Conservation and livelihood impacts of agroforestry system: A case study of Kavrepalanchok district of Nepal

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Abstract

Agroforestry has been recognized as one of the important systems to support livelihoods of many rural farmers in the Nepalese hills. However, its conservation value has received little attention. Moreover, there is no solid information that tells us precisely as to how agroforestry system has changed over time, and what are its causes and consequences in terms of biodiversity conservation and livelihood improvement. This paper aims to investigate the changing impacts of agroforestry systems on improving people's livelihoods and delivering biodiversity conservation outcomes. This research analyses a case study of a local government area of Mahadevsthan in Kavrepalanchok district of Nepal. Mixed methodological approach involving Key informant interviews, Focus Group Discussion and PRA methods was used for data collection. The results indicate that the practice of agroforestry system has changed considerably over time, as a result of which 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 and grasses and fruit trees. The study further revealed that species richness has increased mostly in upland terraces. This resulted in increased livelihood benefits to local people. Meat production from goat and milk from buffalo has increased considerably. The high economic benefit is mainly associated with introduction of various fodder trees and grasses in private farmlands. It is concluded that there is need for agroforestry system to integrate conservation benefits with livelihood of rural people. One way to promote this integration is to improve policy and practices with a view to initiate and support farming co-operatives in the commercialization of agroforestry products and market the conservation values in the changing climate.

Keywords: Agroforestry, Livelihood, Biodiversity, Conservation, commercialization of agriculture

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INTRODUCTION

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

Despite farmers' efforts of growing AF species in private farmlands, these resources are being gradually depleted in the large tracts of fragile agricultural steep-lands in Nepal (Pandit and Thapa, 2004). The forest area has decreased at an annual rate of 1.39% during 2000-2005; and during recent years (2005 to 2010), the forest cover change remains constant (FAO, 2010). Forest degradation was highest from 1990 to 2000 at an annual rate of 2.09% (FAO, 2010). The reason for constant forest cover in recent years is because of promotion[4] of AF species in private lands in hills of Nepal (Pandit and Kumar, 2010). Forest depletion in the past (prior to 2005) has caused serious problems of environmental degradation and decreased agricultural productivity. The annual cost of deforestation was estimated to be about 11 billion Nepali rupees (FAO, 2010).

In view of the above realities, Nepal Agroforestry Foundation (NAF) had been involved to provide support to local communities in establishing AF demonstration in farmers' field in Mahadevstan VDC of Kavrepalanchok District during 1993 to 2000. The aim of this project was not only helping CFUG members and farmers to generate their income but also reducing pressure on the forests. The poor and disadvantaged communities were prioritized to promote AF species on under- utilized terrace risers for their improved livelihoods. This article is thus oriented to provide local evidences as to how Agroforestry system has changed over time, and what are its causes and consequences in terms of biodiversity conservation and livelihood improvement. Hence, this paper aims to investigate the changing impacts of agroforestry systems on improving people's livelihoods and delivering biodiversity conservation outcomes.

This paper aims to investigate the changing impacts of agroforestry systems on improving people's livelihoods and delivering biodiversity conservation outcomes. Specific objectives of the paper are:

a) What are the impacts of agroforestry system initiative in private lands?
b) What are the ways AF impact to people's livelihoods?
c) What are the benefits of AF on conservation?
d) How can AF system be improved? …

The structure of the paper is as follows. The first section reviews literature on the impacts of agroforestry on livelihoods and conservation. This is followed by the description of research methods employed in this study. The third section present results on the impacts of AF, followed by the 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 the path towards sustainable development.

[4] *AF promotion happens in two ways, firstly protection of naturally growing AF species in farm and secondly through plantation by farmers*

What literature says?

