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研究ノート Research Note

Opportunity Cost of REDD+ in Community Forests in the Mid-Hills of Nepal: A Case Study of Thangsa Deurali Community Forest, Dolakha

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Abstract: Reducing Emissions from Deforestation and Forest Degradation (REDD+) was reformulated to cover deforestation and forest degradation, which, until recently, were overlooked in climate change mitigation initiatives. However, whether REDD+ will benefit countries like Nepal, which has a relatively low deforestation rate, less forest cover, and a population predominantly comprising farmers who are heavily dependent on forests, is being debated. To address this issue, the opportunity cost (OC) of REDD+ need to be analyzed. This study analyzes the OC of REDD+ against high-value and mid-value crops in the Thangsa Deurali Community Forest (TDCF) of Dolakha district in the mid-hills of Nepal. This community forest has been participating in the REDD+ pilot program since 2009. In the study, household survey, focused group discussions, and key informant interviews were used to collect data on community forest management, including forest harvesting and agricultural practices. To estimate the OC, the 2011 guidelines from the World Bank were followed. Potato was taken as a high-value crop, whereas maize and millet were taken as mid-value crops, considering their importance in the study area. The members of TDCF harvest mainly timber, fuel wood, fodder, and leaf litter from the forest's 217.1 hectares (ha). The OCs of REDD+ will be US$0.072 million/year and US$0.065 million/year for high- and mid-value crops, respectively. The carbon prices of US$198 and US$179 per ton will be optimal to cover the possible losses for not moving to high- and mid-value crops, respectively, in forestland that can be converted to agricultural land. Co-benefits such as enhancing biodiversity, water recharging, and increasing the role of the forest itself in the farming system could make REDD+ a good choice for managing forests with community participation. The monetary value of such co-benefits is crucial in easing out the optimal carbon price.

Keywords: Forest products, high-value crop, mid-value crops, forest carbon, opportunity cost

Ⅰ. Introduction

It is estimated that the Green House Gases (GHG) emissions from deforestation and forest degradation contribute up to 20 percent of the global emissions (Parry et al., 2007). Hence, reducing deforestation is the single largest opportunity for cost effective and immediate reductions of carbon emissions from land-use change, which is responsible for over 8 $GtCO_2$ in 2000 (Stern, 2007). However, Clean Development Mechanism of Kyoto Protocol adopted in 1997 address only reforestation and afforestation aspects, but did not cover deforestation and degradation of forest. It was only in 2007, The Bali Action Plan (COP-13) opened windows of opportunity for developing countries to participate in forest carbon trading through the mechanism of Reducing Emissions from Deforestation and Forest Degradation (REDD) in order to mitigate the impacts of Climate Change in the globe.

The concept started evolving through 'Marrakesh Accord 2001' and came into its advance form known as REDD+ from the 'Copenhagen Accord 2009'. This expanded version of REDD is defined as "a policy approaches and positive incentives on issues relating to reducing emissions from deforestation and forest degradation; and the role of conservation, sustainable management of forest and enhancement of forest carbon stocks in developing countries" (World Bank, 2011).

It encourages developing countries to contribute in

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mitigation actions in the forest sector by undertaking the emission reducing activities through forest management initiatives. It could support new pro-poor development, as financial flows from REDD+ programs could reach up to US$30 billion a year, in order to reduce emissions between 2005 and 2030. Moreover, it helps in conservation of biodiversity and other vital ecosystem services (UN-REDD Programme, 2009).

According to the United Nation's Framework Convention on Climate Change (UNFCCC), ratification of REDD+ will allow the forested countries to sell its carbon credits to interested buyers in markets, or they can get support from conservation funds. REDD+ has been discussed in international climate negotiations since 2005 with a focus on developing new policies and financial incentives to curb emissions from forests.

Nepal is a signatory of the UNFCCC. Hence, Nepal is committed to contribute in reducing carbon emissions. The Ministry of Forest and Soil Conservation (MoFSC) of Nepal submitted letters of interest to the World Bank in 2008 to participate in Forest Carbon Partnership Facility (FCPF). Foreign Aid Coordination Division (FACD) of MoFSC took initiation to prepare Readiness Plan Idea Note (R-PIN), which was the starting point for REDD readiness. In coordination with non-government organizations; civil society, private institutions, and donor organizations, a final draft of R-PIN was prepared and submitted by the Government to the World Bank in April, 2008 and the idea got approved in July, 2008. The MoFSC and the World Bank got agreement in September, 2008. As a result, Nepal formally became a participating country in FCPF which was the first step in the direction towards Climate Change mitigation through forest carbon trading offered by REDD+ (Kotru, 2009).

In the context of developing countries, there are both optimistic and pessimistic views about REDD+. Some authors like Adhikari (2009) argue that REDD+ ensures the multiple benefits to developing countries. On the other side, Ojha (2009) argues REDD+ cannot give benefit in carbon financing for a country like Nepal. It is suitable only in those countries which have a high deforestation rate and huge quantity of forest like Brazil and Indonesia. He further argues that REDD+ should not threaten the livelihoods of indigenous peoples, the poor, and other forest dependent and marginalized communities who rely heavily on forests for their livelihoods, by diminishing their access to vital forest products for both subsistence and commercial uses.

