Sustainable Local Livelihoods through Enhancing Agroforestry Systems in Nepal

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Abstract: Agroforestry has been recognized as one of the important systems for supporting the livelihoods of a large number of rural farmers in the Nepalese hills. However, its conservation and socio-economic values have received little attention. There is no solid information that tells us precisely how the agroforestry system has changed over time and what its drivers are in terms of biodiversity conservation and livelihood improvement. This paper aims to investigate the changing impacts and drivers of the agroforestry system to improve people's livelihoods and deliver the outcomes of biodiversity conservation. This research analyses a case study of two Village Development Committees, viz Mahadevsthan and Mithinkot, in Kavrepalanchok district in Nepal. The mixed method approach was employed to collect data. The results indicate that the agroforestry system has changed considerably over time. As a result, the number of agroforestry species has increased in private lands. A total of 145 different species were recorded, of which 56 species were medicinal plants, followed by fodder trees, grasses and fruit trees. The study further found that species richness has increased, mostly in upland terraces. This resulted in increased livelihood benefits to local people. Production of goat meat and buffalo milk has increased considerably. The high economic benefits are mainly associated with the introduction of various fodder trees and grasses in private farmlands. It is concluded that the various drivers of the agroforestry system need to be carefully attended so as to improve both positive conservation and livelihood outcomes. Enabling policy and practices are needed to initiate and support farming cooperatives in the commercialization of agroforestry products and market the conservation values in a changing climate.

Keywords: Agroforestry, livelihood, biodiversity bonservation, commercialization of agriculture

INTRODUCTION

The rural landscape that encompasses an agrarian economy, fragile ecology, and a complex and differentiated society is changing rapidly in Nepal, with creation of new opportunities and challenges. Despite this rapidly changing environment, the rural economy is still based on subsistence agriculture. In the middle hills, the agroforestry system, particularly the integration of fodder trees and grasses with livestock system, has been an important source of livelihood for poor people. This also has potential to become a steady source of green employment opportunities (Neupane and Thapa 2001; Miller and Nair 2006; Barakoti 2007). Growing of trees, shrubs and herbs species on private lands to fulfill the basic household needs has been a long established tradition in the mountains of Nepal. Species of trees, shrubs and herbs are mostly from forests but which are also grown in private lands are called agroforestry (AF) species. Farmers have long experience and know-how of propagating the AF species grown in their farmlands. Some examples of the AF species in the middle hills of Nepal are *Choerospondias axillaris* (Lapsi), *Sapindus mukorossi (*soap nut*), Cinnamomum tamala* (tejpatta), guava, mango and litchi.

Despite farmers' efforts in growing AF species in private farmlands, these resources are gradually depleting in large tracts of fragile steep-lands in Nepalese mountains (Pandit and Thapa, 2004). The forest area decreased at an annual rate of 1.39 per cent during 2000–05 and during recent years (2005–2010). However, the forest cover change remains constant (FAO, 2010). Forest

degradation was highest during 1990–2000, at an annual rate of 2.09 per cent (FAO 2010). One of the reasons for constant forest cover in recent years is promotion[1] of AF species in private lands in the hills of Nepal (Pandit and Kumar 2010). Forest depletion in the past (prior to 2005) has caused serious environmental degradation and decreased agricultural productivity. The annual cost of deforestation was estimated to be about Nepalese Rupees (NRs) 11 billion (FAO 2010).

With a view to understanding a range of AF problems, a national-level non-government organization (NGO) was involved to provide support to local communities to establish AF demonstrations in farmers' fields in Mahadevsthan Village Development Committee (VDC) in Kavrepalanchok District during 1993–2000. The aim of this project was helping community forestry users and farmers to generate income, as well as reducing pressure on forests. Poor and disadvantaged communities were given priority in the promotion of AF species on underutilized terrace risers to generate livelihood benefits. This article is an attempt to bring together pieces of evidence as to how the agroforestry system has changed over time in the study area and what its causes and consequences are.

This paper aims to investigate the changing impacts of the agroforestry systems on improving people's livelihood capital, including biodiversity conservation outcomes. Specific research questions are:

a. What are the drivers of the AF system that impact people's livelihoods?
b. What are the changes that have occurred in agroforestry practices at local level?
c. What are the contributions of AF to different forms of capital?
d. How can the AF system be improved?

[1] AF promotion takes place in two ways: first, protection of naturally growing AF species in farm and, second, through plantation by farmers.

The paper is structured as follows. The first section reviews the literature on the impacts of agroforestry on livelihoods and conservation. This is followed by a description of the research methods employed in this study. The third section presents results which include the contributions of AF to different forms of livelihood capital, followed by an analysis of results, bringing out the reasons and implications of the study to improve livelihood and conservation benefits of agroforestry. The paper concludes by highlighting the ways to improve AF so as to contribute to sustainable development outcomes at local level.

RESEARCH METHOD

This research employs the Sustainable Livelihood (SL) framework as an approach to analyse the research questions. Since AF interventions present substantial opportunities and risks to the local communities who are managing private lands and forests, the research, based upon an SL framework, is developed and applied in case studies to evaluate the contributions of AF intervention to different forms of capital. The SL assessment is intended to generate an understanding of the role and impact of a project on enhancing and securing local people's livelihoods. As such, it relies on a range of data collection methods, a combination of qualitative and quantitative indicators and, to varying degrees, application of an SL model or framework. The research used the SL model of the United Kingdom (UK) Department For International Development (DFID) and the notion of the five forms of capital (natural, physical, human, social and financial), albeit loosely, in order to frame the inquiry and capture perceptions of coping/adaptive capacity in the data collection process.

