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# Agroforestry for Sustainable Rural Livelihood : A Review

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**ABSTRACT**

*Adequate and sustainable access to income and resources such as- adequate access to food, potable water, health facilities, and education to meet basic needs is livelihood. Sustaining livelihood is most serious challenge faced by policy and decision-makers in current scenario. In this context land-use options that sustain livelihood security and reduce vulnerability to climate and environmental change are necessary. Agroforestry can play a major role in bringing the desired level of diversification along with sustainability. Agroforestry has the potential to provide food security and help to poverty reduction along with its contribution to environment security viz. soil conservation, carbon sequestration are highly important. Traditional farming and their management such as agro-forestry practices may potentially provide options to enhance livelihoods through simultaneous production of food, fodder and firewood as well as reduce of the impact of climate change.*

***Key words:*** *Livelihood, Agroforestry, Fodder, Traditional Farming, Climate Change.*

## INTRODUCTION

Household livelihood security is defined as adequate and sustainable access to income and resources to meet basic needs (including adequate access to food, potable water, health facilities, educational opportunities, housing, time for community participation and social integration). Livelihoods can be made up of a range of on farm and off farm activities which together provide a variety of procurement strategies for food and cash[18]. Thus, each household can have several possible sources of entitlement which constitute its livelihood (Figure-1). These entitlements are based on the household's endowments and its position in the legal, political and social fabric of society[11].

In the current scenario regarding livlihood, we have two ways: One is to tolerate the conditions and other one is to change them. In this context, while we are in the first one, we need to pursue the second one. One of the most serious challenges faced by policy and decision-makers in many developing countries for maintaing the livlihood security is "how to improve the well-being of the poor in rural areas while maintaining a viable environment".

Because of that, agricultural production in the developing countries has seldom matched the needs of the people[22].

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Indeed, many developing countries, particularly those in the dry lands (arid and semi-arid with low forest cover) have not advanced sufficiently in improving food production, because of the recurrence of drought spells and the vulnerability of their fragile ecosystems to degradation. On the other hand, the widespread poverty in developing countries due to slow rates of economic growth has resulted in deforestation and biodiversity loss due to overexploitation, conversion to farmland, slash and burn agriculture, charcoal production, bush fires and harvesting of wood[2,10,20]. Hence, on the whole, the natural resource has borne the main brunt of both the agricultural revolution as well as the hard economic realities. Moreover, the profound changes in farming systems, markets and investment mechanisms are exposing smallholders to increased vulnerability and often forcing them to change their traditional farming systems.

