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THESIS

ECONOMIC POTENTIAL OF TIMBER PRODUCTION FROM COMMUNITY FOREST UNDER TSIRANG DZONGKHAG IN BHUTAN

GEM TSHERING

A Thesis Submitted in Partial Fulfillment of
the Requirements for the Degree of
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Gem Tshering 2011: Economic Potential of Timber Production from Community Forest under Tsirang Dzongkhag in Bhutan. Master of Science (Tropical Forestry), Major Field: Tropical Forestry, Interdisciplinary Graduate Program. Thesis Advisor: Associate Professor Wuthipol Hoamuangkaew, Ph.D. 123 pages.

The field survey was conducted during spring in 2010 to study timber production and investigate financial return from lumber sale from Yargey Community Forest under Tsirang district in Bhutan. Stratified random sampling for 71 respondents was randomly selected for interviewing with targeted groups like Community Forest Management Group, furniture house/sawmill owners, general timber consumers and contractors. The data was gathered by employing three methods, including semi structured interview, focus group discussion and direct observation.

Demand functions as well as its predictions were carried out. Durbin – Watson statistical test was employed for testing accuracy of demand function for having no problem about serial correlation. The demand for timber was depended on timber price with R^2 at 93.73. The coefficient, timber price of 60.3036 was statistically significant at 0.01 level. The price variable showed that, the relation between price and demand for timber was positive, which mean that when timber price increased the quantity of demand for timber also increased. The price for timber was depended on timber demand with R^2 at 96.70.

Marketing channel for timber product indicated that, 89% was used for domestic consumption and 11% for commercial purpose. Financial analysis revealed that, Nu. 7.17/ft^3 and Nu. 14.45/ft^3 were the profit from 267 ft^3 of timber and 160.20 ft^3 of lumber production, respectively (Nu 44.45 = US $ 1). Profit from sofa set production was the highest with Nu. 3931.30 /set. However, profit from chair was the lowest one with Nu. 443.33 /piece.

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Student's signature Thesis Advisor's signature

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Gem Tshering

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LIST OF ABBREVIATIONS

AAC	=	Annual Allowable Cut
AHL	=	Annual Harvest Limit (term for AAC in CFMP)
CFMP	=	Community Forest Management Plan
Cu. ft	=	Cubic feet
CFMG	=	Community Forest Management Group
CF	=	Community Forest
DBH	=	Diameter at breast height of a tree
DoFPS	=	Department of Forest and Park Services
FAO	=	Food and Agriculture Organization (of the United Nation)
FNCR	=	Forest and Nature Conservation Rules
FUG	=	Forest User Group
NRDCL	=	Natural Resource Development Corporation Limited
GRF	=	Government Reserved Forest
JFM	=	Joint Forest Management
MoAF	=	Ministry of Agriculture and Forests
Masl	=	Meter above Sea Level
mm	=	Millimetre
MA&D	=	Market Analysis and Development
NWFP	=	Non Wood Forest Products
NRDCL	=	Natural Resource Development Corporation Limited
Nu	=	Ngultrum (Bhutanese currency, US $ 1 = Nu. 43)
ORC	=	Out Reach Clinic
PFMP	=	Participatory Forest Management Project
PDR	=	Peoples Democratic Republic
RGoB	=	Royal Government of Bhutan
RNR	=	Renewable Natural Resources
SFD	=	Social Forestry Division
SDC	=	Swiss Agency for Development and Co-operation
Sq. km	=	Square kilometre

LIST OF GLOSSARY

Chewog	=	Sub block
Dzongkhag	=	Administrative District
Dzongda	=	District Administrator
Dangra	=	Mountain (Southern Bhutanese Language)
Drashing	=	Trees large enough for sawing (> 50 cm DBH)
Gewog	=	Block
Khauray	=	Name of a mountain (Southern Bhutanese Language)
DBH	=	Diameter at breast height

ECONOMIC POTENTIAL OF TIMBER PRODUCTION FROM COMMUNITY FOREST UNDER TSIRANG DZONGKHAG IN BHUTAN

INTRODUCTION

The primary aim of this research was to assess the supply of timber from the community forest as well as to assess the demand of timber from the CFMG (Community Forest Management Group) and other stakeholders such as furniture factory owner, saw millers, general timber consumers and contractors. The study aimed to explore whether there was adequate volume of timber in the CF (Community Forest), in order to estimate the timber available for harvest and sale. As reflected in the CF plan, the CFMG's desire for small timber demand from their CF and the huge excess timber stock within CF for income generation motivated this study. Further, the CF area is located near the two urban towns of Damphu and Gelephu, where the timber could be easily consumed. It was also blessed with a fairly good road network from the CF site to the towns.

Some CFMGs had already started selling timber from their CFs including Yargey CF. In this context, there existed limited studies done in the past. But, these studies seriously lacked result on financial analysis, which was a major problem. Without any background knowledge on this aspect, the CFMGs might even sell their timber incurring losses. Thus, this study was felt important, so that the research findings would help to timely intervene the CFMGs and guide them for better timber production and marketing opportunities in the long run. In addition to this, there was undoubtedly great interest at the community level for selling timber, where management plans allow for this. In turn, maximizing benefit to the community at large. In spite of this opportunity, the timber sale was very low. Further, no any financial analysis has been conducted in the other districts where timber has been sold in the past.

The economic study will provide the baseline income data for timber sale from this particular community forest.

The study employed questionnaire survey and focussed group discussion for the study. The overall timber production from CF was computed with the help of volume table, which provided the average volume in standing form. The information on timber demand from the CFMG, furniture factory, saw millers, general timber consumers and contractors was carried out through stratified random sampling using a mixture of qualitative methods including semi-structured questionnaire and focus group discussions.

By the end of December 2009, there were 200 community forest management groups in the country. These consisted of 9763 house holds and covered 25,997 hectares (Ha) of forest. 91 of these 200 CFs had set aside sale provisions for timber sale and 42 had NWFPs (Non-wood forest products) as sale provision. Income generation was one of their main objectives in the community forest management plan (SFD, 2008). The two main underlying principles of the Community Forestry (CF) program were that, the Community Forest Management Groups were able to fulfil their timber requirement and they generate income through sale of excess timber (DoF, 2004). About two-thirds of the 92 Community forest programs were well under way and in most of the districts CFs had been established. Further many CFs were under management plan preparation stage. The recent study showed that the potential for CF was very good. The CF had potential to contribute to poverty reduction through sustainable management of natural resources and rights to use and market the forest resources for the CFMG members, strengthen the group formation process, establish community fund and saving schemes, selling CF products and generate cash income, the CFMG with by-laws enabled the community to better organize themselves for the benefit of community and enterprise development for better CF products development and fetch good market and price in the near future.

OBJECTIVES

1. To investigate the supply and demand of timber from CF.
2. To determine potential timber buyers and timber marketing channel.
3. To determine the financial return of timber and furniture production.

LITRATURE REVIEW

Community forestry was a key component of Bhutan's forest policy and was at present developing very dynamically across the country. In the past, CF had been a trailing and piloting phase and had now become an institutional part of the system for the sustainable management of country's rich and diverse forest resources. The experience gained from CF program as of now, confirms that rural communities were effective forest managers indeed (SFD, 2010).