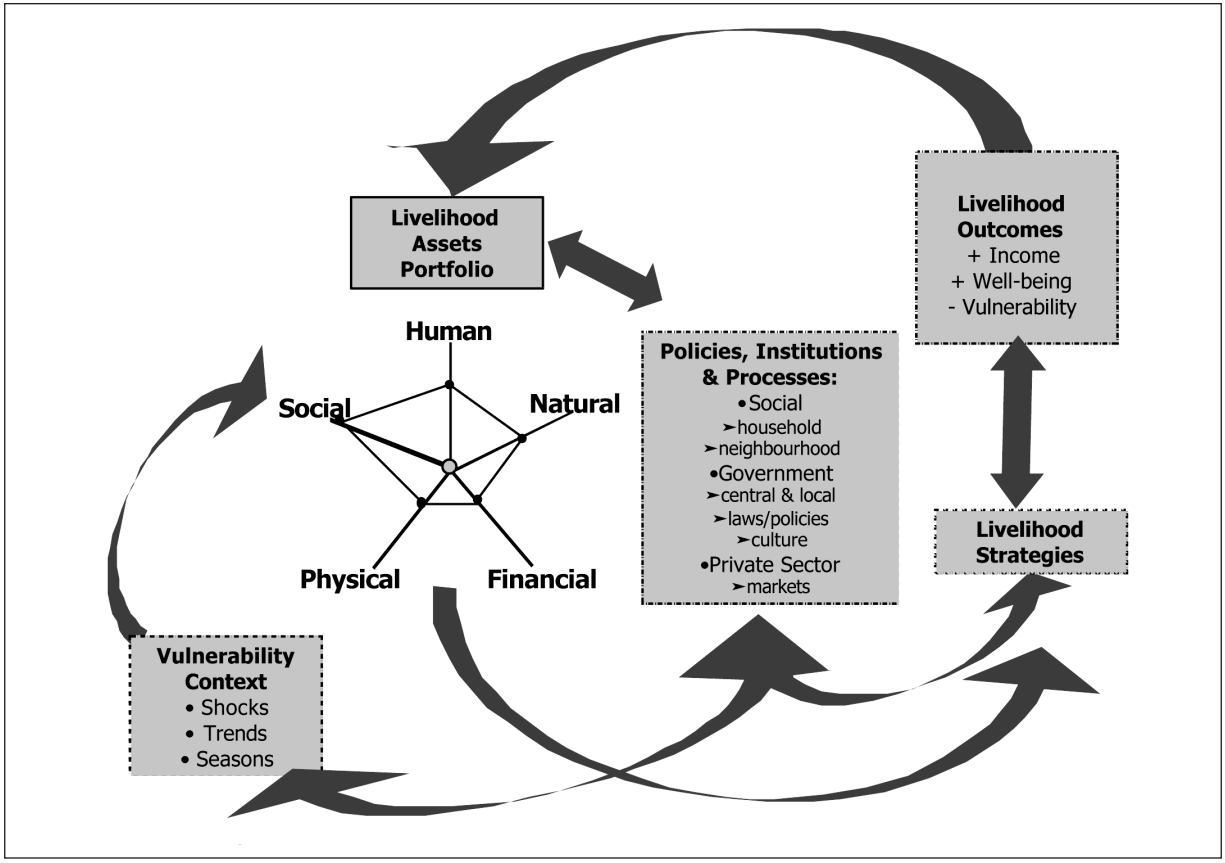
Conceptually, 'livelihoods' connotes the means, activities, entitlements and assets by which people make a living. Assets, in this particular context, are defined not only as natural/biological (i.e. land, water, common property resources, flora, fauna),

but also as social (i.e. community, family, social networks, participation, empowerment, human (i.e. knowledge, creation by skills) and physical (i.e., roads, markets, clinics, schools, bridges). The Brundtland Commission in 1987 introduced SL in terms of resource ownership and access to basic needs and livelihood security, especially in the rural areas. The SL analysis framework is a tool which can be used to conceptually organize the factors that impact people's livelihood strategies (Scoones 1998; DFID 1999).

The International Institute for Sustainable Development (IISD) defines sustainable livelihoods as being 'concerned with people's capacities to generate and maintain their means of living, enhance their well-being, and that of future generations'. The definition used by the DFID incorporates these sentiments.

> Livelihoods are 'the capabilities, assets (including both material and social resources) and activities required for a means of living' (Scoones 1998, p.5).

In SL framework, assets are considered to be stocks of different forms of capital that can be used directly or indirectly to generate livelihoods. They can give rise to a flow of output, possibly becoming depleted as a consequence, or may be accumulated as a surplus to be invested in future productive activities.



Source: Lowe and Schilderman 2001: p.2

The research employs a mixed method approach to collect and analyse data. Both primary and secondary data were drawn on. Data were collected from three community forestry user groups (CFUGs) in Mahadevsthan VDC. Data related to both biophysical (i.e. basal area, diameter at breast height, tree number, etc) and socio-economic (income and food security and poverty level) aspects were collected from Mahadevsthan VDC. Data collection methods included key informant interviews (KIIs), household survey and focus group discussion (FGD). In order to enrich research, similar data were collected from Mithinkot VDC in Kavrepalanchok district using KIIs and FGD. Mithinkot is one of the six sites of the project entitled Enhancing Livelihoods and Food Security through Agroforestry and Community Forestry (EnLiFT) in Nepal, which was implemented from April 2013. In order to assess the livelihood impacts, particularly impacts on financial capital of AF, the principal investigators organized a separate FGD meeting with some members of Charuwa CFUG in Mithinkot VDC. Nine members of Charuwa CFUG representing all socio-economic classes and women participated in the meeting.