Due to very small landholdings, the farmers in the hills have been finding it increasingly difficult to meet their subsistence and income needs from the agriculture lands. More than half of the total population in the Middle Hills of Nepal does not have an 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 & Poudel, 2002; Pandit and Thapa 2004). Most farmlands are located on steep slopes, where farmers practice cereal-based land management, which requires intensive soil tillage, particularly frequent plowing and hoeing. Although most farmlands are terraced, they are nonetheless subject to accelerating soil erosion (Thapa & 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 effect of soil erosion and farmers' limited ability to apply adequate amounts of manure and fertilizer, soil fertility has been steadily declining (Neupane, Sharma, & Thapa, 2001). This is coupled with extreme rural poverty (one in four people is poor and increasing market demand, AF species and their products[5] are facing problems of indiscriminate exploitation from forests leading to degradation of resource base (NTFP, grasses and fodder) with adverse impacts on local livelihoods, biodiversity, and rural health (Abington, 1992; Garforth, *et al*., 1999; Pandit and Thapa, 2004; Rasul *et al*, 2012).

In 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 in Nepal, hill farmers have been growing or in other words protecting selected native tree species in association 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 stocks to livestock. Apart from about one-third of Nepal's area as forest cover there is at least another 33 % of area under other land-use systems including pasture and agroforestry (Joshi, *et al.,* 2010). Sustainably managed non-forest land has the potential to be a significant place for farmers' multiple benefits. Thus there are great opportunities for increasing the contribution (decrease negative effect of climate change and increase 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 the 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 an integral part 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 a*l., 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 complimentary benefits to specific social and environmental contexts across a range of landscapes and economies of the nation.

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

In the context of Nepalese hills, agroforestry practice has a special significance, as 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 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 AF system in private lands. Nepal is being confronted with a multitude of crises, from food and fuel crises to climate and financial crisis. In the last few decades, the forest degradation has not only increased carbon emissions to the environment and water loss, but also reduced forest-based products and feed resources for domestic animal (WBCSD and IUCN, 2008). The current practices or level of skills for AF product extraction, harvest and production management and post- harvest operations are not satisfactory (Pandit and Thapa, 2004). Unlike agricultural crops, the management knowledge and techniques are not well developed yet to suit AF field of studies. Therefore this paper tries to address these issues as to how AF promotion in private land can work for balancing conservation and development.

RESEARCH METHOD

Both primary and secondary data were collected. The latter included reviews and assessments of the agroforestry impacts to livelihood and biodiversity conservation, made from reports and records of various government and non-government offices and organizations. Beside relevant scientific literature was reviewed in detail. A case study was conducted in three CFUGs (Mahadevstan, Jugepani and Sallenibaguwa) in Mahadevstan Village Development Committee (VDC) area of Kavrepalanchok district of Nepaln in 2012. In order to support this study, principal investigators were involved in qualitative baseline data collection in Mithinkot VDC of Kavrepalanchok district recently under ACIAR project.

Study area

Kavrepalanchok district lies in the Central Development Region, and its head quarter is Dhulikhel (Figure 1). This district covers an area of 139600 ha and has population of 389,959 (District profile, 2013). Its elevation ranges about 800 to 3000 metre. It lies in the mid-hills from the topographical point of view. The Kavrepalanchok district occupies an area of 1,396km^2. The elevation of the district ranges from 1,007 to 3,018 m asl. Some of the river basins are as long as 687 m asl 59.4% area of the Kavrepalanchok district is occupied by forests and shrubs, 28.2% is under agriculture land and the rest 12.4% is river basin, rocks and road.

The Mahadevstan VDC lies in the southern-facing mid-hills region of the district, 40 km north-east of the national capital Kathmandu. The area is characterized by many forms of agroforestry systems. Up to now, a total of 11 CFUGs have been registered with District Forest Office from this VDC (DFO, 2013), of which 3 CFUGs were selected for this study. Of the three, the first two, Sallenibaguwa and Jugepanit CFUGs were selected as Project site based on level of agroforestry intervention. The Mahadevstan 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
Sallenibaguwa CFUG	Yes	1994 June	64.25	147
Jugepani CFUG	Yes	1995 May	10.25	102
Mahadevstan CFUG	No	1996 June	6.55	43
Total			81.05	**292**

As an agroforestry intervention, 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 project area. Besides, NAF promoted naturally growing valuable local fodder tree species (baddar- *Artocarpus lakucha*, Kutmiro- *Litsea monopetala*) in this area.