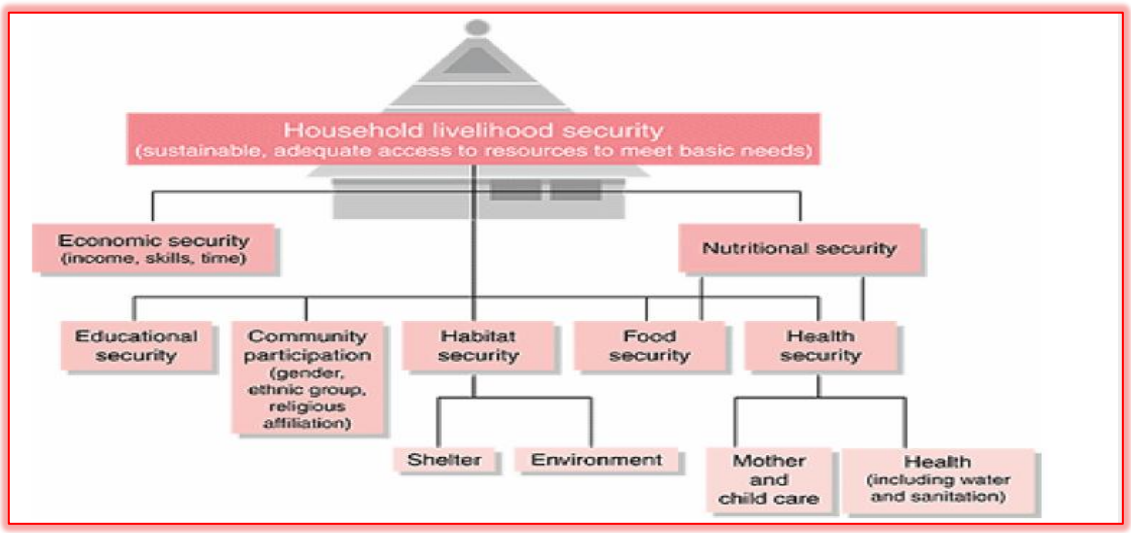


**Fig. 1: Component of household livelihood securities**

## CONTRIBUTION OF AF ON SUSTAINABLE LIVELIHOOD :

Agroforestry has been used as a major strategy to enjoin forest occupants to become partners in rehabilitating degraded forestlands. Agroforestry is a dynamic, ecologically based natural resource management system that, through which the integration of trees/woody perennials in farm and rangelands, diversifies and sustains production for increased social, economic and environmental benefits[27]. Agroforestry was expected to reduce soil erosion, improve soil quality, vegetative cover, land productivity and uplift the farmers level of living through sustained farm productivity[9] (Figure-2). Agroforestry can play a major role in bringing the desired level of diversification along with sustainability. The farm-industry linkages have also helped the systems to be more sustainable than the traditional cropping systems[21,40].

Various patterns of agroforestry systems are practiced in different agro-ecological regions of india which reflects biophysical and social variations. Trees are planted on the borders or within the field, systemically or at irregular intervals, usually with crops such as rice, wheat, pulse, jute, oilseed, sugarcane, vegetables and others, and farmers also grow shade-tolerant crops such as turmeric, ginger and aroid when trees have high canopy coverage[29] (e.g. jackfruit, mahagony). Trees in crop fields work as insurance in case of sudden crop failure or to support crops against environmental hazards and also to provide extra income from trees. Moreover, if there is a failure in one crop, the other crops would supplement the deficit. So, agroforestry is largely evolved with sustainability concerns - resiliency, diversity, and avoiding negative side effects in mind[7].