STUDY AREA

Kavrepalanchok district lies in the Central Development Region of Nepal with Dhulikhel as its headquarters (Figure 1). This district covers an area of 139,600 ha and has a population of 389,959 (DDC 2013). Its elevation ranges from about 800 to 3,000 metres. It lies in the mid-hill region of Nepal. Kavrepalanchok district occupies an area of 1,396 km^2. The elevation of the district ranges from 1,007 to 3,018 masl. Some of the river basins are at an altitude of 687 masl. Almost two-thirds of the area (59.4 per cent) of the Kavrepalanchok district is occupied by forests and shrubs, 28.2 per cent is under agriculture and the remaining 12.4 per cent is river basin, rocks and roads. Mahadevsthan VDC lies in the south-facing mid-hill region of the district, 40 km north-east of the national capital, Kathmandu. The area is characterized by several forms of agroforestry system. The most common form of agroforestry in this VDC is 'terrace planting of fodder trees and grasses', while other forms include border tree plantation and random mixed tree plantation.

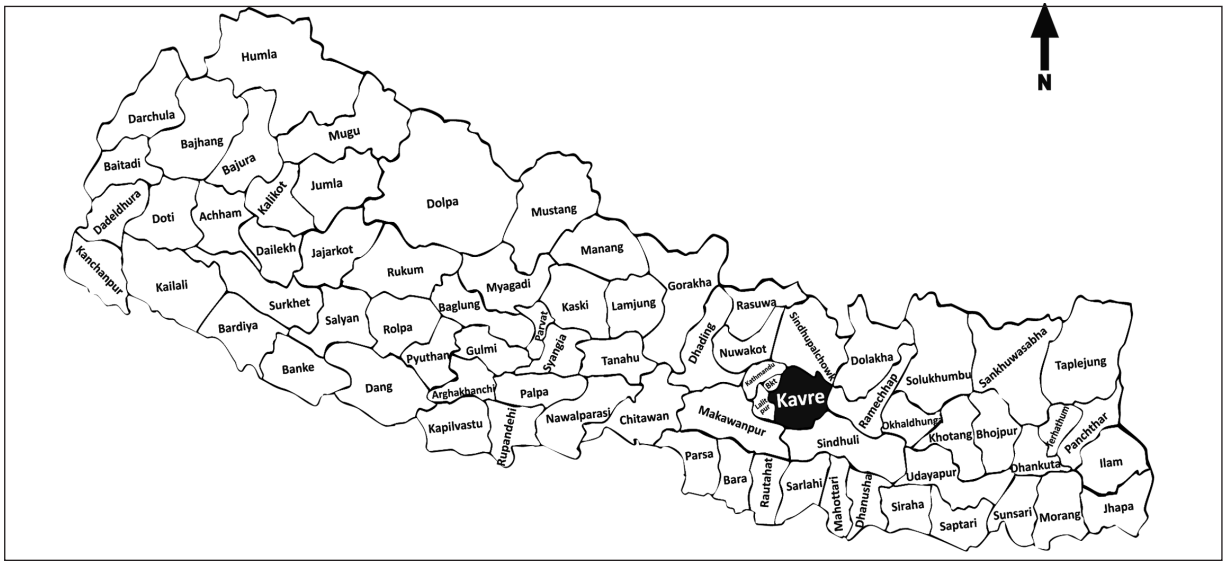


Figure 1: Map of Nepal showing study location

In Mahadevsthan VDC, 11 CFUGs have been registered with the District Forest Office (DFO, 2013), of which three were selected for silviculture measurement. Of the three, the first two, Sallenibaguwa and Jugepanit CFUGs, were selected as project sites based on the level of agroforestry intervention. Mahadevsthan CFUG was chosen as there was no project intervention.

Table 1: Name of CFUGs, forest area and households

Name of CFUGs	Project intervention	Registration date	Forest Area (ha)	Households
1. Sallenibaguwa CFUG	Yes	June, 1994	64.25	147
2. Jugepani CFUG	Yes	May, 1995	10.25	102
3. Mahadevsthan CFUG	No	June, 1996	6.55	43
Total			**81.05**	**292**

Source: Authors

The Nepal Agroforestry Foundation (NAF) facilitated the promotion of various exotic fodder trees and grasses such as ipil ipil (*Leucaena leucocephala* and *L. diversifolia*), Calliandra (*Calliandra calothyrsus*), bhatmase (*Flemingia congesta*), NB 21 (*Pennisetum sp*.) and stylo (*Stylosanthes guianensis*) in the project area. Besides, NAF promoted naturally growing valuable local fodder tree species (baddhar- *Artocarpus lakoocha*, Kutmiro- *Litsea monopetala*) in this area.

The forest type is mixed (both natural and plantation) in all three forests. The common tree species found are *Shorea robusta, Pinus roxburghii, Castonopsis, Schima wallichii* and *Lyonia ovalifolia.* Planted species include *Morus alba, Grevelia robusta, Leucaena leococephala* and *Sapindias axillaris*. All forests face south-east slope.

