climatic zones and identify appropriate uptake pathways for their promotion and wider use. Depletion of forest resources and increasing demand for forest products especially of the rural people who depend on forests for livelihoods, have widened the gap between the demand and supply of forest products in Iran. Identifying alternative options to increase the supply of forest products to support rural livelihoods has become a fundamental concern of policy makers and planners. Agroforestry seems to have the potential to provide options for rural livelihoods and biodiversity conservation (Gordon and Bently, 1990; Kidd and Pimentel, 1992).

The reliability of agroforestry is increasing with more practice and research. Farmers across the globe are discovering ways in which trees and polyculture can replace monoculture so as to make their land more sustainable and productive. Trees are a natural part of almost every ecosystem and so it makes sense to incorporate them in agriculture to maintain a healthy balance. This can help to keep the costs low and make
the land more productive. They can become a profitable enterprise especially on small farms. Agroforestry is the most common traditional farming system in most parts of the world. It has evolved through trial and error as the best way to ensure sustainability of the land while providing a variety of food demanded by local consumers. Agroforestry allows small farmers to make a living off their land. Of course, large scale farming will be around, but there are alternatives.

Lecturers and experts from the University of Iran recommend agroforestry as a suitable solution for most of the destroyed agricultural lands and jungles, in particular, those located in the green slopes of the northern parts of the country. They emphasise that the favourable climate in the northern part can further contribute to development of the jungles and woods in the vast green lands located near the world's largest lake, the Caspian Sea. Nevertheless, implementation of the project calls for precise planning, examination and survey of the general geological characteristics of the region, technical and technological cooperation and coordination with related organisations.

Other experts are of the opinion that agroforestry is not favourable for the region and recommend it for areas where farming is the main activity and forestry is only the secondary source of livelihood. In other words, agroforestry is meant to do away with the traditional forestry exercised here for centuries. Nonetheless, the existing supervisory and executive bureaus, bodies and organisations lack the required potentials or initiatives to move towards the goal (Persian service of IRNA news agency, 2006). Since knowledge about agroforestry is very limited in Iran and is still a new concept at the academic and institutional levels, traditional systems need to be identified to develop a basis for such studies.

The present Government policy in Iran emphasises the need to initiate community and agroforestry programmes. Thus, Non-Government Organisations (NGOs) and researchers can play a significant role in the facilitation of agroforestry programmes, thereby complementing the Government programmes (Rao, 1992) to meet the livelihood requirements of the farming households. There is a need to study the effect of agroforestry on different categories of farming households in Iran. With this background, this study sought to answer the following questions:

- Provide improved livelihood opportunities and income
- Offer poorer households an opportunity to increase income/security
• Deliver environmental benefits perceived by the local population

1.5.1 Agroforestry benefits

Agroforestry has both productive and protective potential and it can play an important role in enhancing the productivity of lands to meet the demand of the ever-growing human and livestock population. The benefits of agroforestry are given below:

Food
1. Enhanced sustainability of cropping systems through soil and water conservation by arrangement of trees to control run-off and erosion;
2. Enhanced food and feed production from crops associated with trees through nitrogen fixation, better access to soil nutrients brought to the surface from deep tree roots, improved availability of nutrients due to high action exchange capacity of the soil and its organic matter and mycorrhizal associations;
3. Food for human beings from trees in the form of fruits, nuts, cereal substitutes, etc;
4. Feed for livestock from trees;
5. Micro-climate improvement due to trees, particularly shelterbelts and windbreaks.

Water
1. Improvement of soil-moisture retention in rainfed croplands and pastures through improved soil structure and micro-climate effect of trees;
2. Regulation of stream flow, reducing flood hazards and a more even supply of water through reduction of run-off and improvement of interception and storage in infiltration galleries;
3. Improvement in drainage from waterlogged or saline soils by trees with high water requirements.