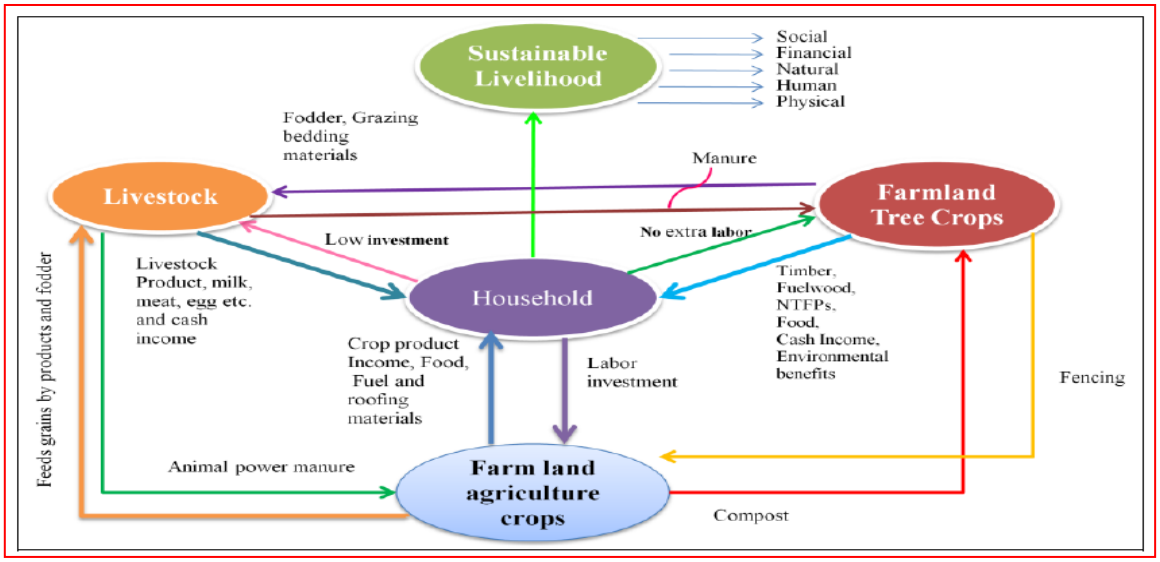


**Fig. 2: Contribution of agroforestry on sustainable livelihood**

In such circumstances, traditional land use pattern should be converted into sustainable land use, which will permit maintenance of productivity combined with conservation of the resources. Agroforestry might be the best land-use system for sustainable livelihood in India to cope with the present situation. It is a land based production system that is directly related to food security, employment, income opportunities and environmental issues. Agroforestry also plays a vital role in rural socio-economic development as well as poverty reduction. Likewise, Agroforestry practice increases yield and services of per unit agro-forest area. At present, people are practicing various agroforestry practices all over the country[4].

Thus this paper seeks to highlight the important contribution that the Agroforestry making to the livelihood of rural communities including food security, income security, habitat security etc. pointing to the importance of maintaining biodiversity, and the contribution that agroforestry as a type of land use can make to the continued conservation and maintenance of agro-biodiversity.

**LIVELIHOOD SECURITY BY AGROFORESTRY:**

**Food Security**:

Asia is the "continent of the current century", according to many; yet, some analysts have shown that many Asian countries may not be able to feed their projected populations in the 21st century[36]. On the one hand, there is less land per person in Asia today than in other parts of the world[6] and on the other, productive land is progressively being displaced by urbanization[44,41]. Historically, food production in the overall Asian context increased at the same rate as that of human population FAO[16]. However, population growth has outmaneuvered the food production trends in the past decade, implying the need to augment food production. According to FAO[17], there are about 800 million people in the developing world who suffer from hunger. And most of this (60%) is in Asia with South Asia accounting for about 36%. To make matters worse, increases in cereal yields are slowing down in all regions of the world due to the so-called 'technology fatigue', and Asia is no exception.

Woody perennial based production systems, such as agroforestry, have the potential to meet the food security of people. farmers depend more on annual crops, the small and marginal farmers in the tropics have long been practicing agroforestry to meet their food, fodder and fuel requirements[24]. Apart from ensuring food production, such systems also would enhance economic returns to the growers. Consistent with this, Rasul and Thapa[35] in a case study of the degraded agricultural lands of Chittagong Hill Tracts

(Bangladesh) reported that economic returns from agroforestry were greater than that from jhum. The higher cash incomes provide greater "buying power" with respect to food, especially when agriculture is not practiced, or when the crops fail. Moreover, diversified production is a form of risk avoidance, which is of special relevance in the context of the current agricultural crises that many countries in South and Southeast Asia are experiencing.

Agroforestry to provide alternate sources of income and employment to the rural poor also has been highligted[5,32,38]. The diverse products (fruits, vegetables, spices etc.), which are available year-round in systems such as home gardens not only contribute to food security during the "lean" seasons but also ensure food diversity[25]. They are also sources of mineral nutrients for improving household nutritional security especially for 'at-risk populations' (e.g., women and children). In experimental studies, target families significantly increased year-round production and consumption of vitamin-rich fruits and vegetables compared to a control group without gardens[42]. This, in turn, alleviated deficiencies of iodine, vitamin A, and iron and made children of garden owners less prone to xerophthalmia. As little or no chemical inputs are used, the produce from agroforestry is also expected to be of superior quality. Over the period when input usage in agriculture was promoted in Asian agriculture, agroforestry being less input intensive, was overlooked as a means of food production. The development community, in particular, was not fascinated by such mixed gardens with scattered and/or boundary planted trees. The woody perennial based mixtures were also thought to be less productive and difficult to manage; instead, the "replicable models" of input intensive production practices became fashionable. The smallholder mixed tree-gardens in Asia thus represent a substantial unexploited potential for enhancing productivity and profitability.

Beside that households food security condition in jassore district of Bangladesh highly improved by practioning Agroforestry[9].