Data collection methods

The following four methods were used to collect the data;

- *Transect walk and observation*: Transect walk was carried out inside the selected forests. Effort was made to cover the whole area of the forest along the foot trail. This was an important part of the data collection because it provided a general impression of the area and helped to triangulate the data obtained from other methods.
- *Quadrate sampling*: This was done on tree saplings in each block of the forest area. The quadrate sampling area was 22.5 m by 22.5 m. This area is equivalent to 1 *Ropani*, a locally used land measurement unit (about 1/20th of a hectare). Five quadrates were taken from each of the three forests. The number of tree species was counted in each plot.
- *Focus group discussion (FGD):* FGD was held with the executive committee members of all three CFUGs. This method was helpful to investigate how agroforestry promotion helped (or hindered) to reduce pressure on forests and to improve the local livelihood and what factors or drivers influenced promoting AF. The discussion was focused on the contribution of AF to household economy and fulfilment of basic needs of fodder, fuelwood and other forest products. Of the 37 committee members of the three CFUGs, 24 people attended the meeting.

- *Key informant interview (KII)*: A total of 14 key informants (village elders, CFUG leaders, school teachers and range post staff) were identified and interviewed. In both FGD and KII, the following questions were discussed.
  - What is the nature of AF initiative in the area?
  - How has the AF initiative made a difference to people's livelihood?
  - Has the change improved the situation in the family/or neighbourhood?
  - What are the other changes that have occurred?
  - What proportion of your livelihood is forest-based and how has the initiative influenced this?
  - Since the initiative started, what has been the impact on forest resources?
  - Given the initiative, what are the challenges you have faced?
  - Do you have fears about the future?
  - What local impacts has the AF initiative had on social structures, infrastructure, education and income?
  - What could be done to improve the contribution of the AF?
- *Semi-structured interviews (SSI):* Several semi-structured interviews were carried out with government officials, NGO workers, business leaders, community federation representatives and academics at district and national level. Questions were focused on gathering the views on the drivers and dynamics of the agroforestry systems in Nepal, the success (or failure) of previous policy solutions and the future direction for a sustainable agroforestry system in Nepal.

RESULT AND DISCUSSION

The results have been presented and discussed in three sections. The first section contains the drivers of the AF system in the hill context of Nepal, which was largely derived from literature review and semi-structured interviews. Section two includes evidence of existing AF practices in the study area. The final section discusses the AF contribution to local people's livelihoods and conservation.

Drivers of AF system

Many factors have affected the evolution of the agroforestry systems in Nepal. Agroforestry plantation in private land reduces villagers' dependency on forests and helps to increase their household income as well, provided the species are commercially valuable (Garforth *et al.* 1999; Thapa and Poudel 2002). This would, in turn, protect forests from degradation and improve prospects of salutary socio-economic conditions for future generations. Growing of tree- and shrub-based AF species reduces farmers' dependence on fuelwood. Similarly, some shrub- and herb-based AF species, such as bamboo and broom grass, reduce farmers' dependence on fodder and grasses. The suitable climatic conditions, combined with the availability of marginal land, offer an opportunity for growing all kinds of AF species in the hills and mountains. Much depends, indeed, on local people's knowledge and skills of the propagation of AF species, appropriate management techniques and other support services and facilities, which are some of the drivers that encourage farmers to embark on AF promotion that helps improving livelihood and food security (Pandit 2003).

The AF tree species in private land as a viable alternative to field cropping under various ecological and socioeconomic conditions have posed a challenge to farmers. Like any technology,

the adoption of agroforestry is influenced by a set of interrelated biophysical, socioeconomic and institutional factors or drivers (Arnold and Perez 1998; Thapa and Weber 1994; Thapa and Poudel 2002; Pandit and Kumar 2010). Farmers decide how to use their land in light of other objectives, production possibilities and constraints. Individual feelings and aspirations considerably influence adoption of technologies (Garforth *et al.* 1999; Thapa and Poudel 2002). Several studies have rendered evidence that the AF species in private lands were mainly influenced by commercial demand for products, rather than fulfillment of subsistence needs, for which the market force plays a crucial role (Arnold and Perez 1998). It was further pointed out that patterns of tree growing in private lands are likely to differ among groups and households and within households by gender, age and labour force. People have different individual characteristics in terms of age, gender and education, which affect their perception of and attitude towards the management of certain resources (Gilmour and Fisher 1991).

One argument that has been frequently made is that relatively unrestricted access to forests strongly influences tree growing in private lands (Neupane *et al.* 2002; Pandit and Thapa 2004). Drivers of AF growing other than the above are extension service, training and education, accessibility, transportation, storage, processing factories and marketing centres. These factors influence human behaviour directly in regard to tree growing (Gibson *et al.* 1998; Valentin and Spangernberg 2000). The growing of trees in farmlands and its contribution to household income was found to be influenced by the size of landholding (Pandit and Thapa 2004) and proximity to forests (Thapa and Weber 1994; Arnold and Perez 1998). Other socio-institutional drivers such as forest policy, laws and regulations, taxation system and credit play a decisive role in tree growing, their use and management (Gilmour and Fisher 1991; Lynch 1993). A study carried out in Dhading district by Neupane *et al.* (2002) shows that male membership in local NGOs, female education level, livestock population and farmers' positive perception of agroforestry has significant positive effects on tree growing in private lands. The other drivers of agroforestry development were policymakers, local entrepreneurs and extension workers. So, long as the policies are conducive, people will try to promote AF and local entrepreneurs will take part in the development process. The role of extension workers is very crucial in agroforestry development.

Thapa and Weber (1994) offers useful insights into key social and economic drivers affecting farmers' use of trees and management of tree growing practices and their effects on the household resource base. Despite considerable research into technical adoption in agriculture-related subjects (Thapa and Weber 1994; Neupane 2000), little attention has been given to studying the drivers of the AF species growing in private lands. As such, there is limited empirical information on why some farmers grow AF trees species in their farmlands while others do not. This research provides evidence of what is constraining in terms of growing of AF species in private lands.