In the country like Nepal where most of the people are farmers and farming systems heavily depend on forest products and its management regimes, it is a matter of discussion on whether REDD+ gives benefit to the rural community in the mid-hills of Nepal or not. Many pilot initiatives on REDD+ from the government and various civil society organizations are in operation. Most of the initiatives are primarily focused on raising awareness, thereby enhancing the capacity of local people for sustainable management of forest to enhance forest carbon stock. However, we could not trace out any study dealing with the opportunity cost of REDD+ in Nepal. Hence, this study is a step forward in gaining understanding on the economic potential of REDD+ in the community forestry system in the mid-hills of Nepal from opportunity cost perspectives.

Ⅱ. Research Methods

1. Study area and data collection

Thangsa Deurali Community Forestry (TDCF) was selected for this study. It lies in the Dolakha district in the central Nepal which can be divided into three geographical areas in terms of its altitudinal variation. Almost 35 percent of its total land lies in the high Himalayas, around 40 percent in the high-hills and 25 percent in the mid-hills. TDCF, which falls in the mid-hills, was established in 1996 after handover of 217.1 ha government forest land to the community as a community forest. Some parts of its forest is a plot of the REDD+ pilot project started since 2009 and received US$1,253 as an initiation fund in 2011, and US$1,243 in 2012 from the Forest Carbon Trust Fund (FCTF) (Ringheim, 2013). Forest and agricultural land co-exist in the community forestry, which makes it relevant to estimate the opportunity cost in land use conversion. Moreover, the proximity of the community forest with district headquarter provides good access of the community to market for selling and buying of forest and agricultural products.

Both primary and secondary sources were used to capture the trend of forest products use. For primary data collection, a questionnaire was developed and household survey was conducted. While developing the questionnaire, the main focus was given to find out the community

forest management practices, agricultural production systems, REDD+ knowledge, its practices and co-benefits of forests. Data were also collected through the constitution and operational plan of the community forest.

Constitution of the TDCF user group was reviewed for selection of sample households. The well-being ranking of its 383 members done by TDCF was used for sample selection in order to administer the household questionnaire survey. The well-being ranking divides the users in five different categories from rich (Ka) to ultra-poor (Nga). Ka to Nga is Nepali alphabetical order corresponding to the English alphabetical order of A to E. Systematic proportional random sampling technique was adopted for sampling. Almost 17.5 percent households from each of these five well-being categories were selected in intervals of every 6th listed number for the household questionnaire survey. Hence, the sample size for this study is 67. The distribution of the population and sample size from each well-being category is shown in Figure 1.

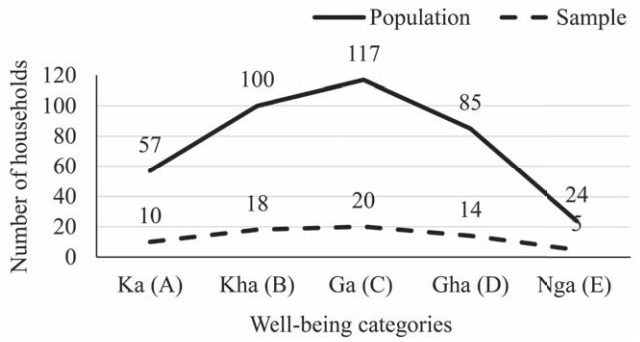

Figure 1　Number of households in different well-being ranking categories and sample selection
Source: Operational Plan of TDCF, 2012.

Two focus group discussions were conducted; one was only with women participants and another was with men and women participants, in order to know the trend of dependency on forest products and its recent conditions (density, diversity, frequency and quantity of collection). Similarly, to know forest types of TDCF, its trend of use, and dependency of community on forest products, key informant's interview with the District Forest Officer, Dolakha and President of TDCF were done. Relevant data, such as main potential agricultural crop of the area, quantity of annual production per ha, irrigation system and market channels (local value of potato, maize and millet) were taken from the District Agriculture Development Office (DADO) – Dolakha and farmers by the means of key informant's interview. Data related to the local economic value of forest products like leaf litter, fuel wood, fodder and timber were collected as secondary data from CFUG's minute book.

2. Data analysis

According to Khatri et al. (2013) carbon sequestration rate in a Charnawati watershed area of Dolakha district is 1.82tC/ha/year. Similarly, the mean carbon sequestration rate in five different forest types in Nepal was 1.86tC/ha/year with the range of 1.35tC/ha/year in pine (*Pinus roxburghii)* forest to 1.92tC/ha/year in Nepalese alder *(Alnus nepalensis*) forest in the mid-hills of Nepal (Baral et al., 2009). Banskota et al. (2007) also found the similar rate of carbon sequestration (1.88tC/ha/year on an average) from three community forest areas (Ilam, Lamatar and Manang) in the Hills and Mountains of Nepal. This sequestration rate is similar to the findings of Dhital (2009), who analyzed the carbon sequestration rate in different types of community forest of Nepal.

All these figures of carbon sequestration rate are more or less similar. Hence, considering the geographical proximity of the study area i.e., TDCF is the part of Charnawati watershed, carbon sequestration rate of 1.82tC/ha/year was taken into consideration in this study. The TDCF can sequester 395.12tC/year (217.1ha* 1.82tC/ha/year) in total. Calculated data on the Present Value (PV) of forest and agricultural products is used to analyze the opportunity cost of REDD+ in community forestry with respect to land conversion into agricultural land for high-value and mid-value crops in the context of the study area.