CF contributes in achieving many development goals such as empowerment of rural communities, sustainable forest management, good governance and poverty reduction. There was a reversal of the forest management paradigm from nationalisation and centralisation to the devolution and decentralisation in forest resource management; entirely through CF. The management of forest was devolved right down to the rural communities in the form of community forest management groups. The rural people who had traditionally and had been involved in the management of forest once again became the custodians of local forest resources and effectively became forest managers with professional foresters taking on technical backstopping and facilitation roles (SFD, 2010). The CFs had been formulated and established in a truly participatory approach involving all the relevant stakeholders and partners. The new local institutions were being formed which could play an important role in local development and improved local governance for future with the help of CFMGs. In addition to this, CF further made bigger contribution for the conservation of at least 60% of the total land area under forest cover in perpetuity, which was requirement by the constitution of the Kingdom of Bhutan.

As reflected in SFD, (2010), the past decade has seen a gradual change of emphasis in the management of country's forest lands. It emerged as a shift from a primary focus on protection and conservation towards a more focus on balancing conservation at the same time with sustainable utilization of forest resources for the development of rural livelihood.

The rate of establishing CF increased greatly during 2007, however the year 2008 only accounted for more than half the total numbers established. CF had proved to be a viable policy option to complement the other key forest management regimes, particularly the commercial management of in forest management units and conservation of forest lands through protected area management. By the end of tenth five year plan (2008 – 2013), Bhutan had targeted to have 400 CFs through out the country. With this present trend, Bhutan could achieve the target by 2013.

In case of Yargey CF, the annual work plan activities for 2009 included removal of matured, dead, dying and diseased trees, plantation, sale of excess timber, NWFPs, fire wood, grazing control and fire line clearance. The main silvicultural activies were pruning, thinning, clearing, identification of seed trees and retaining (Yargey CFMG, 2008). The CF has three blocks with a standing timber volume of 938,084.25 cubic feet in 2009. About seventy trees were found excess within the CF and could be sold annually for income generation. At present, the main timber consumers were contractors, shop keepers and furniture house owners.

Demand

Demand could be defined as the amount of a particular economic good or service that a consumer or group of consumers would want to purchase at a given price. The demand curve was usually downward sloping, since consumers would want to buy more as price decreases. Demand for a good or service was determined by many different factors other than price, like the price of substitute goods and complementary goods (http://www.investorwords.com/1396/demand.html).

The demand theory states that, the quantity of good demanded was a function of its price, the price of substitutes, population and income. The quantity of good supplied was also a function of its price and the price of inputs in the production process (Hoamuangkaew, 1978).

Demand Function and Demand Equation

The demand equation was the mathematical expression of the relationship between the quantity of a good demanded and those factors that affect the willingness and ability of a consumer to buy the good. The demand equation could be expressed as:

$$Q_d = f(P; P_{rg}, Y)$$

Where:

Q_d = Quantity of a good demanded

P = Price of the good

P_{rg} = Price of a related good

Y = Income

Supply

Supply could be defined as the total amount of a product such as good or service available for purchase at any specific price. It was determined by: (a) The price: producers would try to get the highest possible price where as the purchaser would try to pay the lowest possible price both settling at the equilibrium price where supply equals demand. (b) The cost of inputs: lower the price of input, the higher the profit at a price level and more products would be offered at that price. (c) The price of other goods: the lower price of competing goods would reduce the price and the supplier might switch to more profitable products thus reducing the supply (http://www.businessdictionary.com/definition/supply.html).

Supply Function/Equation

The supply function was the mathematical expression of the relationship between supply and those factors that affect the willingness and ability of a supplier to offer goods for sale (http://www.businessdictionary.com/definition/supply.html).

The supply could be expressed as:

$Qs = f(P, P_{rg} S)$

Where:

P = Price of the good

Prg = Price of related goods

S = Number of producers

In accordance to (Hoamuangkaew,1978) the three equations to determine lumber demand, lumber supply and lumber price can be expressed as:

1. Aggregate demand model

$QD_t = f (X_{1t}, X_{2t}, X_{3t}, X_{4t}, X_{5t}, X_{6t}, X_{7t})$

2. Aggregate supply model

$QS_t = f (X_{1t-1}, X_{8t}, X_{9t}, X_{10t})$

3. Aggregate price model

$X_{1t} = f (QS_{t-1}-QD_{t-1}), X_{5t}, X_{9t})$

Where:

QD_t = current domestic consumption of lumber (cu.ft)

QS_t = current production of lumber (cu.ft)

X_{1t} = current average wholesale price of lumber over the year (Nu/cu.ft)

X_{2t} = current average price of steel over the year (Nu/length)

X_{3t} = current average price of cement over the year (Nu/length)

X_{4t} = current average price of plywood over the year (Nu/sheet)

X_{5t} = current percapita disposable income (Nu)

X_{6t} = current population (Thousand)

X_{7t} = current value of total construction (Nu. In million)

X_{1t-1} = past one year average wholesale price of lumber over year (Nu/cu.ft)

X_{8t} = current wage rate of labour (Nu/day)

X_{9t} = current average whole sale price of logs over the year (cu.ft)

X_{10t} = current quantity of every kind of logs for export (cu.ft)

QS_{t-1}-QD_{t-1} =difference between last year's production and consumption of lumber (cu.ft)

Wessels and Walter (2000) mentioned that, the price elasticity of demand was a measure of the sensitivity or responsiveness of the quantity of good or service demanded to changes in its price. The formula for the price elasticity of demand for a good was expressed as:

$$Ed = \frac{P}{Q} \times \frac{dQ}{dP}$$

Where:

P = Price of lumber

Qd = Quantity demand for lumber

Krittanon (1974) studied the supply and demand of lumber market in the Philippines. He tried to determine demand and supply relationship and prepared models for projecting consumption, production and price of lumber using time series data covering the period 1957 – 1972. The study was purely designed for supply and demand projections and policy analysis and consisted of three main equations to determine lumber supply, lumber demand and lumber price as follow:

1. $S_t = a_o + a_1 (S_{t-1} - D_{t-1}) + a_2 (P_{t-1}/X8_{t-1}) + Q_3 X_{12t} + a_4 (X_{13t}/X_{10t}) + a_5 (S_{t-1} - D_{t-2})$
2. $D_t = b_0 + b_1 S_t + b_2 P_t$
3. $P_t = C_o + C_1 (S_{t-1} - D_{t-1}) + C_2 X14_t$

S_t = current production of lumber (million of board feet)

S_{t-1}= past one year production of lumber (million of board feet

D_t = current consumption of lumber (million of board feet)

D_{t-1} = past one year production of lumber (million of board feet)

D_{t-2} = past two years production of lumber (million of board feet)

P_t = current average wholesale price of lumber over the year (US $ per thousand board feet)

P_{t-1} = past one year average wholesale price of lumber over the year (US $ per thousand board feet)

$X8_{t-1}$ = past one year average wholesale price of logs over the year (US $ per thousand board feet)

X_{10t} = current daily capacities of existing mills (ten thousand board feet)

X_{12t} = current quantity of log export (thousand cubic meter)

X_{13t} = current total credits granted by commercial bank (million US $)

$X14_t$ = time trend (1959 = 1; 1960 = 2, etc.)

He also estimated that the elasticises of demand with respect to price of lumber, price of steel and price of cement, which were – 0.74, 0.72 and – 2.07 respectively. The elasticity of supply with respect to price of lumber, capacity of sawmills and log production was found 4.63, 0.64 and 1.243 respectively.