The forest type is mix (both natural+ plantation) in all three forests. The common tree species found in these forests are *Shorea rubusta (Sal), 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.

Four specific methods were used for collection of both primary data. These include:

1. *Direct observation* of the forests: This was done by transect walk inside the selected forests. Effort was made to cover the whole area of the forest along the foot trail. This was important part of data collection because it provided a general impression of the area and helped to triangulate the data obtained from the following three methods.
2. *Quadrate sampling*: This was done on tree saplings in each block of the forest area. The quadrate sampling area was 22.5 by 22.5 square meters. This area is equivalent to *Ropani* a locally used land measurement unit, it is $1/20^{th}$ of a hectare. Five quadrates were taken from each of the three forests. The number of tree species was counted in each plot.
3. *Focus group discussion (FGD):* Focus group discussion was held with the CFUG committee members of all three CFUGs. This method was helpful to investigate as to how agroforestry promotion has helped to reduce pressure on forests and to improve local livelihood. The discussion was focused on what has been the contribution of AF to household economy and to fulfill other basic needs of fodder, fuelwood and other forest products. Of the 37 committee members of the three CFUGs, 24 people appeared in the meeting. Data collected from other ACIAR sites also provided some evidences of AF contribution on livelihood and biodiversity conservation.
4. *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 KI, the following questions were discussed.
    - How is the nature of AF initiative in the area?
    - How has the AF initiative made a difference to people's livelihood?

- Has the change contributed to a better 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 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?

RESULTS AND DISCUSSION

Agroforestry Practice in the study area

Traditionally, farmers in the study area are managing trees by themselves from the very beginning (more than a century) in different types of lands. In one form or the other, farmers have long been practicing 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, the NAF, an NGO, has introduced some improved fodder trees and grasses. These are also planted on terrace edges and risers in close spacing by maintaining one-two meter 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). Of the various species listed above, most of the species are grown for animal fodder. Most of these species have multipurpose values 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 in reconciling conservation and household economy

The contribution of AF has been discussed into five major sub-sections. The first sub-section deals about 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 capacity of AF households, third is about social capital. The fourth is financial capital, which deals about increased income due to AF intervention. The fifth sub-section is discussed on food security issues.

1. Change in biodiversity and tree density

Tree species diversity in Community forests

It was observed that AF intervention 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 the one, major tree species richness and density has increased significantly over time (Table 2). For example, *Shorea robusta* density has increased by 40 per ha. Four new species appeared in the forest because of AF intervention in the study area (Table 2). The increased number is because of 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	Equal
4. Schima Wallichii	45	48	3
5. Lyonia ovalifolia	31	28	-4
6. Morus alba	-	31	New appear
7. Grevelia robusta	-	38	‘
8. Leucaena leucocephala	-	32	‘
9. Choerospondias axillaris	-	6	‘
Total	219	377	158

Source:

**Data of “before” project was estimated by FGD participants*

***Quadrate sampling of trees in forest in 2012,*

Species diversity is not limited to 9 tree species listed in Table 2. Besides there are as many as hundreds of tree, shrub and herb species available in community forests in the study area. Example of other tree species includes: *Phyllanthus emblica L., Terminalia chebula, Terminalia bellirica, Bauhinia vahlii Wight & Arn, Melia azedarch, Tamarindus indica, Acacia catechu, Aegle marmelos (Linn.), Sapindus mukorossi, Alstonia scholaris, Bauhinia variegate, B. purpurea L., Syzygium cumini, Ficus religiosa L., 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 of the herbs and runner species are also 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).*