If the forest land is converted into an agricultural land the following formula suggested by the World Bank (2011) was used to find out the opportunity cost (OC)

OC=PV of income from crops−PV of income from forest

Ⅲ. Results and Discussion

1. Current status of TDCF

There was a dense forest with large trees in the upper parts called Thangsa and Sahilikhorea Kapethala of this community forest, but lower parts called Syagahira, Okhreni, and Tokaldhunga were bare before

1991. There were not any people or organizations to look after the forest except District Forest Office, Dolakha during those periods. Due to this, the forest land gradually converted into the grassland. Valuable plant species were depleted and many wild animals also perished because of scarcity of habitat and food. The condition of the forest became the worst with almost no possibility to collect forest products from the forest. This led to the realization by local residents for the need to conserve the forest. The forest user then started becoming aware through the observation of activities carried out by other communities for conserving the forest. They also established forest conservation committee in 1991. This committee became very strict for conserving the forest. After some years the condition of forest improved. In 1996, the forest was handed-over to the community who were users of that forest as the name of the Thangsa Deurali Community Forest. After handover to the community, the condition of forest improved in its density and coverage. Renewal of Constitution and Operational Plan of community forest took place again in 2010 in order to comply with changing government policies (Constitution of TDCF).

The area of TDCF is divided into eight blocks. The main aim of the block division is for better forest management. Both broad-leaved and coniferous trees were found in each block. Regenerating seedlings, saplings and other commercial trees were equally distributed in almost all the blocks. In TDCF area, the average numbers of regenerated seedlings were 6538, saplings were 321 and commercial trees were 222 per ha. Hence, the community forest is dominated by regenerated seedlings covering more than 92 percent of the forest area. The growing stock of tree volume was 2400 cubic feet per ha. Thus, all the blocks have the potentiality for collection of timber, fuel wood, fodder and leaf litter in a sustainable manner. This also reflects the future potential for enhanced carbon sequestration in the forest. There are more than 35 plant species in the community forest. Major forest species and their uses are presented in Table 1. Lokta (*Daphne papyracea*), Chiraito (*Swertia chirayita*), and Argeli (*Edgeworthia gardeneri*) are some commercially important non-timber forest products (NTFPs) in the community forest, the potentiality of which is yet to be tapped.

TDCFUG members have a remarkable number of trees on their private land. The private land can fulfill almost one third of their demand for timber, half of the demand of fuel wood, more than two third demand of leaf litter, quite lesser than half of the demand of fodder and two third demand of plough (Table 2).

The policy of TDCF shows that forest products are

Table 1　Main forest species and their preferred uses in TDCF

S. No.	Name of species in Nepali	Botanical name	Preferred uses							
			HM	FW	FO	FE	AT	FS	M	OT
1.	Gobre sallo	*Pinus wallichiana*	■	■	■	■	■		■	■
2.	Thingure sallo	*Tsuga dumosa*	■	■	■	■	■		■	■
3.	Patle sallo	*Pinus patula*	■	■	■	■	■		■	■
4.	Rani sallo	*Pinus roxburghii*	■	■	■	■	■		■	■
5.	Utis	*Alnus nepalensis*	■	■	■	■	■	■	■	■
6.	Arupate	*Prunus cornuta*	■	■	■	■	■	■	■	■
8.	Guras	*Rodhodendrom arboreum*	■	■	■	■	■	■	■	■
9.	Banjh	*Quercus spp.*	■	■	■	■	■	■	■	■
10.	Arkhaulo	*Lithocarpus elegans*	■	■	■	■	■	■	■	■
11.	Katus	*Castanopsis spp.*	■	■	■	■	■	■	■	■
12.	Dudhilo	*Ficus neriifolia*			■	■	■	■		■
13.	Paiyun	*Prunus cerasoides*	■	■	■	■	■	■	■	■
14.	Khasru	*Quercus semecarpifolia*	■	■	■	■	■			■
15.	Lokta	*Daphne papyracea*							■	■
16.	Argeli	*Edgeworthia gardneri*							■	■

Note: HM=Housing materials, FW=Fuel wood, FO=Fodder and organic manure, FE=Fence, AT=Agricultural tools, FS=Food and spices, M = Medicine, OT=Others.
Source: Operational Plan of TDCF, 2012.

Table 2　Annual demand and supply of forest products

S. No.	Forest products	Unit	Annual demand	Supply capacity from the CF	Supply capacity from private forest
1.	Timber	cubic feet	2,244	2,726	897
2.	Fuel wood	*bhari*	26,928	13,835	13,464
3.	Leaf litter	*bhari*	204,765	28,425	163,812
4.	Fodder	*bhari*	74,800	6,365	33,660
5.	Plough	Number	300	450	200

Source: Operational Plan of TDCF, 2012.

Table 3　Perception on change in forest density and biodiversity

Particulars	Improved	Not improved	Decline	Don't know	Total
Forest density	44 (65.7)	18 (26.9)	-	5 (7.4)	67 (100)
Biodiversity	40 (59.8)	11 (16.4)	8 (11.9)	8 (11.9)	67 (100)

Source: Field Survey, 2012
Note: Figures in parentheses indicate percentages.

being sold only to the members of CFUG. Currently, the community forest is fulfilling the demand of 36.02 *bhari* (*bhari* is the local unit of head load of approximately 25 Kgs) of fuel wood, 16.57 *bhari* of fodder and 74.02 *bhari* of leaf litter per household per year. The supply from the community forest does not fulfill all the requirements of a household. The households fulfill the rest of the demand from their private lands.