Fight and Youngday (1977), tried to study the effect of changes in price of logs and income on the percentage of expenditure for logs to the total expenditure of log and high income consumers. They concluded that, when the price of consumer goods and services changes the effect on the consumer was equivalent to a change in income, which may be distributed differentially to high and low income consumers. To cite an example, in terms of dollars, an increase in the price of log had the greatest effect on high income consumers, in proportional terms, however, the reduction was equivalent to a large percentage of total expenditure of low income consumers. The similar relation holds with reduction in log prices except that their effects mean an equivalent increase in consumer income.

Analysis of timber supply was a process of examining the effects of current forest management practices and information uncertainties on timber supply (Bogle, n.d). This was the method used to forecast annual timber supply from each blocks of Yargay community forest. The annual timber supply from an area depends on how much land was available for harvesting, the tree species growing on it, its productivity

(Tanz, 2001) and the way the land was managed**.** A good indicator of timber supply was based on the growing stock in the current year minus growing stock for the last year or the current growth rate per unit area. The Selected equation for supply calculations was as below.

Qs = Growth rate per unit area x Annual Cutting area

Where:

Qs = Quantity supply

Maximum Area Ceiling of Community Forest

Wangchuk and Beck (2008) studied about the area size required for each forest types in order to fulfil the CFMGs basic timber requirement and income generation from sale of excess timber. The study indicated that, the area requirement differed among the forest types greatly with usually large areas in case of broad leaf forest types and smaller areas in conifer forest types. The present area ceiling of 2.50 ha per house hold in accordance to RGoB (2006), was a limiting factor for income generation opportunities in the near future. Therefore, there must be a minimum area ceiling enhancing CFMGs to sell excess timber after meeting their domestic requirements and not rely any more to GRF and also to have a maximum area limit based on certain income possibility criteria.

They recommended that the ceiling be removed and the area of CFs be based on local specific conditions and concerning willingness and ability of communities to manage their forests in their vicinity.

Wangdi (2009) provided evidence in support to the arguments of Wangchuk and Beck that, the ceiling of 2.50 ha per house hold limits the ability of CFMGs to manage their forests for income generation. In addition to this, he also noted that, some CFMGs harvested less than what was allowed by annual harvesting limit, especially in that CFs which had abundant timber stock. In such cases where there

was excess timber after meeting local requirements could be sold to generate easy cash flow to benefit CFMGs.

Further more, the establishment of CF must be encouraged where the forest could meet the basic timber requirements of the communities and also meet their income generation opportunities. This will directly motivate and instigate the CFMGs for better management of their CFs in the long run, since there was ample opportunity to meet both their income generation as well as timber needs for local use could be easily fulfilled.

The participants of the National CF Workshop held in April 2009 and the National CF Strategy (Gilmour, 2009) recommended removing the cap on the area of CF per household for CF allocation, and using possible, traditional and natural boundaries for the CF. The Strategy suggested determining the CF areas by a set of criteria including customary rights and practices, availability and productivity of forests, and the willingness and ability of the CFMG to manage its forests

This liberalisation of rules would allow the allocation of larger forest areas to encourage CFMGs to manage their CFs for commercial as well as subsistence goods. The inclusion of substantial areas of productive forests in CF was a precondition for the generation of income by the communities. These changes would also lead to clearer boundaries of the CF area enhancing the easier monitoring of CF activities by forestry staff and reducing the risks of conflicts over unclear boundaries (SFD, 2010).

Timber sale from Community Forest

Dorji and Phuntsho (2007) tried to study on timber sale from Community forest from Mongar and Bumthang in Bhutan. The study revealed that, there were several choices of options for timber sale like auction and direct sale, which were possible and would benefit the CFMGs at large. Further more, as per the present

timber market demand and price, the CFMGs had a good opportunity to earn cash income from the sale of surplus timber enhancing the livelihood of the community.

Bhutan

Bhutan had a total land area of 38,816 sq. km and a population of about 691,141 (http://en.wikipedia.org/wiki/Bhutan). About 72.50 percent of the land area was under forests. Forestry was an immense potential source of national income and employment generation and plays an important role in the protection of environment in the Himalayan kingdom. A large percentage of population in Bhutan depends upon forest for timber, food, fodder, medicine and wood energy.

Until recently, due to the abundance of forests, scarcity of timber and wood energy had not been felt in the country. But the consciousness about the future additional demand for timber due to population growth and development of wood based industries, and its possible effect on existing forest was already causing of timely action to over come possible future problems. The areas where Bhutan was keen to share experiences with other countries of south Asia sub region include community forestry.

Economic Potential

The economic potential comprises the amount of timber of the technical potential which, could be sustainably produced from the economic point of view, taking into account the prevailing economic condition and future development.

Environmental Benefit

Temphel *et al.* (2005) stated that, many foresters had reported an increase in vegetation cover in the CF area after the introduction of CF. CFMG members also report that there had been improvements in forest conditions since they gained the rights to regulate harvesting of forest resources and grazing in CF areas. Buffum *et al*.

(2005) added that, Community Forest Management Groups were harvesting timber conservatively and at levels below the prescriptions in the CF management plan, which means that the CFMGs were very careful in harvesting forest products from their community forests. I agree to this since it was observed in several CFs. In addition, controlling the harvesting of forest produces, communities work in their CF for the development of the CF conditions. To cite an example, Dozam, Yakpugang and Masangdaza community forests had invested 7,524 man days in silvicultural practices after handing over their CFs in 2000. The silvicultural practices included fire line clearance, seedling raising and planting cane in the CFs (Wangdi and Tshering, 2006). When labour was calculated in monetary value, it represents about US$ 16,720, which was a direct investment in the CFs.

Wangdi and Tshering (2006) stated that, the forests which were located near the vicinity of villages and those which were not handed over as CF were over degraded. Therefore, when covering forest areas under the CF Program, the condition of the forest resources would gradually improve. The CF Program, when implemented, could improve the forest resources in Bhutan. In addition to plantation activity and other related silvicultural practices, the CF Program also makes the community more responsible for environmental conservation in and around their villages.

As stated by Temphel *et al.* (2005) that, Dozam community forest which was handed over to the community in 1997 as the first community forest in the country had frequent forest fire incidents before the ownership of the area was provided to the beneficiaries. There was no major fire occurrence after transferring the ownership to the local community. Several CFMGs had developed effective mitigation measures for the prevention of forest fire through construction of fire lines in the fire prone areas in and around their CF boundary. I would agree to this, it was true for this kind of activity was seen within the CF in Tsirang Dzongkhag too. In fact, I would mention here that, the number of fire incidences had reduced but had not stopped yet. However, this would directly help the growth of the plant communities without fire affect for the benefit of the local people.

If the community had excess forest resources than they need for their own consumption, they had the right to sell the surplus; by paying minimal royalty to the Government as per the FNCR (Forest and Nature Conservation Rule). Until now, only a very few community forests such as Shambayung and Masangdaza had the potential to sell their excess timber. Through better silvicultural management, the potential of selling timber from community forests would increase and generate high monetary benefit to the people who participate in the CF Program.

As observed in the field, the Communities do harvest timber from their community forests, in a very conservative manner. Thus, as capacity increases and the quality of the resources improve, there was a greater potential for direct economic benefits from community forests by optimizing the harvesting of timber. The danger from over harvesting was limited, as the management plans are based on sustainable forest management principles and the activities are closely monitored by the Department of Forest.