Due to very small landholdings, the farmers in the Nepalese hills have been finding it increasingly difficult to meet their subsistence needs from agriculture lands. More than half of the total population in the mid hills does not have adequate food supply throughout the year (Pandit and Kumar 2010). This problem is likely to be aggravated in the foreseeable future as crop yields are gradually decreasing due to soil erosion, declining fertilizer supply and continually shrinking average per capita landholding size because of a steadily growing population (Carson 1992; Thapa and Poudel 2002; Pandit and Thapa 2004). Most farmlands are located on steep slopes where farmers practise cereal-based land management, which requires intensive soil tillage, particularly frequent

ploughing and hoeing. Although most farmlands are terraced, they are subject to accelerated soil erosion (Thapa and Poudel 2002). Farmlands in the hills have been losing soil at a rate of 8–12 t ha−1 yr−1 (Carson 1992). Due to the combined effects of soil erosion and farmers' limited ability to apply adequate amounts of manure and fertilizer, soil fertility has been steadily declining (Neupane *et al.* 2002; Neupane and Thapa 2001). This is coupled with extreme rural poverty (one in four people is poor) and increasing market demand, because of which, AF species and their products[2] are under exploitation, leading to degradation of the resource base (NTFP, grasses and fodder), ultimately having adverse impacts on local livelihoods, biodiversity and rural health (Abington 1992; Garforth, *et al.* 1999; Pandit and Thapa 2004; Rasul *et al.* 2012). These are considered to be very important biophysical drivers of AF systems in the hills and mountains of Nepal.

The whole farming system in which hill farmers are engaged can be considered as agroforestry (Garforth *et al.* 1999). Though modern AF with exotic fodder and grass species is still a relatively new practice, hill farmers have been growing, or in other words, protecting selected native tree species along with field crops on their farmland to maintain land productivity and to provide for subsistence needs, including timber, fodder for livestock and fuelwood for cooking (Neupane *et al.* 2002). AF tree species grown on farmland have been an integral component of local economies because they are sources of animal feed and food and for cash earnings where farmers have access to market centres (Gilmour 1997; Neupane and Thapa 2001). A typical agroforestry system allows synergistic interactions between woody and non-woody components to increase productivity and diversify total land output, while conserving the environment in a sustainable manner (Nair and Nair 2003; World Bank, 2010). Agroforestry not only supplements farmers' incomes, controls soil erosion and maintains soil fertility but also contributes to feed the livestock. Apart from about one-third of Nepal's area being under forest cover, at least another 33 per cent of the area is under other land-use systems, including pasture and agroforestry (Joshi, *et al.* 2010). Sustainably managed non-forest land has the potential to bring multiple benefits for farmers. Thus, there are great opportunities for increasing the contribution (decreasing negative effects of climate change and increasing farm income) from agroforestry (Pandit, *et al.* 2013).

Today, acting as an interface between agriculture and forestry, agroforestry is considered to be a promising and sustainable land-use practice, especially in developing countries, to maintain or increase agricultural productivity while preserving and even improving land fertility and quality (Malla 2000; Neupane and Thapa 2001). Farming communities around the world have developed complex agroforestry practices to fulfill their household needs by combining trees, crops and livestock in their farming practices based on traditional knowledge and research findings (Thapa *et al.*, 1995; Walker *et al.,* 1995; Miller and Nair 2006). Forests and trees have been integral parts of subsistence farming systems in developing countries to add diversity to the farming system and to sustain the rural household economies (Arnold and Dewees, 1997; Neupane *et al.* 2002). Lately, the positive benefits of AF practices to the producers (i.e. farming households) and to the environment have been increasingly recognized, e.g. AF, carbon sequestration and biodiversity conservation (Nair *et al.* 2009). Agroforestry practices improve food and nutritional needs and mitigate environmental degradation by combining trees and crops in spatial or temporal arrangements (Sinclair, 1999; Nair 2007). In addition, AF can provide supportive and complementary benefits to specific

[2] AF products are those products which are produced directly or indirectly from farms by the use of tree, shrub and herb components. Examples of direct products are timber, non-timber forest products (roots, nuts, fruits, rasin, etc.) and indirect products (milk, meat, wool).

social and environmental contexts across a range of landscapes and economies of the nation.

In the context of Nepalese hills, agroforestry practice has a special significance. It is an integral part of the existing farming system to sustain agricultural practices, to support livestock production and to produce forest products for household consumption (Carter 1992; Amatya and Newman 1993; Garforth *et al.* 1999; Neupane *et al.* 2002). Therefore, to provide sustainable incentives to manage forest resources and to generate benefits to poor people, conservation efforts must go along with enhancement of productivity. If conservation provides returns that safeguard and improve the poor people's livelihoods, the forest-dependent poor will be able to protect their resources and even invest for their improvement. In order to answer the question of livelihood, the productivity of natural resources has to be enhanced, which is believed to be possible through integration of the AF system in private lands.