2. Perception on change in forest and income management

Nearly 66 percent of the members perceived that there has been improvement in the density of the forest after the forest is managed through the community forest; around seven percent did not feel any changes. On the contrary, 26.9 percent denied the improvement in the forest density (Table 3). According to the historical background stated in TDCF's work plan, there were lots of valuable wild flora and fauna. In the present context, 59.8 percent of respondents perceived that there has been improvements in biodiversity after the forest is managed by the CFUG. Around 16 percent said there is no difference in biodiversity before and after the forest is managed through the community forest. In contrast, 11.9 percent respondent perceived that there was a reduction in biodiversity after the forest management by the community (Table 3). According to them, wild fauna such as tiger (*Panthera tigris*), leopard *(Panthera pardus)* and foxes *(Vulpes spp.)* disappeared from the forest. Medicinal plants such as Chiraito *(Swertia chirayita)*, Argeli *(Edgeworthia gardneri)* are also disappearing.

Regarding the annual income of the CFUG, only 22 percent respondent knows how much the community forest was earning each year by selling its forest products and other sources such as membership (Figure 2). According to them, they got the information from the general assembly. Around 71 percent did not know how much the community forest was earning each year, but they know that the CFUG is involved in development activities such as construction of a community forest building, distribution of improved cooking stove, provision of emergency fund for natural disaster (if the house of the community member get destroyed in the disaster the community forest supports by providing some fund and timber for reconstruction) from the income. It is in-line with what is stated in the Operational plan of the CFUG.

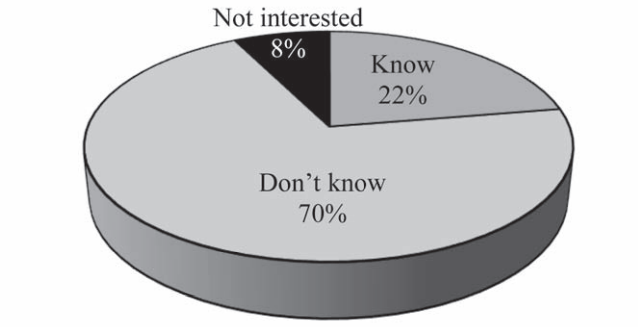

Figure 2　Information on annual income of the CFUG
Source: Field Survey, 2012.

In the Operational Plan of the TDCF, it was clearly mentioned that income generated from the community forest should be spent in the management of CFUG office, development in the agroforestry system, support the ultra-poor for their income generation activities, construction of roads, school, temple, irrigation canals and the drinking water. It had also a provision of the prize to the person who contributes remarkably in improving the situation of the community. Around eight percent are not interested in knowing the annual income. Exact money earned by the community forest was only known to the executive committee members.

TDCFUG has a plan to increase around 5000 plants each year in its forest area. To get better income from forest land, there was also a provision of fodder and spices plantation which helped the community to generate income. In the fiscal year 2065/2066 BS (2009/2010 AD), they had planted 3000 Argeli (*Edgeworthia gardneri)* in the forest. They plan to add same numbers of trees in the different part of the forest area every year. Such activities will be important in conserving important plant species as well as in improving the carbon sequestration capacity of the forest in the future, hence, contributing to improve the competitiveness of the forest for REDD+.

3. Role of forest resources in production system

Forest resources are important in the life of most villagers of Nepal (Bajracharya, 1983; Fox, 1984; Baland et al., 2010; Piya et al., 2010). In the rural Nepali village, several units have direct or indirect roles in the village level production system. In TDCF, agricultural lands, Katero (the small wooden house where livestock is kept), livestock, market, and the forest were the vital units. In TDCF, individual household owned small agricultural plots just like most of the rural villages of Nepal hills do. Most of the plots were in narrow terraces. So the modern means of agricultural tools, for example, use of tractors to plough in the field was quite difficult. The villagers also managed diverse cropping pattern according to their year-round need of food. The fragmented small plots of agricultural land require the engagement of a single person in farming. They need the agricultural implements which can be operated by a single person using animal draft power. Local blacksmiths (Kami) make iron tools and the villagers extract the handle from the local forest.

Villagers use basement of Katero for livestock and upper part to store hay and firewood. Some households have made separated Katero nearby their house. Livestock also have a significant role in the farming system and moreover to the production system in TDCF. The manure from livestock was the main source of organic fertilizer (compost) for the farmland. The commercial farmers mostly prefer to use the chemical fertilizers. Poor farmers use only pesticides and insecticides because they do not have enough money to buy expensive chemical fertilizers.