Energy
1. Fuelwood for direct combustion;
2. Pyrolytic conversion products such as charcoal, oil and gas;
3. Ethanol produced from fermentation of high-carbohydrate fruits;
4. Oils, latex and other combustible saps and resins.

Shelter
1. Building materials for shelter construction;
2. Shade trees for people, livestock and shade-loving crops;
3. Windbreaks and shelterbelts for protection of settlements, crop lands, pastures and roadways;

**Raw Material for Industries**
1. Raw material for pulp and paper industry;
2. Tannins, essential oils and medicinal ingredients;
3. Wood for agricultural implements and various crafts;
4. Fibre for weaving.

**Cash**
1. Direct cash benefits from sale of tree products.
2. Indirect cash benefits from increased productivity.

The wide range of products and objectives along with an increased resource base helps minimise risk for the farmer. By spreading out cultural and management requirements over the year, these systems can also reduce peak workloads and ensure a more stable economy. These benefits have become increasingly well known in recent years, although scientists have described them almost 60 years ago (Smith, 1929).

### 1.5.2 Why Agroforestry?

Agroforestry practices have many benefits for society, farmers and ranchers and the ecosystem. As agroforestry is based on natural ecosystems, it uses natural relationships and replenishment to make land both productive and sustainable. While monoculture encourages pests, erosion, disease and inefficient water use, use of chemical fertilisers and pesticides and reduces local wildlife, agroforestry promotes multiple species of crops and wildlife, harbours pest enemies, promotes soil health and reduces costs. Trees are an important aspect of almost every natural ecosystem and hence they should be incorporated into crop and animal production.

In conjunction with crop rotation, planting trees can reduce soil pathogens and starve out crop pests while harbouring pest enemies. When legumes such as clover are planted with elms, they improve soil quality by replenishing nitrogen content. Trees also replenish other nutrients needed for healthy soil by bringing them up from the ground and depositing them on the surface through leaf litter. Leaf litter is also important
because it acts as a crop cover, shades crops and forage and increases humus content. The litter and trees also help choke out weeds.

Tree growth improves microclimates, a term which refers to soil and the organisms living in it. Trees also rid the soil of toxins and filter pollutants from water. Roots help in developing soil aggregates. Trees keep animals comfortable during hot and cold seasons by providing they shade and protecting them from wind so that they can gain weight and enhance their productivity. As animals can find shade and protection wherever they feed, they can graze on pasture evenly instead of standing in a clump of shade, refusing to wander out despite lack of grazing material.

Trees also control dust, runoff and reduce evaporation so that all the water that hits a field stays in the field. Since they ensure efficient water management, trees also mitigate the effects of drought. When used as windbreaks for orchards, mulberry, hackberry and other berry trees keep birds away from the fruits. The windbreak also ensures that work can be done in the field or orchard even on windy days. As fruits and vegetables are protected from wind and harsh weather, their size and quality are better. Growing windbreaks in orchards also keeps trees straight in high wind areas without the use of poles.

Trees are invaluable for maintaining soil health and efficient use of water and they also diversify economic avenues. Not only can trees be harvested for wood and fruit, they also enhance crop and animal performance and attract farm and ranch visitors with picturesque surroundings, protection and shade. Putting trees back into the ecosystem keeps the cost of chemical fertilizers and pesticides low. The bush and tree cover supports wild populations of deer, turkey, waterfowl, and a number of other beneficial animals. Whether trees are reducing erosion, solving water management problems, or acting as a “bio shield” against wind or natural disasters, what is best about this system is that it uses already established biological interactions, enhances beneficial relationships, and makes the most of land and resources (Johnson, 2006).

By using trees and shrubs, agro forestry systems restore the benefits of forest plants to agricultural lands, increase the productivity and improve environmental services, such as checking of erosion, pest control, water management and climate regulation. Agro forestry can increase farm profitability in several ways:
• The total output per unit area of tree/crop/livestock combinations is greater than any single component alone;
• Crops and livestock protected from the damaging effects of wind are more productive and
• New products add to the financial diversity and flexibility of the farming enterprise.