Of the various drivers discussed above, the policy and institutional driver has the greatest influence on promotion of AF species in private lands. This obviously has a strong role to achieve the overall goal of agroforestry. Review and field observation indicated that the policy and institutional drivers have restricted the promotion of AF products in the market value chain, starting from nursery establishment, through cultivation, harvesting, transportation to marketing (Pandit *et al.* 2014). AF products from private lands require a transit permit for transportation to markets like that of other forestry products (MoFSC 1993). Farmers have to pay royalties to the forest department for cultivated products if they are transported without having registration of their private forests. Agroforestry producers of the case study sites are constrained by a number of issues; of which obtaining private tree registration certificate and associated transportation permits from DFO involves at least seven steps to process or issue the certificate. Even a single step (first step-making application) requires the submission of five other documents (photocopies of land certificate, citizenship certificate, tax payment receipts, fee payment receipt for survey work by land survey engineer and DFO staff, and VDC recommendation). Despite the existence of Private Forestry Guidelines, 2011, there are a lot of hassles during transportation of AF products en route. Because of such a complicated process, farmers of the case study site reported that they preferred to sell private land timber through contractors. The income of such sale is almost five to ten times less than what is usually received from the local market. There are a lot of risks and uncertainties for marketing of their products from private lands. This demonstrates that regulatory and institutional drivers are crucial in determining the extent of benefits local communities can receive from the markets than simply by the physical characteristics or the market value of the product itself.

Changes in agroforestry practices at local level

In the study area, farmers have been managing trees in different types of land for more than a century. In one form or the other, farmers have long been practising AF to meet fodder and fuelwood requirements, as well as to maintain land productivity. Farmers reported that, in recent years, these practices have become unable to meet the fodder requirement and replenish soil nutrients to increase food production and provide fodder to the livestock.

We observed that most AF species were naturally growing on the edges and farm boundaries along with upland crops, and on the walls of gullies and barren lands called *Kharbari* where some kinds of thatch grasses are naturally grown. However, during the last decade, NAF has introduced some improved fodder trees and grasses. These are also planted on terrace edges and risers in close spacing

by maintaining 1-2 m tree height. Its special significance in the study area is due to heavy reliance of farming households on tree resources and the need to sustain farming system and to generate environmental benefits (e.g. reducing soil erosion) from the same piece of land.

Farmers reported that they derive a substantial part of their daily supplies from AF species such as raw material to make bamboo baskets and mats from *Dendrocalamus strictus (nigalo)* fruits of *Terminalia* and *Emblica*. *Ficus semicordata (Raikhaniyo)*, *Arundinaria intermedia (Nigalo)*, *Ficus nemoralis (Dudhilo)*, *Ficus lacor (Kabro)*, *Litsea monopetala (Kutmiro)*, *Artocarpus lakucha (Baddar)*, *Bauhinia purpurea (Tanki)*, *Emblica officinalis (Amala)*, *Shorea robusta (Sal)* and *Schima wallichii (Chilaune)*. Most of the species listed above are grown for animal fodder. Most of these species have multipurpose value, including fodder, fuelwood, timber and NTFPs. Some of the exotic fodder tree species introduced by NAF in the study area are: *Leucaena leucocephala*, *L. diversifolia* and *Flemingia congesta*.

Agroforestry's contribution to enhance livelihood capitals

Using the SL Framework, the contribution of AF has been discussed in five major sub-sections below. The first sub-section deals with natural capital, where AF has contributed to conservation of biodiversity resources in both forests and farms. The second sub-section deals with the human capital, which is mostly related to the capacity of AF households, whereas the third is the about social capital. The fourth is financial capital, which deals with increased income due to AF intervention. The fifth sub-section discusses physical and institutional capital enhancing food security.

AF contribution to enhance natural capital

In community forestry, AF intervention in private lands has made tremendous contribution to reducing pressure on community and government-managed forests. The increase in cultivation of medicinal plants, fodder trees and fruit tree species in private farmlands is the evidence of pressure reduction in CF and government-managed forests. More than two-thirds of the key informants claimed that with AF intervention, major tree species richness and density have increased significantly over time (Table 2). For example, *Shorea robusta* density has increased by 40 per ha (See table 2 below). Four new species appeared in the forest because of AF intervention in the study area. The increased number is due to regeneration of these species.

Table 2: Tree species regeneration and their density/ha in community forest

Major tree species	Before 1993*	After 2012**	Difference
1. *Shorea robusta*	58	98	40
2. *Pinus roxburghii*	34	45	11
3. *Castonopsis indica*	51	51	Same
4. *Schima Wallichii*	45	48	3
5. *Lyonia ovalifolia*	31	28	- 4
6. *Morus alba*	-	31	New appearance
7. *Grevelia robusta*	-	38	New appearance
8. *Leucaena leucocephala*	-	32	New appearance
9. *Choerospondias axillaris*	-	6	New appearance
Total	**219**	**377**	**158**

Source: *Data of "before" project was estimated by FGD participants, Field survey, 2012.**Quadrate sampling of trees in forest in 2012.

Species diversity is not limited to the nine tree species listed in Table 2. Besides there are hundreds of tree, shrub and herb species found in the community forests in the study area. Examples of other tree species include: *Phyllanthus emblica L., Terminalia chebula, Terminalia bellirica, Bauhinia varigata, Melia azedarch, Tamarindus indica, Acacia catechu, Aegle marmelos (Linn.), Sapindus mukorossi, Alstonia scholaris, Bauhinia variegate, B. purpurea L., Syzygium cumini, Ficus religiosa L.,* and *Semicarpus anacardium (Bhalayo).*

Examples of some shrub species found in CF are: *Asparagus racemosus Wild*, *Dendrocalamus sp., Rhus javanica (Bhakemlo), Agave cantula, Trichilia connaroides, Zizyphus mauritiana Lam., Inula cappa , Entada phaseoloides (Pangra), Smilax aspera (Kukurdaino), Mallotus phillippinensis (Sindure), Oxilum indicum, Woodfordia fruticosa* and *Vitex negundo L.*