While assessing the relationships between the units, forest resources were found to have significant relationships with every major unit of production system in the village, which also has an important role in the villagers' day-to-day life. Most of the people in the village made their living primarily from local farms. The farming needs bedding materials (leaf litter) for animals, fences, agricultural implements, and draft power. To build houses, lots of forest products are required. Likewise, the occupations of some of the villagers were also directly tied up with the forest products. The villagers, who weave *doko* (small bamboo piece knitted box used for carrying leaf litter, firewood etc.), fully depended on the local forest for bamboo. Thus, the villagers were of the opinion that the changes in one unit, such as in the forest will have several interlinked effects to other units and poor to be hit the hardest. For example, if oxen are not allowed to graze on forest land, there will have effects on farm land and then to the people. Likewise, if small bamboo is banned, there will have the effects of the occupation of the people, who do not have other alternatives. Hence, the forest is one of the major units in a production system of TDCF area which has direct as well as indirect significant relationships with other units of the system.

4. Knowledge on REDD+ pilot project implemented in the community forest

The REDD+ pilot project funded by Norad's Climate and Forest Initiatives was implemented in the community forests of three districts Dolakha, Gorkha and Chitwan by a consortium of three organizations, namely; International Center for Integrated Mountain Development (ICIMOD); Asian Network of Sustainable

Agriculture and Bio-resources (ANSAB) and the Federation of Community Forestry Users, Nepal (FECOFUN). REDD+ was initiated in Dolakha district since 2009 (Khatri et al., 2013). Some plots of the pilot projects lie within the TDCF. Hence, the TDCF also received US$1,253 as an initiation fund in 2011 and US$1,243 in 2012 (Khatri et al., 2013; Ringhiem, 2013). Members of the CFUG perceive it as a new approach to get money from forest management, which was locally termed as "*hawako paisa*" (money from the air). Some of the community members, mainly members of the executive committee know that they received money by conserving the forests.

Most of the community members, i.e. almost 76 percent of the respondents, do not know about the REDD+. Only 23.9 percent of the respondents know that their community forest has received money by selling carbon from their forest. In the meantime, they also know that they have to conserve forest to receive payment on a regular basis. Around 73.1 percent respondents were happy after hearing the fact that their community forest has received money from the REDD+ program (Table 4). Almost 75 percent of the respondents wish for the continuation of receiving money from REDD+ and believe that if they receive money from REDD+ it will be helpful for initiating development activities, and also optimistic that it can help poor people in the times of natural calamities and other forest improvement activities.

Table 4 Information about the REDD+ pilot project implementation and respondent's view

Particulars	Yes	No	Total
Informed about the implementation	16 (23.9)	51 (76.1)	67 (100)
Happy to know	49 (73.1)	18 (26.9)	67 (100)
Wish to continue	50 (74.6)	17 (25.4)	67 (100)

Note: Figures in parentheses indicate percentages.
Source: Field Survey, 2012

5. Perception on different aspects of REDD+ implementation

5.1 Perception on change in forest resources

Only around three percent of the respondents believe that there is a high increase in forest density and biodiversity in last two-year period (Figure 3). Almost 55 percent of the respondents believe that there is an increase in forest density, contributing to improvement in biodiversity after the implementation of REDD+. In contrast, about three percent of the respondents do not believe the statements and opine that the forest is degrading (the quality and quantity of forest become lower). The rest, 39 percent of the respondents have not noticed any changes in forest density.

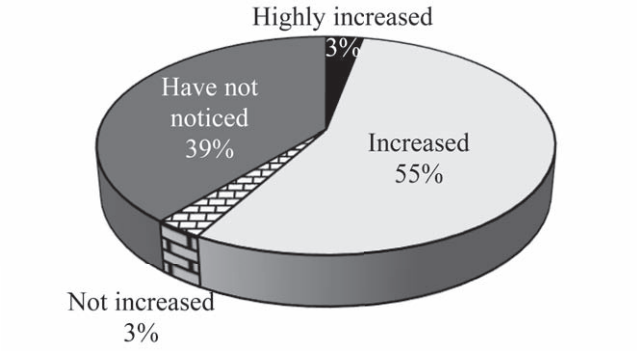

Figure 3 Perception on change in forest density and diversity after REDD+
Source: Field Survey, 2012

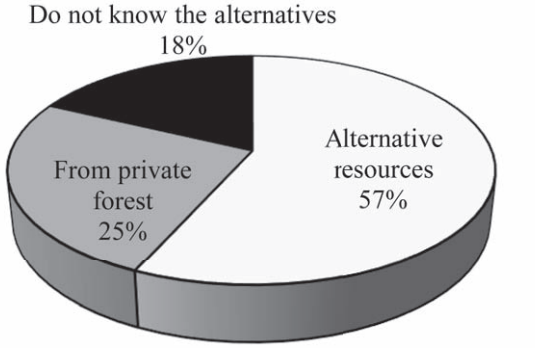

Figure 4 Alternatives for forest products from the CFUGs
Source: Field Survey, 2012

5.2 Prospects of reducing dependency on community forestry

REDD+ might demand reduction in the uses of forest products by adopting other alternative resources so that forest can be conserved and the community receives payment from REDD+ more efficiently. In this regards, 57 percent of the respondents replied that they can fulfill the demand of forest products from other alternative resources such as the use of biogas and efficient use of fuel wood through the use of improved cooking stove (Figure 4). Similarly, 25 percent of the respondents have their own private land where they have cultivated some forest plants (private forest), thus can fulfill the demands of the forest products. However, 18

percent respondents do not know the alternatives of forest products. They need to be trained about alternatives to the forest products and their efficient use. Thus, almost 82 percent of the total respondents are in the position to manage the alternatives of the forest products in the case collection of forest products from the forest is restricted after REDD+ implementation.