**Poverty reduction:**

Agroforestry provide a greater contribution of the total income of farmers per year. This contribution is obtained from agricultural crops, forestry (timber) and livestock. Agricultural crops such as cocoa, coffee, cloves, rice and fruits derive most of their income due to crop harvest to include plants that do not require a long time and has economic value so that farmers get a continuous income to meet daily needed. Timber species are widely grown in agroforestry is chrysolite, bayur, teak, sengon, medang and hibiscus. Timber grown mostly for long-term savings, if households need large amounts of cash then the wood is cut down. Timber prices vary widely depending on the type, age, size, and quality of the wood. Commercialize livestock farmers as savings for the future. Many households keep cattle that are regularly sold or redeemed for cash and food as part of their normal activities yearly. Cows and goats are the animals that most commonly cultivated by farmers. In addition to the use of manure as a fertilizer for crops as well as the fuel of biogas. Cost of production in agroforestry management covers the cost of fertilizer, pesticide, labor, and seed. Land management is not carried out intensively.

By following agroforestry as suggested above farmers get additional income that would help to expenditure and ultimately involved to poverty reduction. The study of chakraborthy *et al*.[9] suggested that farmers Physical assets which are important indicator of wealth is a source of coping shocks in the rural livelihoods. It is also a good indication of life standard. People having more physical assets reveal that he/she enjoys more social status than others. They observed during their study farmers which are performing agroforestry having more no. of physical assets as compare to non agroforestry practitioner (Table-1).

**Table-1: Physical Asset of the Respondents[9]:**

| Physical asset | Agroforestry Practitioners (Percentage) | Non agroforestry Practitioners (Percentage) |
|---|---|---|
| Television (No.) | 55 | 38 |
| Radio (No.) | 8 | 14 |
| Mobile Phone (No.) | 100 | 95 |
| Bicycle (No.) | 74 | 66 |
| Motorcycle (No.) | 24 | 10 |
| Power-tiller (No.) | 12 | 5 |
| Spray-machine (No.) | 26 | 32 |
| Shallow-machine (No.) | 21 | 15 |
| Paddy threshing machine (No.) | 33 | 20 |

The concept of Trees outside Forests (ToF) emerged in the early 90s FAO[15] as a holistic approach which encompasses integrated tree-based farming system in farmlands and pasturelands to promote sustainable agricultural production and forest resource conservation. Indeed, in small-scale agricultural production systems, TOF management seems to hold a high promise as a bridge between food production and environmental protection, due to its capacity to restore the ecosystems and improve soil fertility. Farmers welcome tree cropping because they are economically advantageous since they provide substantial cash incomes which could be recycled into food in case of crop failure[13].

Bugayong[8] described some of the benefits derived by farmers from the practice of agroforestry in the farming site. Comparisons are made between CBFM-ISFP participants and non-participants perceived changes in their socioeconomic conditions since the start of the project to the time the survey was conducted. These are validated by survey results of their income, level of living and net returns from various cropping systems. He observed that Agroforestry practitioner having more on-farm and off-farm income along with better housing pattern as compare to non practitioner (Table-2).

**Table-2. Farmers' perceived socio-economic changes with agroforestry practice (in%)**

| Categery | Participants | | | | Total | Non-participants | | | | Total | M-W |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | L | M | H | No. | 0 | L | M | H | No. | test |
| Income from Farm | 8.57 | 11.43 | 45.71 | 34.29 | 35 | 12.90 | 16.13 | 64.52 | 6.45 | 31 | * |
| Income from off-farm sources | 15.15 | 21.21 | 42.42 | 21.21 | 33 | 22.58 | 16.13 | 61.29 | 0.00 | 31 | ns |
| Type of house | 16.67 | 30.55 | 30.55 | 22.22 | 36 | 25.81 | 25.81 | 45.16 | 3.22 | 31 | ns |

O = none, L = low, M = moderate, H = high; * significant at 5% confidence level; ns - not significant

Agroforestry provide a greater contribution (91.44%) of the total income of farmers per year. This contribution is obtained from agricultural crops, forestry (timber) and livestock observed by Qurniati *et al.*[33] (Table3).