Experiences and field studies from the CF in Nepal showed evidence reflecting that, the degraded forests areas had regenerated and the conditions of forest had improved drastically with the introduction of CF in Nepal. A study in four eastern hill districts revealed that, the total number of stems per hectare increased by 51 percent, and basal areas of forests increased by 29 percent (Gilmour *et al.,* 2005).

CFMG Fund Development

Another main income generating activity was through establishment of community funds. These funds begun by saving the income, the proceeds from fines, commercial sales, royalties and donations contribute to these funds. Until 2008, a total of US$ 12,150 had been collected by CFMGs from the establishment of CF program in the country. At present, many CFMGs used their funds for small credit and loan services to their members, and to pay operational costs to manage the community forest. Available sources indicated, the limited investments incurred by the

communities particularly for forest activities, motivation must be developed amongst the communities in order to willingly invest in development and management of their community forests.

Microfinance helped rural households to plan and manage consumption and investments, cope with risks, and improve their living conditions. Saving schemes such as the community funds were normally the major source of such finance before other microfinance schemes were explored and implemented (FAO 2005).

Temphel and Beukeboom (2005) stated that, due to sale of timber and NTFPs and the commencement of CFMG funds, the CF Program had the potential to improve rural livelihood because this Program had potential to reach the entire population of 69 %. Nevertheless, it could directly make a considerable contribution toward income generation.

Phuntsho and Sangay (2006) found that, the needs for construction timber in the five studied CFMGs, often could not met their timber requirement with the available resources within their CFs. While administering interview (53.1%) of the interviewees responded that, their community forests can meet the needs of the community, and for the rest (46.9%) CF could not meet their needs. The irony was that, it was a common phenomenon amongst most of the CFs, which were established in the country. However, timber consumption greatly differed from one CF to another. At present, the requirement for timber for many CFMGs needs to be either fully supplied or partially supplemented by the Government Reserved Forests (GRF). Another key factor was also due to the lack of preferred wood species in CFs, was an additional reason for not being able to meet timber requirement of CFMGs.

Community Forest Management Group Fund Utilization

The JFM model in Laos, raised their community fund by timber logging within CF and the expenditure incurred were as follows:

- Expenditure for other developmental activities
- Expenditure for forestry operations
- Amount distribution to the families
- Expenditures for administration

The maximum expenditure was kept for other developmental work which, directly benefited the communities, for example, tube wells for water supply and construction of road in the village, followed by expenditure for forestry development activity. One important thing noticed was that, a substantial amount was directly disbursed within the family members to meet their daily basic necessities. It was observed that, the lowest expenditure was left for the purpose of administration (Manivong, 1997)

In Yargey CF also, it was the right time to discuss and plan on wise and judicious expenditures management to be made once the money starts flowing from the timber sale. Some of the mechanisms developed by Laos Peoples Democratic Republic for various expenditures could be adopted in Bhutan. However, it might depend upon the situation and the community's needs and priorities. While managing CF fund, money would be needed by the CFMG to pay for the activities planned according to the CF Management Plan and the annual work plan (DoF, 2004).

Economic Impacts

With regards to the economic, CF addressed first and foremost the needs and priorities of the local communities in particular. In general, the economic impacts of community forests which were studied across the kingdom were generally positive, but differs a lot (Wangdi and Tshering, 2006). Until now, the CFMGs had not derived the maximum economic benefit from their community forests, in spite of sound management planning and practices. To cite an example, the timber operation in Yakpugang and Masangdaza community forests was well below the annual harvesting limits. On the other hand, timber had been not harvested from Dozam community forest, due to the inadequate capacity to supply wood (Masangdaza CFMG, 2002).

The natural resources were considered as one of the most important assets that contribute to economic growth (Rostow, 1960). However, this doesn't happen. The critical example was that, the community living close to the rich community forest failed to transform that, richness into their own economic well being as seen in Yargey CF. the CFMG had been able harvest timber way below compared to the annual allowable cut in their CF management plan.

The past experiences of community forestry program in India, Nepal and Philippine reflected, community forestry being able to deliver significant environmental, social and economic benefits. These benefit sharing mechanisms delivered enough extra incentives to incur expenses on forest management. Further more, the cost and benefits from community forestry must be shared equally. However, in Nepal, China and India, it was astonishing to learn by Scheyvens *et al*. (2007) that, the poorest user groups were most of the time burdened by contributing labour force for community projects and were finally benefited the least.

Social Impacts

Wangdi and Tshering (2006) noticed that, with the establishment of community forests, there was positive impact on community livelihoods. This was mainly because of the sense of ownership and empowerment, community participation, decreased conflict among members and the establishment of local institutions. There were better opportunities for CFMG members to intermingle together and interact on any issues regarding their community forest. On top of this, they had freedom of speech in the village meetings and block meetings to raise their voice and express their thoughts for the benefit of community.

Community forestry in Bhutan respected the social morality. With a respect to the human values of individual member of the community, people were more encouraged to live together in harmony along with the nature. On the other hand, the scenario was very different in urban industrialization where, people get separated

from their families or communities, while community forest tends to keep people at home and in the community (Wasi, 1997).

Opportunity for Community Forest Development

It was usually in an old growth forest, like in Yargey CF, which had a considerable potential for commercial exploitation. In such a situation, the potentials for both rural livelihood development as well as forest conservation were the highest priorities set aside by the communities. This delivered an opportunity on government side to intervene. In Lao PDR, the department of forestry, in collaboration with international projects, was fully supporting the community's efforts in the sustainable harvesting, processing and marketing of timber from community forest (Veer *et al*., 1997).

Legal Provision of Timber Sales from Community Forest

The enabling legal framework encouraged the participation of rural communities in forest management (Phuntsho and Sangye 2006). In accordance with Chapter 27 section 34 (4b) of the Forest and Nature Conservation Rules of Bhutan 2006, it clearly stated that "when the amount of forest produce harvested from the CF in accordance with the Management Plan exceeds the requirement of the members of the CFMG, they can sell or authorize its member to sell the excess produce to persons, agencies in the market." While, the Department of forest shall impose, a sale tax as per the prevailing government rules and regulation (RGoB, 2006).

Timber Demand Fluctuation within CFMG

One of the reasons for not able to sell timber from some CFs was attributed towards the fluctuation of timber demand from CFMGs. A study indicated a total of 52 interviewed CFMG members of Shambayung CF and Masangdaza CFs, 40.40 percent expressed their opinion that they preferred not to sell the entire timber (Shacha and Sonam, 2007) which they were allowed as per the CF management plan.

This was mainly because the demand of CFMG members fluctuates annually because of increasing population in the communities that resulted into household fragmentation. Other reason was because of unforeseen risks like the power transmission corridor line inside Masangdaza CF which may have the possibility of same experience in other CFs in the near future. 15 percent of the respondents were neutral or undecided, while the rest 44.60 percent of respondents preferred to sell the entire timber quantity as allowed by their CFMP (CF Management plan). This was mainly because of the abundance of good stocked forests and importantly, CFMGs had some silvicultural practices in the CF like plantations, tending operations including clearing, thinning and pruning which would ensure a sustainable timber supply.