6. Opportunity costs of REDD+

The stepwise estimation of the opportunity cost of REDD+ is presented in this section. The section starts with the estimation of gross income from the forest under REDD+ followed by income from the forest conversion into high-value agriculture crop, and mid-value crops respectively. The opportunity costs are then estimated.

6.1 Gross income from the community forest under REDD+

Financial report of TDCF showed NRs250,000 as its average annual income for the last 8 years. The sources of income comprise of the new registration fee, permit to harvest the forest products, annual membership fees, and house rent from some rented-out rooms of its office.

The CFUG has not yet sold its forest products to the outsiders, so the income is from its members only, which is collected as the permit and is quite nominal. At present, community members are using fuel wood, leaf litter, fodder and timber on a regular basis from their community forest area.

According to the Operational Plan of the community forest, the TDCFUG could supply 13,835 *bhari* fuel wood, 28,425 *bhari* of leaf litter (bedding materials), 6,365 *bhari* fodder and 2,726 cubic feet (cft) timber to its members (Table 2). Among these products, only fuel wood and timber is tradeable in the study area, hence have a market value. Focused group discussion, key informant interview as well as questionnaire survey reported the market value of fuel wood and timber to be NRs100 per *bhari* and NRs20-200 per cft respectively. On an average, the price of timber is established to be NRs180 per cft. Thus, the estimated annual income from selling fuel wood and timber at market value would be NRs1.874 million (Table 5).

Besides these forest products the community forest can also generate income from the forest carbon through REDD+. As discussed under methodology section, carbon sequestration rate of 1.82tC/ha/year is considered. Similarly, the price of carbon reported by Banskota et al. (2007) is taken into consideration to estimate the possible income generation from REDD+. The price ranges from NRs1200 to NRs1500/tC, hence, the average price of NRs1,350/tC (US$15/tC) is adopted (US$1 equivalent to NRs90 during the field survey period). Considering the study being conducted in the same region, the price is more realistic. Moreover, this price lies between the global average price of US$13.9/tC and REDD early movers proxy price of US$18/tC (Hamrick and Goldstein, 2015). Thus, under the given carbon sequestration rate and the carbon price, 217.1 ha of the forest under the CFUG will generate the income of NRs0.533 million.

Thus, the total annual gross income from community forest management under REDD+ sums up to NRs2.408

Table 5　Opportunity cost of REDD+ against high- and mid-value agricultural crops

Particulars	Amount (in million)
Gross income under REDD+	NRs2.408 (US$0.027)
Gross income from forest products (217.1 ha)	*NRs1.874 (US$0.021)*
Gross income from REDD+ (217.1 ha)	*NRs0.533 (US$0.006)*
Gross income under high-value crops	NRs8.924 (US$0.099)
Gross income from high-value crops (150.8 ha)	*NRs8.352 (US$0.093)*
Gross income from forest products (66.3 ha)	*NRs0.572 (US$0.006)*
Gross income under mid-value crops	NRs8.245 (US$0.092)
Gross income from mid-value crops (150.8 ha)	*NRs7.673 (US$0.085)*
Gross income from forest products (66.3 ha)	*NRs0.572 (US$0.006)*
Opportunity cost of REDD+ against high-value crops	NRs6.517 (US$0.072)
Opportunity cost of REDD+ against mid-value crops	NRs5.837 (US$0.065)

Source: Field Survey, 2012

million (US$0.027million). This income can be achieved without undermining the access of local to the forest product under existing rule and regulations of the community forest (Table 5).

6.2 Income from the forest conversion into agriculture crops

The main crops of the village are maize, millet, potato and cauliflower. Cauliflower and potatoes are regarded as the high-value crops by the community due to its higher yield. Whereas, maize, millet and rice are mid-value crops. Rice is cultivated in only some irrigated crop land. Besides, some of the villagers are commercial vegetable farmers. Almost all households in the village have livestock except some (3 percent) households who stopped keeping animals due to the lack of manpower as they are busy in other occupations like vegetable farming and casual laboring. Those who are doing vegetable farming have high income. They directly sell vegetables in the local market (Charikot) and Kathmandu, which is 127 km far from TDCF area. Thus, based on the suitability of the land and also the climate as suggested by the community, potato is considered as the high-value crop and maize and millet as the mid-value crops. Potato requires 7-8 months to complete its production cycle, hence other crops cannot be grown in the same plot of land within a cropping year. In contrast, maize and millet can be cultivated as a relay crop and can be grown within a cropping year.

According to the Operational Plan of TDCF, the fertile area for agricultural crop is almost 150.8 ha (2,900 *ropanis*). Rest 66.3 ha land is not suitable for agriculture and can remain as a community forest. This is also verified by the key informants and the participants of the focused group discussion. Hence, 150.8 ha land is considered to have potential for conversion into agricultural land.

Gross income from the community forest after conversion into high-value crops

Potato and cauliflower are the high-value crops. However, the district is famous for potato production due to its land and climate suitability. The soil in TDCF is loose, deep light and well drained, which is suitable for potato production. Hence, potato is taken as a high-value crop for opportunity cost calculation. The normal yield of potato suggested by the key informants, including the key informant from the District Agriculture Development Office of Dolakha is 240kg/*ropani*, which is equivalent to around 4.62ton/ha. This yield is far below the district average of 11.7tons/ha in 2011/12 (MOAD, 2012). The market price of potato was reported to be NRs12 per kg during the field survey.