**Table-3: Agroforestry farmers income in the pesawaran indah village in 2012.**

| Revenue | Total Income | Average revenue/year (Rs/year) | Percentage (%) |
|---|---|---|---|
| **Agroforestry** | | | **91.43** |
| ➢ Agriculture | 652,204,118 | 15,528,670 | 74.98 |
| ➢ wood | 66,060,054 | 1,572,858 | 7.59 |
| ➢ Livestock | 77,067,500 | 5,137,833 | 8.86 |
| **Non Agroforestry** | | | **8.57** |
| ➢ Trade | 44,580,000 | 7,430,000 | 5.13 |
| ➢ Labour | 21,400,000 | 3,057,143 | 2.46 |
| ➢ Service | 8,520,000 | 4,260,000 | 0.98 |
| **Total** | **869,831,672** | **32,701,140** | **100** |

Thus agroforestry as a strategy to uplift the economic conditions of the farmers while rehabilitating the degraded uplands has made inroads in the productivity site .Although the future returns from the harvesting of mature trees in the farm forests are expected to further improve the farmers' income and well-being.

**Environmental Security:**

**Enhancing soil fertility:**

The primary objective of soil conservation is to improve or maintain soil fertility. To achieve this, control of erosion, maintenance of organic matter and physical properties, organic matter addition, maintenance of nutrient is necessary. In this way agroforestry system constitute sustainable land use and helps to improve soils in the number of ways. Maintenance and enhancement of soil fertility vital for global food security and environmental sustainability[14]. Ecologically sound agroforestry systems such as intercropping and mixed arable-livestock systems can increase the sustainability of agricultural production while reducing on-site and off-site consequences and lead to sustainable agriculture[14]. Alternate land-use systems such as agroforestry, agro-horticultural, agro-pastoral and agro-silvipasture are more effective for soil organic matter restoration[28].

Samra and Charan[37] and Ram Newaj *et al.*[34] were also observed that soil organic carbon status increased by 5 to 6 times higher in agroforestry system than growing of either sole tree or sole crop.

**Biodiversity conservation:**

Over exploitation of natural resources is a major challenge for sustainable production and livelihood security. Deforestation is that major cause which affected the bio-diversity of an ecosystem. Agroforestry with components like trees, agricultural crops, grasses, livestock etc. provides all kinds of life support. However, agroforestry may not entirely reduce the deforestation[3] but in many cases it acts as an effective buffer to deforestation. Trees in agroforestry system act as a refuse to biodiversity after catastrophic events such as fire[19]. The traditional society of coastal belts and tropics of the country practicing homegardens and sacred groves help in bio-diversity conservation.

**Carbon sequestration:**

Tree components in agroforestry systems can be significant sink of astmospheric carbon (C) due to their fast growth and high productivity. By including trees in agricultural production systems, agroforestry can, arguably, increase the amount of C stored in lands devoted to agriculture, while still allowing for the growing of food crops[26]. In agroforestry system, tree components are managed, often intensively by pruning of minimizing competition and maximize complementarity. The pruned materials are mostly non- timer products. Such materials are often returned to soil. Besides, the amount of biomass and therefore C that is harvested and exported from the system is relatively low in relation to the productivity of the tree. Therefore, unlike in tree plantations and other mono culture systems, agroforestry seems to have unique advantage in terms of C sequestration.

In India, evidence is now emerging that agroforestry systems are promising land use system to increase and conserve

aboveground and soil C stocks to mitigate climate changes (Table-4). The average potential of agroforestry has been estimated to be 25 t C $ha^{-1}$ over 96 m ha[39]. In this way the total potential of agroforestry in India to store C is about 2400 mt, but the C storage capacity varied from region to region and also depends upon the growth and nature of tree species involved in the system.