It could be agreed, with regards to timber demand fluctuations within CFMG members and unforeseen risks could have possible adverse impacts on sustainable timber production from CFs in the long run. However, the AAC/AHL (Annual Allowable cut/Annual Harvesting Limit) was based on sustainable harvesting principles. For the unforeseen events such as pest/diseases and forest fires occurrence a new resource assessment should be conducted immediately after the assessment of the damage by the incident to determine a new AAC/AHL for the sustainable harvest of the timber.

Accessible with Motorable Road

The availability of a road connection to the CF area was an additional potential opportunity for the Yargey CFMG. The road had been constructed since a long time back and needs maintenance before transporting the timber from the CF site. However, it does not extend to the entire area of the CF but covered a major part of the CF site. This would facilitate the sale of timber. In case of a major road block in summer, the CFMG could still sale their timber. The simple alternative to this could include, converting timber into appropriate sizes that, could be manually transported to the road heads for further disposal to the destination.

Market Opportunities

A new township development in Tsirang Dzongkhag, was under process and had a high demand for timber. Moreover, new satellite towns were booming up within the district which would have rocketing demand for timber and open new opportunities for Yargey CFMG to sell their timber. Further more, there was neighboring Sarpang Dzongkhag which lied at 45 km away from the Yargey CF. This Dzongkhag had many sawmills and furniture houses where the timber could be consumed as well. These towns would consume huge quantity of timber for house construction as they were purely based on Bhutanese traditional design where large quantity of timber was required.

The government was involved in the forest products market and maintains a differential pricing policy for forest products in urban and rural areas, which often provides an incentive to divert some of the subsidized that was high value but low priced forest products from rural into urban areas, indicating the difficulty of enforcing forest regulations.

Timber Price

In the demand theory, higher the price of a commodity, lower the demand and vice versa. Where as the case in Bhutan was a twist. When the demand was high subsequently the price was also high, and the timber price in Bhutan had hiked up considerably over the last few years. However, for Shambayung and Masangdaza CFs, the average increase in price for the last five years was about 26 percent for log form and 10 percent for sawn timber in Mongar Dzongkhag inline with NRDCL (Natural Resource Development Corporation Limited) data base. In case of Bumthang Dzongkhag, the average increase of timber price was 25 percent and 27 percent (Shacha and Sonam, 2007) for logs and sawn timbers respectively. The trend of average timber prices from the neighbouring NRDCL and saw mills for the last five years would be explored to assess the prevailing timber price for the broad leaf

species in the region to calculate timber price per Cu. ft. This could serve as a comparison between different timber prices in the market under various Dzongkhags.

Options for Timber Sale

The procedures for timber sales from CF were not at all reflected in FNCR, 2006 of Bhutan. So, CFMGs could pursue any sale options as per their convenience. The experiences from other CFs showed that, CFMGs were not certain on which sale option was appropriate for them since the timber sale from CF had not begun. Thus, it was crucial for them to know which options would suit them best with maximum profit. For this, according to the recent studies the results revealed that, 65 percent of the CFMGs preferred to sell through auction together with the timber auction of the NRDCL. The rest 35 percent preferred direct sale to local contractors and saw millers. The main purpose for desiring auction sale was because CFMG members could easily combine their timber with NRDCL auction sale lots and can avoid and save time in looking for customers. On the other hand, some preferred direct sale because the CFMGs were not at all experienced in conducting auction and further, it involved considerable organization and expenses right from advertising the sale through to the release of the timber (Shacha and Sonam, 2007). Eventually, this would fetch higher price than direct sale and would be worth making a try. The required assistance could be sought out in collaboration with NRDCL.

Foresters preferred 50:50 against auction and direct sale. Their reasons were, for auction sale with NRDCL there would be more transparency and accountability in the process. While some opted direct sale due to lengthy procedures and time consuming. Study by Shacha and Sonam (2007) concluded that, because of direct sale, the CFMGs could sell their timber within a short period of time.

The researchers supported the opinions of CFMGs members and foresters who preferred auction sale, in combination with NRDCL auction lots, considering better transparency and accountability aspects. Importantly, auction sales usually fetched higher prices for many timber consumers participate in the auction. They suggested

that, NRDCL conducted an auction every month in which CFMGs could participate. Also as per the policy of the Department of Forests, the NRDCL shall, as far as possible, auction small timber lots so that small scale enterprises could afford to buy the timbers (RGoB, 2006). This policy ensures that CFs could combine their timber of any quantity for sale through the NRDCL auction (Shacha and Sonam, 2007).

In Yargey CF also, timber could be sold through auction in order to compare and determine profit from direct sawn timber sale and auction sale as CFMG had tried direct sawn timber sale till now. Where the timber depot was far from CF area, the combining of timber from CFs with the auction may not be economically feasible. In such case a direct sale was recommended.

Sale of Standing Timber

The sale value of standing timber was known as its stumpage value. For a given species, volume, and quantity of timber, stumpage prices were highest when trees were easily logged and located near markets. If a forest owner participates in harvesting, his income from the enterprise was increased in accordance with the value added by cutting, loading and hauling on to wood dealers or directly to mills. To determine which trees to sell and when to sell them, the CFMG or the forest extension officer must be intimately acquainted with the local markets and prevailing prices, and they should learn to anticipate seasonal or periodic fluctuations in demand for various types of stumpage. Only by becoming thoroughly familiar with specifications for various wood products could the CFMG expect to realize consistently high returns from timber sale (Avery and Burkhart, 1994).

Timber Sale Contracts

For most sales of standing timber, even for small tracts of low value species, it was desirable to draw up a simple written agreement to protect both buyer and seller and to avoid unnecessary misunderstanding in the transaction. A timber sale contract contained sections on location and description of timber, Prices and terms of payment,

utilization standards and related conditions of timber removal, and procedures for settling disputes (Avery and Burkhart, 1994). At this juncture, this small and important procedure was lacked in most of the CFs areas. It must be initiated and adopted to avoid unforeseen conflicts in future.

Impact of Mills in Gelephu

Until 2009, there were four saw mills in the region, three in Gelephu Town, which were open and one in Damphu town which was shut down most of the time due to unavailability of raw material like timber. The Sawmill owners and one furniture house in Gelephu town remained open inspite of obtaining timber from long distance at the NRDCL depot in Shemgang. These firms were reasonably expected to be interested in timber sales and log purchases from the community forest.

The saw mills and their approximate log processing capacities, location and mill types were crucial information for the approximate log consumption on annual basis (Paul F. Ehinger and Associates 2001)**.** It was assumed that, the total log consumption of these mills in the study areas appeared to be not adequate supplies without expensive haulage from Shemgang and other depot in Bhutan.

Options for the Future

For any type of consumers, there was potential of log availability in Community Forest. There would be buyers for the timber. Timber purchasers from Gelephu would be interested in timber offerings from this particular community forest under two conditions. Firstly, the cost of the timber would be affordable due to lower transportation cost. Secondly, there would be no institutional barriers that would reduce the number of potential markets for timber.

Income Generation from Community Forest

The sources of income for the CFMG were mainly obtained from timber royalties, penalty, entry fee, timber sale and contributions. The major part of the income could come from timber sale followed by royalties. The least income would be collected from contribution. “A rapid appraisal of forest product utilization, income and patterns of expenditure of 1,788 Forest user groups by Gilmour and et al. (2005) from Terai districts in Nepal was carried in 2002.” The result indicated that the total annual cash income from sale of timber from CF was 747 million rupees which was more than US $ 10 million. Out of this 100% benefit went to the FUG (Forest user groups). In the long run, there was also seen a similar phenomenon with regards to income generation from CFs across the country in Bhutan.