Hence, in the area of 150.8ha of land with the yield of 4.62tons/ha and price of NRs12 per kg, the income from a high-value crop will be NRs8.352 million.

In addition, income can also be generated from the remaining forest land by selling the forest products. Hence, referring to the potential of forest in supplying forest product (Table 2) and the market price of forest product discussed in section 6.1, NRs0.572 million can be generated from remaining 66.3ha forest land (Table 5).

Thus, the total annual gross income from the forest after conversion into high-value crop will be NRs8.924 million (US$0.099).

Gross income from the community forest after conversion into mid-value crops

Maize cultivation is a way of life for most farmers in the mid-hills of Nepal. It is a traditional crop cultivated as food and fodder on slopping *Bari* land (rain-fed upland) in the hills. It is grown under rain-fed conditions during the summer (April-August) usually relayed with millet. Millet also comes as a main food menu in the mid-hills of Nepal. Millet needs very little water for their production. It does not demand rich soils for their survival and growth. Cultivation of millet is very easy compared to other crops. Millet production is not dependent on the use of chemical fertilizers. Most millet farmers use farmyard manures.

Millet is rich in their nutrition content. Millet is considered to be three to five times nutritionally superior compared to the widely promoted rice and wheat in terms of proteins, minerals and vitamins (Gupta et al., 2014). Thus, maize and millet are the main food in the mid-hills of Nepal, where the production of rice is less.

TDCF area is suitable for maize and millet production. From the economic and production point of view, maize and millet are taken as mid-value crops, which can be cultivated as a relay crop; maize followed by millet. The key informants and group discussion suggested that 100 kg (1.92tons/ha) maize and 50 kg (0.96

ton/ha) millet can be produced from 1 *ropani* land in the locality with the local market value of NRs18 and NRs17 respectively. The suggested yield of maize and millet is less than the district average of 2.5 and 1.3tons/ha respectively (MOAD, 2012). Hence, in the area of 150.8ha of land with the yield of 1.92tons/ha and price of NRs18per kg, the income from maize will be NRs5.212 million. Similarly, in the area of 150.8ha of land with the yield of 0.96tons/ha and price of NRs17 per kg, the income from millet will be NRs2.461 million. This sums up to the income NRs7.673 million from mid-value crops.

In addition, as estimated earlier NRs0.572 million can be generated from remaining 66.3ha forest land.

Thus, the annual total gross income from the forest after conversion into mid-value crops will be NRs8.245 million (US$0.092million) (Table 5).

6.3 Opportunity costs of REDD+ against high-value crop

Opportunity Cost of REDD+ is the difference between the gross or net income from the community forest under REDD+ and the community forest under high-value crop. In this analysis, we considered the gross income. The gross income from the community forest under REDD+ is NRs2.408 million and the gross income from the community forest under high-value crop is NRs8.924 million. Thus, the opportunity cost of REDD+ to high-value crop is NRs6.517 million (Table 5). The community will forgo NRs6.517 million (US$0.072 million) for not converting forest land into agricultural land for high-value crop in order to remain under REDD+. In other word, the opportunity cost of REDD+ against the high-value crop is US$198/tC. This implies that the price of US$198/tC can bring the difference to zero, hence, motivate the community to choose REDD+ instead of converting the agricultural potential areas of the forest into agricultural land for high-value crop.

6.4 Opportunity costs of REDD+ against mid-value crops

In case of mid-value crops the opportunity cost of REDD+ is NRs5.837 million (US$0.065 million) (Table 5). The community forest will loose the amount, if remain under REDD+ instead of going for mid-value crops in the potential areas within the forest. This can be translated into US$179/tC. Hence, setting the carbon price of US$179/tC will be the optimal price for the community forest users to remain under REDD+ instead of converting the agricultural potential areas of the forest into agricultural land for mid-value crops.

7. Co-benefits of REDD+ (Forest) in TDCF

All the secondary benefits which are received from conserving forest under REDD+ are known as co-benefits. Environmental or ecosystem services which include biodiversity and water recharge are the best example of such co-benefits. Other important co-benefits of REDD+ are climate change adaptation, creation of employment, and livelihood (World Bank, 2011). In TDCF area, direct co-benefits such as water and biodiversity were qualitatively analyzed.

7.1 Water co-benefits

TDCF comes under the Charnawati watershed, where there is high potentiality of water resources with a big source of water in the community forest. This has facilitated the connection of tap water for almost 90 percent of the respondents in their own home. The members are aware about the importance of forest in conservation of those water resources. They believe that if the forest converts into the agricultural land, the source of water might decrease gradually consequently leading to the high scarcity of water in the future. Hence, the CFUG has made a provision not to cut trees within 5km of the water source.