**Table-4: Total C storage under agro-forestry systems in different regions of the country[14]**

| Region | Agroforestry system and components | Total C storage (t C / ha) | References |
|---|---|---|---|
| **Semi-arid region** | Silvi-pastoral system (age 5 years)<br>*Acacia nilotica* + natural pasture<br><br>*A. nilotica* + established pasture<br>*Dalbergia sissoo* + natural pasture<br>*D. sissoo* + establed pasture<br>*Hardwickia binata* + natural pasture<br>*H. binata* + established pasture | <br>9.5-17.0<br><br>19.7<br>12.4<br>17.2<br>16.2<br>17.0 | Rai *et al.*[31] |
| **North- western India** | Silvipastoral system (age 6 years)<br>*Acacia/ Dalbergia/ Prosopis* +<br><br>*Desmostacya*<br>*Acacia/ Dalbergia / Prosopis* +<br>*Sporobolus* | <br>6.8-18.5<br><br>1.5-12.3 | Kaur *et al.*[23] |
| **Central India** | Block plantation (age 6 years)<br>*Emelina arborea* | <br>24.1-31.1 | Swamy *et al.*[45] |
| **Arid region (Rajasthan)** | Agri- silvicultural system ( age 8 years)<br><br>*Emblica officinalis* + *Vigna radiate*<br><br>*Hardwickia binata* + *vigna radiate*<br>*Colophospermum mopane* + *Vigna*<br><br>*Radiata* | <br>12.7 -13.0<br><br>8.6 - 8.8<br><br>4.7 - 5.3 | Singh[43] |
| **Semi -arid Region** | Agri-silvicultural system (age 11 years) *Dalbergia sissoo* + crop | 26.0 | NRCAF[30] |
| **North-western Himalays** | Silvi-pastoral system<br>Agri- horti- pastoral<br><br>Horti -pastoral | 2.17<br>1.15<br><br>1.08 | AICRAF[1] |

**LIVELIHOOD SECURITY COMPARISON OF TRADITIONAL AGROFORESTRY SYSTEM AND COMMERCIAL AGROFORESTRY SYSTEM:**

In the tradtional agroforestry systems since the trees are naturally growing especially in traditional agroforestry region and are just allowed to be thriving by the farmers, the costs associated with management of the trees are negligible except that of indirect costs associated with the shade and competition due to moisture and nutrient needs[12]. Therefore, only the benefits from trees on account of

harvest and sale of tree produce were accounted, while commercial agroforestry system is characterized by trees in close association with crops either on farm bunds/ boundaries or within the fields.

Socio-economic diagnosis of traditional as well as commercial agroforestry practices followed by farmers in western Uttar Pradesh carried out by Dwivedi *et al.*[12] and they found that tree species like *Azadirachta indica*, *Acacia nilotica*, *Dalbergia sissoo* and *Eucalyptus spp.* were dominant species in traditional system whereas, *Populus deltoides* and *Eucalyptus spp.* were the main species of commercial agroforestry. Fuel wood (50.6 %) was major driving force for agroforestry adoption followed by additional income (24.4 %) and shade (17.5 %) in traditional agroforestry region indicated in table While, additional income (71.3 %) was the major factor in commercial agroforestry region (table-10). Although traditional agroforestry seems less promising as compared to commercial agroforestry, but it is also relevant to the farmers. Both the system will helpful for farmers livlihood (Table-5).

**Table-5: Determinants of traditional Vs commercial agroforestry system[12]**

| **Traditional agroforestry system** | | **Commercial agroforestry system** | |
|---|---|---|---|
| **Major reason** | **Percentage (%)** | **Major reason** | **Percentage (%)** |
| Additional income | 71.3 | Fuel wood | 50.6 |
| Source of money in emergency | 17.5 | Additional income | 24.4 |
| Source of fuel wood | 2.5 | Shade | 17.5 |
| Source of employment | 4.4 | Timber | 3.8 |
| Others | 4.4 | Others | 3.8 |

## CONCLUSION

The natural forest resource continues to play a major role in improving the livelihood of rural communities and this it does, because of the rich biodiversity in forests. Thus, natural forests are able to provide for energy, food and nutrition and health. However, the current levels of deforestation which cause land degradation, soil nutrient depletion, loss of natural habitats and therefore change in structure and composition of the natural woodlands. Improved agroforestry systems brings significant change in the agricultural farming systems among farming communities and affects farming households. Agroforestry allows the growth of multiple crops simultaneously and provides several livelihood benefits to farming households. Agroforestry also have potential to contribute to the maintenance of biodiversity in natural systems due to the reduction in overreliance of rural communities on natural forest resources, as they are able to maintain their production systems through improved agroforestry systems..Commercial agroforestry important for assured income as compared to traditional, but both forms of agroforestry have specific roles to play in the livelihoods.

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