Income Prediction

The experiences from Masang-daza and Shambayung CFs indicated income generation opportunity to meet the cost of their CF development and other activities in 2007. Masang-daza CFMG could sell their timber worth 1,271 Cu. ft in log form or 826 Cu. ft of sawn timber on the transmission line, generating a net income of Nu.211,043 (US$ 5,276: 1US$=Nu. 40) . while, Shambayung CFMG could also sell ten drashings of approximate volume of 784 Cu. ft in log form or 510 Cu.ft of sawn timber as per their management plan, and earned a net income of Nu.156,315 (US$ 3,908). The existing sawn timber market prices of the two respective Dzongkhags of Mongar and Bumthang were based for the current price to calculate the income prediction (Shacha and Sonam, 2007). The income predictions for the entire management plan period were calculated to understand the overview of income generation for the two CFMGs at the end of their management plan implementation. The total income for the entire management plan period was calculated as per the prevailing price during 2007, since the timber price fluctuated and was difficult to predict.

The Shambayung CFMG could generate a net income of Nu. 1,094,205 (Nu. 156,315 x 7 years) at the end of their CFMP. This was equivalent to Nu. 47,574 per CFMG member (Sambayung CFMG, 2003). However, the net amount was expected to be higher as the price of timber was expected to increase over the years. Considering the demand uncertainties of the CFMGs and some unforeseen risks, even if Shambayung CFMG sells at least half of the quantity of timber, they could earn a good amount and raise their community fund (Shacha and Sonam, 2007). In a similar manner, the Yargey CFMG could generate a sum of Nu. 54,982.39 as net income i.e. (Nu. 54,982.39 x 10 years), provided that their timber selling trend remains at a very conservative manner as of now. However, if there was rise in the timber sale then there was definitely going to be a drastic increase in the income for future.

As the amount predicted for the CFMG is huge and the CFMP does not address this, the study suggested that, a clear economic analysis needs to be conducted and specified in the future CFMP, particularly for income utilization and benefit sharing aspects. Wangchuk and Beck (2008), assumed that an ideal CF area consisted of minimum area to meet the basic timber products and an additional area for income generation by sale of timber. Their study revealed that, to generate an annual income of Nu. 10,000, Nu. 25,000 and Nu. 50,000, an area of 2.7 ha, 6.8 ha and 13.6 ha were required for the CF located in the cool broadleaf forest like Yargey CF. At present only not more than 2.5 ha was the flat ceiling kept in the rule.

Future Trends

The CF Program initially focused on the timber resources in community forest areas and preparation of management plans. A community forestry manual was produced to improve the quality of the management plans, including the maps and annual harvesting limits. Recent attention was diverted to the potential value of timber from community forests. At the same time, the importance of building the capacity of CFMGs in record keeping, reporting, and silvicultural and managerial skills had been identified as pressing priorities. Better use of timber would provide additional economic benefits to communities, especially if the business skills and product

development capacity of the communities could be improved (Temphel and Beukeboom, 2006).

Silvicultural activities were improving forest conditions, degraded or barren land was being planted with a variety of species, and headwaters were being protected. In addition to conserving and improving forest conditions and livelihoods of rural communities, the CF Program was supporting Bhutan's commitment to the MDGs. The DoFPS should be more flexible in implementing the CF Program, enacting rules that allow communities to benefit economically by streamlining the sale of timber and NTFPs. Community forestry already contributed to the livelihoods of Bhutan's rural communities through sales of timber and NTFPs, in a small way but could contribute substantially more in the future.

The DoFPS could look at options for CFMGs to supply greater amounts of timber to the domestic market by initiating pilots where CFMGs could sell timber without first having to supply their own demands, based on the justification that the communities could increase their overall net income.

By potentially reaching 69% of the total population, the CF Program had an opportunity to contribute to local economies through saving schemes, the sale of forest products, and the establishment of small businesses, while also contributing socially through improved decentralization and democratization. An added benefit of the CF Program was improved environmental conservation and the sustainable use of forest resources. These benefits could be further stimulated through up-scaling and refining the policies on community forestry development and building the capacity of the existing CFMGs in various fields.

In most of the CFs, meeting the wood requirements of CFMGs from the allocated community forests was a challenge. The capacity of existing community forests to meet the construction timber demands of the CFMGs differs from one area to another due to different forest types and conditions. Timber deficits from the community forests were currently being met from the Government Reserved Forest.

Community forestry had a positive impact on the social, economic, and environmental aspects of rural life. Community members had strengthened social relationships as they worked together to improve forest cover and maintain catchments by planting valuable tree species and protecting them. At this stage, benefit sharing among the CFMG members was minimal due to the fact that CFMG members had harvested only small quantity of timber from their community forests, most of which had been used to meet domestic needs. However, CFMG members were positively inclined towards future community forest management because of the clear social and environmental benefits and the potential for increased cash income in the years to come through sale of excess products outside the community.

To expand and increase the benefits of community forestry for the purpose of rural livelihood development and poverty alleviation, extension services should be strengthened so that communities and government agents were more aware of the potential of community forestry in rural areas. Further, the Government should provide increased support to rural communities to promote participation in the CF Program, as it had a direct positive impact on rural livelihoods.

The Community forestry had benefited many people. To cite an example, Masangdaza community forestry in Mongar, had helped the community earn more than Nu 0.6 million by selling timber and forest products. A harvesting limit had also been fixed to ensure that, there is no over exploitation of timber. There was emphasis on good technical support and had to monitor the CFMG on the management practices of their community forest. If they were not given proper guidance and support, there was already a feeling that, people may over harvest because of limited forestry knowledge.

Networking System

There must be conducive atmosphere for networking in the areas of CF economy development. In particular, there must also be free exchange of information on community forestry related issues within the region. One example could be the

marketing information on timber sale, which could facilitate effective business mechanism at the community level (Williams, 1997) which would ultimately benefit the whole CFMGs.

Application of Silvicultural System

The long term management goal for the CF could be selection cutting and replanting, which is a sustainable yield management practice. It gradually and systematically replaces the natural forests with organized, managed plantations of commercial timber species. For this, the fast growing species could be selected. The planting of fast growing young trees would increase the projected timber yield and increases the immediate annual allowable cut (AAC) for the harvest in the forth coming years.

Taking an Economic View

Forest management economics had to deal with much more than a short term cash flow perspective, no matter where it was applied and no matter who was the owner or the manager. The economic assessment of management must integrate all the functions of the forest, and it was the inclusion of all the various functions that makes forest management economically sustainable. The main question then becomes how to make sure that the beneficiaries share the costs equitably (FAO, 1993).

FAO (1993) argued that, the strength of economics, whether conventional or based on ideas of sustainability, was that it provides a method for examining the range of cost and benefits associated with the choices open to society. Cost and benefits may be distributed in space or time, and may be seen differently by those with different perspectives like Government, private owner, logger, local communities and environmentalists. Benefits may be obtained as marketable goods or as public service, or even as other human values. Economic analysis permits an objective comparison of the overall costs and benefits of various options from various viewpoints.

Raw Material for Wood-based Industries

The wood-based industries in Bhutan were very important because they were second largest revenue earner for the government after hydropower (Wangchuk, 1998). However, much of the industry was at an early stage of development and often used old technology. Most industrial units were small and utilizing local sources of supply. The total annual intake of the wood based industry was in the range of 100,000 to 200,000 cubic meters.