Similarly, some herb and runner species are found in community forests. These are *Thysanolaena maxima (Roxb), Piper longum, Dioscorea deltoidea Wall, Tinospora sinenses, Artimisia indica (Titepati), Rubia manjith, Phonix humilis (Thakal), Centala asiatica (Ghotapre), Euphorbia royleana (Siudi), Aloe vera, Oxalis corniculata (Chariamilo)* and *Cassia sophera (Tapre).*

AF intervention has enormous impacts on private lands. As explained above, farmers in hills of Nepal have been traditionally growing tree, shrub and herb species in private lands. The results indicate that the practice of growing agroforestry species in private land has changed considerably over time, as a result of which more agroforestry species have appeared in private lands. A total of 145 different species were recorded, of which 56 species were medicinal plants and non-timber forest products NTFPs, followed by fodder trees (36), grasses (14), fruit trees (11) and others (16) (Table 3). The study further revealed that species richness has increased mostly in upland terraces.

Table 3 Number of AF species observed in private lands

Species types	Number	Percentage of total
1. Medicinal plants and NTFP species	56	39
2. Fodder tree species	36	25
3. Grass species	14	10
4. Timber species	12	8
5. Fruit trees	11	8
6. Others (ornamental, religious)	16	11
Total	**145**	**100**

Source: Field survey, 2012

In terms of number of individual species, a study conducted elsewhere in the middle hills of Nepal shows significant increase in the number of fodder trees in private lands (Pandit, *et al.*, 2013). The change in the number of fodder trees is higher than that in fruit trees, fuelwood and timber species. The total change is 147, which is almost double of what farmers used to cultivate before agroforestry intervention (NAF 2013). This result is consistent with the findings of Carter and Gilmour (1989). This has not only increased the number but also improved the biodiversity of the agroforestry species and at the same time reduced pressure on forests (Box 1). Home nursery approach would be a better option for multiplying seedlings for private land AF plantation, which increases AF productivity on a sustained basis.

Box 1: Agroforestry reduced pressure on forests and enriched soil organic matter

Ms Krishna Kumari Rai, 49, lives in Judigaon of Mahadevsthan VDC. She has a daughter. She separated from her husband more than two decades ago. Now she lives with her parents. Immediately after separation from her husband, she started agroforestry with support from NAF. Prior to initiating agroforestry, she had grown some local fodder tree species. In the new plantation she introduced almost 1,000 mixed legume and non-legume fodder tree species produced in her home nursery. After three years of AF promotion, she became a trainer and got job with NAF, where she worked for almost a decade. With the money she earned from her job, she sent her daughter for nursing training in Kathmandu. After returning, she resumed her AF work. She has more than 500 fodder trees in her farm. She claimed that fodder from these trees is enough for her four large animals and six goats in the dry season, which has reduced pressure on forests. She further told us that the legume fodder trees and grass species (such as *Leucaena and Flemingia spp*) have increased nitrogen content in the soil and increased crop yield. Krishna Kumari's efforts have not only contributed to natural capital but also enhanced her capacity to access other services and livelihood capital. She is a good farmer trainer now.

AF contributions to improving human capital

Individuals can secure their well-being through the development of human capital. Developing human capital is a cumulative and multiplicative process. For developing human capabilities, training is not enough, but other social, economic and physical capital is very important. For example, it can create new organizing roles for women on committees to oversee savings groups. Human capital can be developed through savings or accessible drinking water or labour-saving agricultural technologies. More free time allows poor people to spend their time on knowledge enhancing and skill generating activities (Dev *et al.* 2003). Agroforestry has contributed to improving 'human capital' in various ways. Change in human capital due to AF intervention has been assessed in terms of development of leadership, increasing literacy rate, access to information and improvement in children's health. In the study communities, the leadership, particularly of women from marginalized communities, has enhanced (see box 1).

The FGD held with marginalized communities indicated that transfer of knowledge and skills in agroforestry species and nursery management, cultivation and harvesting has a multiplier effect. Now, women group members can raise their voices for their rights. Every farmer in FGD reported that they have educated their neighbours, relatives and colleagues on the integration of AF species in the existing agriculture system. Leader farmers were also trained in marketing AF products, including NTFPs grown in their private lands. Twelve farmer groups federated into a cooperative network that is dealing with marketing of agroforestry products. With increased financial returns, the local people have developed their capacity to invest in education. The FGD meeting showed that the literacy rate had increased significantly. The study conducted in Rasuwa district indicated that the literacy rate has increased by 25 percent after 10 years of agroforestry project intervention (Pandit 2008).

AF contributions to enhance social capital

There are genuine as well as unanswered questions on how agroforestry has addressed the interests of poor, women and marginalized people? Since growing trees on farmland requires some land, how can the landless practise agroforestry? How can the issue of gender exclusion be addressed? How is social harmony maintained? This study tries to answer these questions. NAF, while designing the project, included these questions in the proposal and implemented the programme accordingly. For example, in many training programmes, almost 50 percent of the participants were female (Table 5). This approach has reduced gender gap in society.

AF contributions to improving financial capital

During the FGD, that average household income was estimated as NRs 106,420 (Table 4). Of the various income sources, remittance was the highest. This is attributed to the fact that many people (at least one person/household) had migrated outside their area in search of job. Nonetheless, if we consider indirect income from AF (such as income from goat and milk sale), fruits and cash crops, the highest income was from AF. The second highest income was from livestock sale (24 percent), followed by sale of vegetables (9 percent) and wage labour (7 percent). The increase in livestock and livestock product sale is attributed to improved nutrition following introduction of nutritious fodder trees and grasses on farms (Table 4).