Water is also used for the irrigation purpose in the study area. The marginal return to water, or the value of water, varies across time, space and across the water using sectors. Irrigation water has a very high-value at certain times of the year; say it will be very high at certain critical crop growth stages as compared to other periods of crop growth. Value of irrigation water also depends upon the type of crops grown in an area, it will be high in a region growing fruit, and vegetables compared to an area growing fodder and other low value cereal crops. The average selling price of water is found to be NRs95 (US$1.1) per ha within a range of NRs73 – NRs117 (US$0.8-US$1.3) per ha (Bhandari and Pandey, 2006). This finding is consistent with the results of other studies on water markets in Nepal (Khatri-Chhetri, 2004). The average value is NRs110 (US$1.106) for potato and NRs33 (US$0.33) for rice (Aylward et al.,

2010). In TDCF, the present cost of water for irrigation is NRs16,588 for 150.8ha, which is NRs 110/ha/year.

7.2 Biodiversity co-benefits

TDCF is rich with different types of wild flora and fauna. Trees and other flora are important for community to fulfill the demand of housing materials, fodder for livestock, forest-products based income generating activities such as weaving (*doko, dalo, gundri*) etc. If the forest density and diversity will improve then flora and fauna will also increase. Almost 85 percent of the respondents supported the statement and they believe that the conservation of the forest through community forest is helping in enhancing the biodiversity of the forest. The economic value of biodiversity is difficult to calculate and will be varying from place to place. It can be estimated by using the Contingency Valuation Method but is out of scope of this study.

Ⅳ. Conclusion

Considering the importance of the forestry sector in Climate Change mitigation, this sector has received high importance in the international climate regime since COP13 in 2007. Nepal's initiative in this sector has been widely acknowledged by the international community, hence, has been rewarded as a pilot country for REDD+ implementation. However, in the countries like Nepal where most of its population derive their livelihoods from agriculture, and forest being an integral part of agriculture, its potential cost or benefit to the rural community is an important issue. With this backdrop, this paper aims to assess the opportunity cost of the REDD+ to the members of TDCFUG, through the understanding of the forest management practice, and the contribution of the forest. Primary and secondary data were employed for this purpose. Primary data were collected through the household survey among 67 members of TDCF representing each of the well-being ranks of the members, key informant interview, and focused group discussion. Similarly, secondary data were collected from TDCF records as well as a literature review of relevant papers.

In TDCF area, the forest is dominated by the regenerated seedlings with the growing stock of tree volume of 2400 cft/ha, which reflects its future prospects on forest based carbon trading like REDD+. There are more than 35 species in the community forest area. TDCF is a good source of water, and the biodiversity of flora and fauna are high, indicating the community forest to be a good habitat for different types of wild plants and animals.

Almost all the respondents have at least a few number of livestock in their home. Main livestock are cow, ox, buffalo and goats. Those livestock requires fodder and leaf litter, which are collected from the community forest area. Hence, almost entire households are dependent on forest products directly for fulfilling their daily needs. Besides, the households have a remarkable number of trees on their own private land. The private land can fulfill one third demand of timber, half of the demand of fuel wood, more than two third demand of leaf litter, slightly less than half of the demand of fodder and two third the demand of plough. This indicates decreasing dependency on forest through private forest. Similarly, introduction of technology such as biogas and improved cooking stove is also helpful in decreasing dependency on forest through increased efficiency of fuel wood use. This decreasing dependency on the forest can enhance the carbon sequestration capacity of the forest.

Like other area of Nepal, the main occupation of TDCF community is agriculture (almost 89%). Especially, through the economic point of view and to fulfill the demand of food in the area, converting forest land into high or mid-value crop land is another good option because the soil and geographical climate are suitable for potato, maize and millet production. The high opportunity cost of REDD+, the incentive for protecting forest, to some extent also justifies the conversion of forest land into agricultural land either for high-value crop or mid-value crops. The community has to forgo US$0.072 million and US$0.065 million annually for not converting forest land into high- and mid-value crops, respectively.

Forest in TDCF is being managed in a sustainable way contributing to improvement in the quality of the forest. If community forest is converted into the farmland, the community should change their lifestyle, which is actually not easy. For, instance, still around three quarters of respondents are dependent on the community forest for the forest products, which are crucial for their livelihoods. Hence, before converting forest land into an agriculture land, sufficient alternatives

of forest products should be identified. Thus, potential conservation of forest is one good option to go for REDD+ which give economic support to the community while managing the forest and keeping the lifestyle in the same way. However, for REDD+ to be attractive, carbon price need to be increased almost 14 and 12.5 times more than the present rate (US$14.3/tC) (Hamrick and Goldstein, 2015), thus need to set at US$198/tC and US$179/tC to compensate the OC of high and mid-value crops respectively. Considering the fact that carbon being traded in Switzerland and Tokyo region of Japan at the rate of US$155/tC and US$511 respectively, (The Climate Group, 2013) the figures are not unrealistic. But the monetary valuation of the co-benefits generated by the forest conservation due to REDD+ may help in easing out the need for high increase in the carbon price for REDD+ to be competitive enough. In addition, due to the close ties of the community with forest for their livelihood, conservation of forest through REDD+ mechanism will provide them further incentives.

The main limitation of this study is that the stumpage value of trees in the forest is not considered in the study. Considering the nature and consumption of the forest in the TDCF inclusion of such value in the analysis would have shown the different results in terms of opportunity cost of REDD+. Similarly, the concept of gross income is used instead of the net income. Besides, REDD+ is a new concept whose architecture is still being developed. Information dissemination at both the national and local levels is crucial for generating interest in REDD+.

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