Biodiversity in agro forestry systems is typically higher as they incorporate several plant species in a given land area and create a more complex habitat that can support a wider variety of birds, insects, and other animals. Agro forestry also has the potential to help reduce climate change since trees take up and store carbon at a faster rate than crop plants. Agro forestry contributes to the economic and resource sustainability of agriculture.

1.5.3 Agro forestry and Sustainability

The problem of biodiversity conservation goes hand-in-hand with larger issues of social and economic development: Land use must be both ecologically and economically sustainable. If practiced in a sustainable manner, agro forestry can contribute towards these goals. Sustainable use is generally defined as the use of components of biological diversity in a way and at a rate that does not lead to long-term decline of biological diversity, thereby maintaining its potential to meet the needs and aspirations of present and future generations. Ecologically, agricultural systems need to be oriented in such a manner that they can last longer than just a few years. Agro forestry provides one significant way in which this can be done, but it is important that they are managed organically. Organic agriculture (eliminating chemical use and promoting soil enriching practices) works hand-in-hand with agro forestry in promoting sustainable agricultural systems.

Economically speaking, agro forestry can provide income from many alternative sources as well as provide materials and foods used by the farmers. In contrast to sun crops frequently grown for export and often with volatile markets, diverse agro forestry produces many crops, buffering the ups and downs of international markets. Diverse systems with high levels of biodiversity also have better ecosystem services, increasing local functions of pest control and pollination, often with high economic returns. In
brief, agro forestry systems are not only ecologically sustainable for growing crops but also provide income and resources to farmers and ensure biodiversity conservation.

1.6 Agroforestry in Iran

Agro forestry land-use technologies are not new in Iran or the world for that matter. This sustainable land use system has been practiced in traditional forms for many years by villagers in nearly every part of the country. In a loose sense, agro forestry began when Man first turned from a hunting and gathering to plant culture. Although not deliberately integrated, trees and farm crops have always occurred together in systems where subsistence was the primary objective of farming.

Since, Iran is located in arid and semi arid zone and has a poor forest cover (less than 10%); tree farming plays a major role and mitigates pressure on natural forests. Poplar planting in Iran dates back to ages ago. The people have planted Populus nigra and Populus alba species in the mountainous parts of the country. These two species are not found in the natural forests of Iran. Poplar is planted by the rural people, private sectors and rural cooperatives outside the forests. Afforestation and reforestation with exotic and native conifer species in destroyed natural forests and abandoned lands by Forest and Range Organisations is a common land management activity in the country.

Nowadays, afforestation with Eucalyptus sp. and Paulownia sp. as well as poplar are recommended for farmers, private sectors and wood industries due to the new silvicultural system policy (single tree selection cutting) by the Government to reduce degradation of forests and exploitation. Walnut, almond and olive are the multipurpose trees which are favoured by farmers all over the country.

The diverse climatic condition in the country make it possible to cultivate a diverse variety of crops, including cereals (wheat, barley, rice, and maize), fruits (dates, citrus, figs, pomegranates, melons, and grapes), vegetables, cotton, sugar beets and sugarcane, pistachios, nuts, olives, spices (i.e. saffron), tea, tobacco, and medicinal herbs. In some cases, farmers mix trees in the same land with food crops or domestic animals as a source of fodder for livestock, fuelwood, building material and fruits for household consumption. Farmers in Iran are used to planting poplars, fruit trees or other indigenous fast growing and multipurpose trees as windbreak, shelterbelt and hedgerows to produce wood, fuel and fodder or for many other purposes in their farms.
Inter-cropping of beans and watermelon with poplar or alfalfa and walnut are common in many parts of the country. The traditional forms of homegardens are the most general systems of agroforestry spread over different climatic zones. This study therefore undertook to observe and document traditional agroforestry practices in Iran.