There was no accurate information about the state of operation of the mills. The raw material such as wood prices in many cases was fixed by government to sustain and develop the industry. For example, the broom handle industry got wood at subsidized prices to earn foreign exchange while the building industry was provided sawn wood at subsidized prices to discourage the use of round wood.

About 49 sawmill concentrated in the western and southwestern parts of Bhutan produce about 75 to 80 percent of the total sawn wood. A typical Bhutanese sawmill had an input capacity of 10 to 20 m^3 per day or about 4,000 to 5,500 m^3 per annum. The rated capacity, with a recovery rate of 50-55 percent, would be about 1,750 to 2,500 m^3 per annum, but the capacity utilization rate was often as low as 25 to 30 percent (MPFD, 1991). About eight sawmills produced tea chest battens or other kinds of crates or boxboards. The tea chest battens were usually sold through a middleman who provided the needed materials, such as plywood from others sources.

Production, Commercial and Exploitation Forestry

According to Vyas (2000), the principle objective of Production, commercial and exploitation forestry was to supply goods and services to people to meet their basic needs for food, firewood, fodder, fertilizer, fibre, timber and medicine. To meet the demand for industries for timber of all types, plywood, matchwood, fibreboard, paper and pulp. The objective could be achieved by research and development input for higher productivity. The important part of management strategy was thus to

increase the productivity annually per unit area. In USA, the productivity of Douglas fir was enhanced 70 to 300 times. This was mainly done by control of weeds, insects, pest and diseases, genetic improvement, optimizing silvicultural and nutritional requirements and judicious use of tissue culture techniques.

Community Forest Stands Improvement

More attention had to be given for harvesting practices to assure better regeneration within the CF. Annual tree planting had to be increased drastically from 4 acres in 2009 to 8 acres today. The removal of cull trees and other stand improvement practices had to be done in all the blocks annually. Thinning of young stands of various species (Josephson and Hair, 1973) especially in Sanumalingay and Battarai blocks needs to be initiated. Thinning could be applied in only small portions of the community forest which could offer better opportunities for better yield in future.

Development of Enterprises

The communities of Upper Beteni village were never involved in producing and selling logs and timber, they lacked the necessary organizational, technical skills and knowledge in marketing. This lead to a massive loss of profit for the urban contractors who had better skill and knowledge played against them during price negotiations since they were hired for the work including operating chainsaws and lucas mill. So it was felt very important to build their capacity on market analysis and development process to establish logs/timber interest groups to gain marketing knowledge (Thoma and Camara, 2005) and understand the production and value chain of their products. Furthermore, they would realize and better understand their chances of establishing firm marketing structures in order to by pass middlemen would be much higher if they join forces to promote the formation of associations amongst forest committees to strengthen their capacity and their negotiation power.

The case study from Gambia clearly resulted in the spontaneous creation of a dynamic association which sustainability appears to be guaranteed by visible and significant returns generated by the association. Under their association the enterprises had set fixed prices, hired chainsaws and operated them, organized transportation, negotiated with sawmills operators and urban firewood sellers, and shared out the work within the communities. These arrangements achieved doubled the enterprises' profits from 33 to 63% of the total value, created jobs in the communities and empowered them and had more control and responsibilities. The association intended to purchase chainsaws so that the profit margin can further rise and had applied for support to establish a central tree nursery under the FAO's 'Telefood' program. One of the strategies of the association was to produce seedlings of fast growing fuel wood species and to sell them at local markets (Thoma and Camara, 2005). Same case could be applied by CFMG of Yargey CF to get a better profit and create job opportunity.

Most of the enterprise development goals defined by the enterprises, referred to sustainable resource management and improved livelihoods through additional income. Among others, some enterprises aimed at environmental and biodiversity protection, employment generation, keeping prices for wood at an affordable level, and address gender issues. It was interesting to note that, as of now, there were no reports that the enterprises established (Thoma and Camara, 2005) through the market analysis and development approach overexploited their resource base. In contrary, many enterprises had realized that, their resource base was fairly small for increasing the future production. Consequently, they had applied via respective committee to extend the community forest area. Such requests were not observed before and therefore could be directly linked to the impact of market analysis and development approach.

Introducing Market Analysis and Development Methodology

Experience in participatory forest management in the Gambia had shown that once local communities had recognized the value of trees and forests, they would

develop a vested interest in their protection as permanent sources of income and livelihood. Already some years ago, CF development in the Gambia had reached a stage at which forest utilization and forest products marketing became more and more important, not only for the benefits of the communities and their engagement in resource protection but also for the sustainability of the approach itself.

The Market Analysis and Development (MA&D) methodology developed by the Food and Agriculture Organization of the United Nations (FAO) provided a framework for planning tree (Thoma and Camara, 2005) and forest product enterprises. The underlying philosophy of the approach was that, a diverse and secure natural resource base was essential to meet the needs of present and future generations. Many natural resources were at risk because of the current livelihood needs of communities. The demand for income to meet pressing financial needs often resulted in over-exploitation of the resources base. The result was degradation of the resources and continued poverty of the harvester. Therefore, utilization of forest products must not be only financially viable, but also environmentally, socially and technically sustainable.

Thoma and Camara (2005) stated that, MA&D was a step by step approach, which provided community members with the ability to identify and develop viable and successful tree and forest product enterprises and to manage them independently. Its strength was the systematic inclusion of four important aspects of sustainability like environment, market, social/institutional and technology in supporting the development of viable and successful tree and forest product enterprises. It enabled communities to directly link forest management and conservation activities to income generating opportunities. Other major strengths included emphasis on institutional development ensuring that, user groups or community enterprises would be independent and sustainable after facilitators leave.

Due to its positive evaluation, the FAO continued supporting the introduction of the MA&D approach in two other divisions through 18 months technical cooperation project which ended in November 2004. To date, 22 community forest

committees spread among 26 villages in 3 divisions were actively employing the MA&D methodology and had developed 72 community based enterprises (Thoma and Camara, 2005). As indicated by the study, the CFMG of Yargey CF in Tsirang could make good profit by establishing furniture house enterprise. A financial analysis on various furniture products had been analyzed for this. They could obtain a good source of income from furniture sale as well as get employed in furniture venture in future.

Economics of the Enterprises

In the Gambia, the firewood and logs/timber enterprises joint forces in order to overcome marketing constraints. They formed an association in 2003 and built their capacity through technical training, setting fixed prices for chopped firewood and timber, and joint monitoring of their resource base. They collectively negotiated a flat price with their customers and now get 17,000 Dalasis per truckload of canted timber instead of 9,000 Dalasis, the average price which they used to achieve individually. This increase was possible by taking on the responsibilities of cutting the trees and preparing them for transport for which they used to hire contractors, negotiating with private sawmills, and sharing out the work within the community. The price increase had made no effect on the high demand for timber, as sawmill owners still making a large profit. These new arrangements had almost doubled, the enterprises' profits and contributed, to the creation of many additional jobs in the communities (Thoma and Camara, 2005). In the similar manner, the CFMG at Tsirang could carry out the timber felling and processing work by them selves and make a good profit. At present they hire outsiders to do this job and huge expenditure was incurred on them for timber harvest work and income flows outside the community.