Diversity of AF species in private lands

As explained earlier, 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 number of 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 followed by fodder trees (36) and grasses (14), fruit trees (11) and others (16) (Table 3). 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	38.62
2. Fodder tree species	36	24.83
3. Grass species	14	9.66
4. Timber species	12	8.28
5. Fruit trees	11	7.59
6. Others (Ornamental, religious)	16	11.03
Total	145	100

Source: Field survey, 2012

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

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

Ms. Krishna Kumari Rai of age 49 has one daughter and lives in Judigaon of Mahadevstan VDC. 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 also grown some local fodder tree species. In the new plantation she introduced almost 1000 mixed legume and non-legume fodder tree species produced in her home nursery. After 3 years of AF promotion, she became farmer trainer and got job with NAF and worked almost a decade. With the money she earned from her job, she sent her daughter for nursing training in Kathmandu. Now she returned home and resumed her AF work. She has still more than 500 fodder trees in her farm. She claimed that fodder from these trees is enough for her 4 large animals and 6 goats in dry season, which has reduced pressure in forests. She further informed us that the introduction of legume fodder trees and grass species (such as *Leucaena* and *Flemingia* spp) have increased nitrogen content in the soil and increased crop yield. Ms. Krishna Kumari's efforts have not only contributed to natural capital but also enhanced her capacity to access to other services and livelihood capital. She has been a good farmer trainer.

2. Change in human capital

Individual's capabilities to secure his/her well-being are possible through the development of human capital. Developing human capital is a cumulative and multiplicative process. For developing human capabilities, only training is not enough, other social, economical and physical capitals are very important. For example, it can create new organizing roles for women on committees to oversee savings groups. Human capital can be developed by saving through accessible drinking water or labor-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 and access to information and children health improvement. In the study communities, the leadership, particularly of women from marginalized communities has enhanced (box 1).

The FGD held with marginalized communities revealed that transfer of knowledge and skill in agroforestry species and nursery management, cultivation and harvesting has a multiplier effect. Now women group member can raise their voice for their rights. Every farmer in focus group discussion reported that they have educated their neighbors, relatives and colleagues on AF species integration in the existing agriculture system. Leader farmers were also trained on marketing of AF products including private land NTFPs. Twelve farmers groups federated into one cooperative network that is dealing with marketing of agroforestry products. With the increased of financial return, the local people have developed capacity to invest in education. As a result we observed in increase in literacy rate in the case study site. The literacy rate had been increased from 43 percent to 67 percent (i.e. 25 %) agroforestry project intervention.

3. Change in social capital

There are genuine as well as unanswered questions to all of us on how agroforestry has addressed poorer, women and marginalized people's interest? Since growing trees on farmland requires some lands, how landless people can do agroforestry? How has issue of gender exclusion addressed? How social harmony is maintained in the society? This study tries to answer these questions. NAF, while designing the project deliberately included these questions in the proposal and implemented the program accordingly. For example, in many training programs, almost 50 percent participants were female (Table 5). This approach has reduced gender gap in the society.

4. Change in financial capital and income

In order to assess the livelihood impacts of AF, principal investigators organized focus group discussion meeting with Charuwa CFUG in Mithinkot VDC, one of the ACIAR project sites. Nine members of Charuwa CFUG representing all socio-economic classes and women participated at the meeting. The focus group discussion revealed that average household cash income was estimated as NPR 106420 (Table 4). Of the various sources, remittance is the highest. This is attributed to the fact that many people (at least one person/ household) has migrated outside their area for search of job. Non-the le, if we consider indirect income from AF (such as income from goat and milk sale), fruits and cash crops, the highest income would be from AF. The second highest income is from livestock sale (24%) followed by vegetable (9%) and wage labor (7%). The increase in livestock and livestock product sale is attributed to the improved nutrition by introduction of nutritious fodder trees and grasses on farms (Table 4).

Table 4: Mean household cash income (NPR)

Source of cash income in NPR	Income NPR/year	% of total income	% HH involved	Remarks
Sale of vegetable (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 labor	8200	7.71	20	
Remittance	35000	32.89	35	
Others (business)	15000	14.10	7	
Total	106420			

Source: Focus Group Discussion held at Mithinkot on Dec 7, 2013.