Table 4: Mean household cash income (NRs)

Source of income	Income (NRs)/year	Percentage of total income	Percentage of HHs involved	Remarks
Sale of vegetables (tomato , cauliflower)	10000	9.40	72	
Sale of livestock and livestock products	25600	24.06	65	Goat meat and milk
Sale of fruits (Litchi, mango and guava)	6500	6.11	36	
Sale of potato, ginger, turmeric,	6120	5.75	10	
Wage labour	8200	7.71	20	
Remittance	35000	32.89	35	
Others (business)	15000	14.10	7	
Total	**106420**			

Source: FGD held at Mithinkot on December 7, 2013.

Corroborating the findings, various studies have shown that household cash income has increased due to agroforestry intervention in the hills of Nepal (Neupane *et al.* 2002; Basukala 2011). Further to this, Pandit *et al.* (2013) assessed how or which sources of income complemented the food shortage of poorer households in the hills of Nepal and confirmed that the dependency on wage labour and working for tourists declined marginally, which were complemented by AF and livestock income significantly. The income from the sale of AF products and livestock and livestock products has reduced the frequency of borrowing loan from relatives/neighbours and wage labour.

AF's contribution to food security

Food sufficiency is measured by quantifying the amount from own farm produce and purchase with cash income generated from sale of other household-level farm produce. Before the project intervention, 40 percent of the farm households could support themselves for three months from own produce, whereas it declined to 33 percent after the project intervention (see table 5).

Table 5: Change in food sufficiency level

S.N.	Food sufficiency by months	Before project intervention		After project intervention	
		No of HHs	Percentage	No. of HHs	Percentage
1	Sufficient for three months	117	40	95	33
2	Sufficient for six months	102	35	91	31
3	Sufficient for nine months	73	25	106	36
	Total	**292**	100	**292**	100

Source: Food security ranking by CFUG members

Similarly, 35 percent of the farm households had food sufficiency for six months before project intervention, which declined to 31 percent after the project intervention. Importantly, 25 percent of the farming households had food sufficiency for nine months before the project intervention, which increased to 34 percent after project intervention (see table 5). Asked how or which sources of income helped them meet the food deficit, respondent farmers reported that the income from sale of AF products and livestock and livestock products increased their household food security. Despite increase in food security, farmers in the study area feared decreasing crop productivity due to nutrient competition and shade effect.

CONCLUSION

In the study area, the AF system is complex and consists of different components such as agriculture, livestock and forest, which together meet the subsistence needs of a typical household. Many farmers maintain trees in the farmland adopting several forms of agroforestry, and collect fuel wood, leaf litter and fodder from these trees for their subsistence. Apart from supporting local livelihoods, this type of management system has contributed to diversifying livelihoods and increasing socio-ecological resilience against climate change. In such a complex farming system, both agriculture and forestry are equally important and cannot be isolated from each other. There is a huge scope for increasing productivity of both agriculture and forest for increased benefits to the farming communities. Hence, the government of Nepal should focus on increasing growing of AF species in private land.

A large number of households of the study area had migrated from their villages because of declining productivity, as well as higher and immediate income from remittance. Therefore, policies should concentrate on optimizing the environmental outcomes of resulting changes in household livelihood activities and community interaction. Integrated resource management plans capitalizing on labour migrant households' reduced dependency on agriculture and nature resources (e.g., programmes encouraging the conversion of marginal or abandoned farmland to high value forests) can enhance both livelihoods of the rural people and environmental sustainability.

Despite some improvement in food security over the years, local communities, particularly the poorest sections of society, have been suffering from food shortage and periods of hunger, partly due to their abandoning of traditional farming practices in search of job. One way to empower these people is to protect the local ecosystem and to promote stability in the study area. It has been estimated that agricultural growth has greater poverty-reducing effects than any non-agriculture sector. However, as such activities heavily draw on natural resources, they should have greater stake on most natural resources.

The impacts of agroforestry have been diverse across the local communities studied. One of the most significant achievements has been that the widely anticipated problem of serious shortage of forest produce has largely been addressed due to AF intervention. Most respondents expressed that degradation of forest has been reversed and that benefit flows are now more or less sustainable. In some cases there has been an overall increase in benefit flows; in some FUGs, product flows have stabilized and regeneration has taken place and in some cases they have been slightly reduced, to ensure sustainable flows in the future.

AF initiative has not only brought about economic returns but has also provided many environmental (e.g. biodiversity conservation, land rehabilitation, control of soil loss and environmental amelioration) and social benefits. These are not considered as poverty alleviation initiatives. The government of Nepal should recognize and count these values in the Gross Domestic Product (GDP) so that the Millenium Development Goal (MDG) and the target of the government's own three-year approach are achieved.

This study also recommends several ways in which policy and regulatory practices can be improved to support farming communities in the commercialization of agroforestry produce for better livelihoods and sustainability of agroforestry landscape in Nepal. These include preparing and enforcing simple private tree registration guidelines, different from the one which is currently available; formulating different royalty systems for forest- and farm-based products; simplifying en route checking and limiting product verification to the site of origin; amending environmental regulations to waive Initial Environmental Evaluation (IEE) and Environmental Impact Assessment (EIA) requirements for private forestry products; and removing land taxes for private forestry.

This study has not been able to investigate the details of the drivers of agroforestry system and farming practices in the hills of Nepal, which needs immediate attention of the government, research scientists and local communities as a whole for improved local livelihoods.

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