In support of the above finding, various studies have revealed that household cash income has increased due to agroforestry intervention in hills of Nepal (Neupane et al., 2002; Basukala, 2011). Further to this, Pandit, et al. (2013) assessed how or which sources of income complimented the food deficit of poorer households in hills of Nepal and confirmed that the dependency on wage labor and working for tourists declined marginally, which were complemented by AF and livestock income significantly. The income from AF product, and livestock and livestock products sale have reduced the frequency of borrowing loan from relatives/neighbors and wage labor.

5 Change in level of food sufficiency level

Food sufficiency is measured counting the support from own farm produces and buying by other cash income generated from sale of household level other farm produces. Before the project 40 percent farm households could support for three months from own produces where as it declined to 33 percent after the project (Table 5).

Table 5: Change in food sufficiency level

No	Food sufficiency by moths	Before project		After project	
		No of HH	Percent	No of HH	**Percent**
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

Similarly, 35 percent farm households had food sufficiency for six months before the project which declined to 31 percent after the project. Importantly 25 percent farming households before the project had food sufficient for nine months which increased to 34 percent after the project (Table 5). Farmers were asked how or which sources of income complimented the food deficit. Farmers reported that the income from AF product, and livestock and livestock products sale has increased household food security. Despite increase in food security, farmers in the study area fear from decreasing crop productivity due to nutrient competition and shade effect.

CONCLUSION AND POLICY IMPLECATION

Complex topography of the area has created a delicate situation between forest resources and farming practices. Nepal's heavy reliance on land-based agriculture makes it hard to justify protection of any land of forests without improvement in AF farming condition. As almost 80% of people relies on land and forests they have strong stake in land use. Most of them feature trees and, in some cases, can be treated as agroforestry areas. However the country comprises a complex farming system involving agriculture, livestock and forest that altogether supply subsistence needs of a typical household especially in the study area. Many farmers maintain trees in the farmland adopting several types of agroforestry; collect fuel wood, leaf litter and fodder from these trees as the means of 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 which cannot be isolated from each other. There is great scope for increasing productivity of both agriculture and forest for increased benefits to the farming communities. Hence, the Government of Nepal's focus should be towards increasing AF species plantation in private land.

It was observed that many rural households of the study area had migrated from their village because of fear of declining productivity. Therefore, polices should concentrate on optimizing the environmental outcomes of resulting changes in household livelihood activities and community interaction. Integrated resource management plans capitalizing on labor-migrant households' reduced dependency on agriculture and nature resources (e.g., programs encouraging the conversion of marginal or abandoned farmland to high value forests) can enhance both rural people's livelihoods and environmental sustainability.

Despite some improvement in food security over the years, local communities are suffered by shortages of food and periods of hunger, partly due to abandoning traditional farming practices in search of job. One way to empower local people is to protect the local ecosystems 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 upon natural resources, 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 forest product shortage has largely been averted due to AF intervention. Most respondents expressed that the degradation of the forest has 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 of the FUGs product flows have stabilized and regeneration has taken plance in a positive manner and in some cases been slightly reduced, to ensure sustainable flows in the future.

Contribution of AF initiative has not been limited to economic return, but also providing many environmental (biodiversity conservation, land rehabilitation, control of soil loss and environmental amelioration) and social benefits. These are not considered as poverty alleviation initiatives until today. The government of Nepal should recognize and count these values in the GDP so that the MDG and three year approach paper of Government of Nepal's target will be achieved.

Home nursery can produce required fodder trees and grass species. To be better used our terrace lands a mixture of nutritious grasses and fodder trees can be grown on the terraces. As a first step, a thick grass variety can be planted in a line along the edge of the terraces, which at the same time provides fodder to animal and prevents soil run-off from our fields. Just below the grass line, fodder trees are planted. Nitorgen fixing trees that can be lopped regularly for high quality fodder should be planted.

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