STUDY AREA

1. Location and Geological Land form

Patshaling was one of the four chiwogs along with four others namely, Bulkay, Pakhay and Thangray in Patshaling gewog, under Tsirang Dzongkhag. It was located at 25 kms from the Dzongkhag Head Quarter and bordered by Mendrelgang geog on the north, Barshong geog in the south west and Sarpang Dzongkhag in the extreme south. The geog has an area of 170.9sqkm (42,229.39 acres). The total area of dry land is 230.31 acres, wet land 51.09 acres; orchard land 36.45 and cardamom land 69.46 acres. In general, the topographic features of the village could be classified mostly as steep slopes, high hills and some plain in southern part, with altitude ranging from 600-1900 m a s l.

2. Climate Characteristic

The climate in Patshaling was classified characteristically as temperate climate. The area was influenced mainly by heavy monsoon shower. The area had four different types of season such as spring, summer, autumn and winter. The spring begins from March – May with lots of flowers and greenery all over the areas. The monsoon lasts from June – August with frequent monthly rainfall. This was followed by autumn season starting from September – November, with turning of paddy field into golden color, ready for harvest and the winter commences from December to February with cold weather.

3. Soil Characteristic

In fact, the soil characteristics were directly controlled by relief, parent materials, climate and organisms. The soil textures originated by decomposition of parent materials in Patshaling village were mainly sandy clay and loamy type. The area was well drained and moderate to low fertility.

4. Vegetation, People, Crops and Infrastructure

The study site, Yargey Community forest falls within Patshaling village and was located in cool broadleaved forest and falls towards south east of Tsirang Dzongkhag (Figure 1). The five numbers of valuable timber species found in the study area were namely, Titey Champ (*Michelia cathcartii),* Lal Chandan *(Daphnephyllum himalayense),* Katus *(Castanopsis species),* Lekh Chilawney *(Nyssa javanica),* Piplee *(Bucklandia populnia)* and Bandaray *(Helicia nilagirica).* Among these species the CF was dominated mainly with Katus *(Castanopsis species).* The over all forest condition was good with average canopy density of less than 70%. The average basal area of whole community forest was 17m^2/hectare which was considered potential for timber harvesting (Yargey CFMG, 2008).

The CF boundaries were as follows:
North: Forest road and Patshaling village
South: Government Reserved Forest
East: Government Reserved Forest along Khauray dangra
West: Government Reserved Forest (from forest road end point to Pipli dangra)

The CFMG was comprised of 44 household members from Patshaling villages. It had 46 households with the population of 485 people. 90 % of the communities were Sherpa and remaining 10 % of Gurung and Tamang linguistic group.

The main food crops grown by the community were Paddy and Maize. The cash crops cultivated were vegetables, Pear and Passion fruit. The community also reared livestock like cattle, poultry, piggery, fishery and ape-culture to supplement annual household income. The village had maximum dry land and the average land holding per household was 3 acres. The annual household income was Nu.21, 681.00 per household and the main source of income was through sale of livestock products (butter, cheese, egg, pork, & chicken) followed by vegetables. They reared improved

cattle breeds enhancing more livestock products and it demanded less work comparing to local breed (Yargey CFMG, 2008).

The village had amenities such as Primary school, ORC (Out Reach Clinic), RNR (Renewable Natural Resources) extension services, good drinking water supply, communication services (telephone) and irrigation channels. Most of the households replaced their wooden roofing materials with corrugated galvanized iron sheets thus reduced pressure on timber extraction.

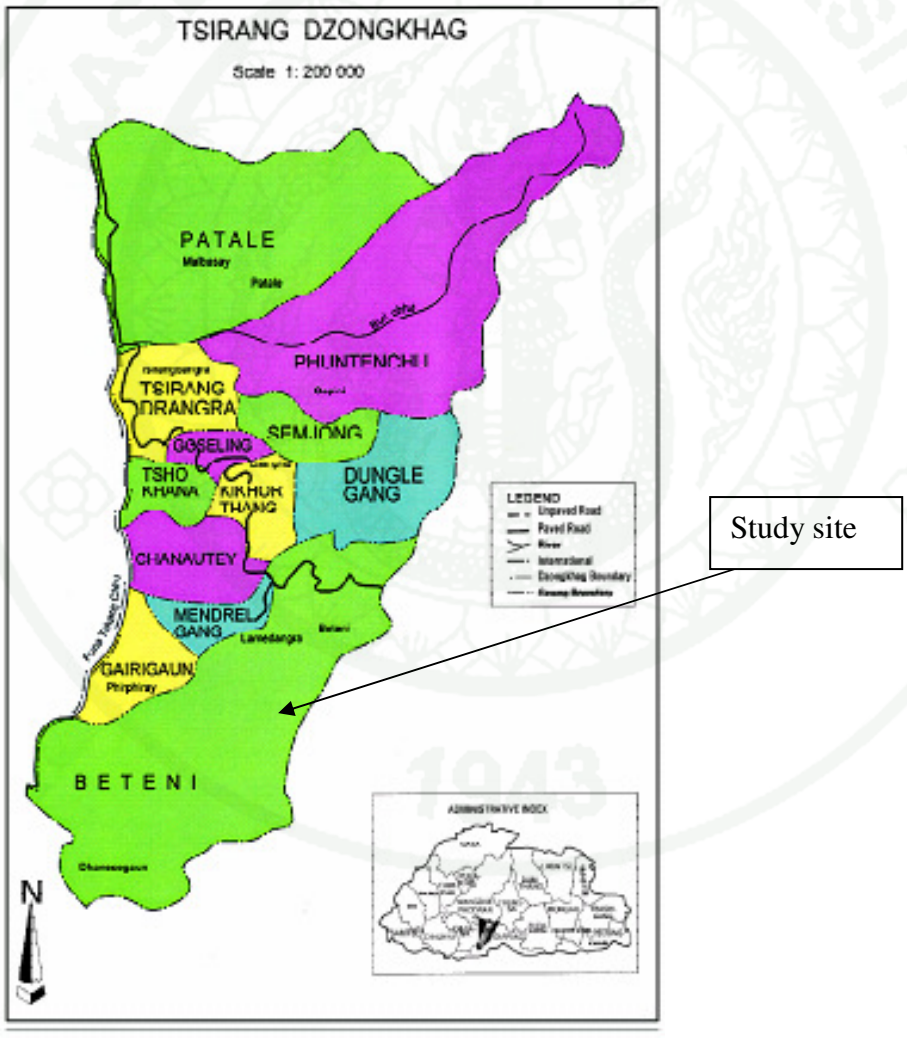

Figure 1 Map of Bhutan and Study area in Tsirang dzongkhag

Source: National Statistical Bureau (2007)

MATERIALS AND METHODS

Materials

The data were collected with the help of the materials and equipments such as suunto compass, Altimeter, GPS (Garmin 12XL), Spare batteries, Camera, Questionnaires, Pencil, Pen, Scanned Topographic map, Eraser, Field note book, Tracing paper, Protractor and Oziexplorer.

Methods

1. Conceptual Frame Work

The conceptual frame work of the research included input, activity and output. Input consisted of the components like CF boundary survey and multi stakeholder survey. The activities consisted of GPS (Geographical Positioning System) survey and mapping, stratified random sampling, timber volume assessment, focus group discussion, questionnaire analysis and financial analysis. The outputs were timber supply, demand and marketing channel (Figure 2).

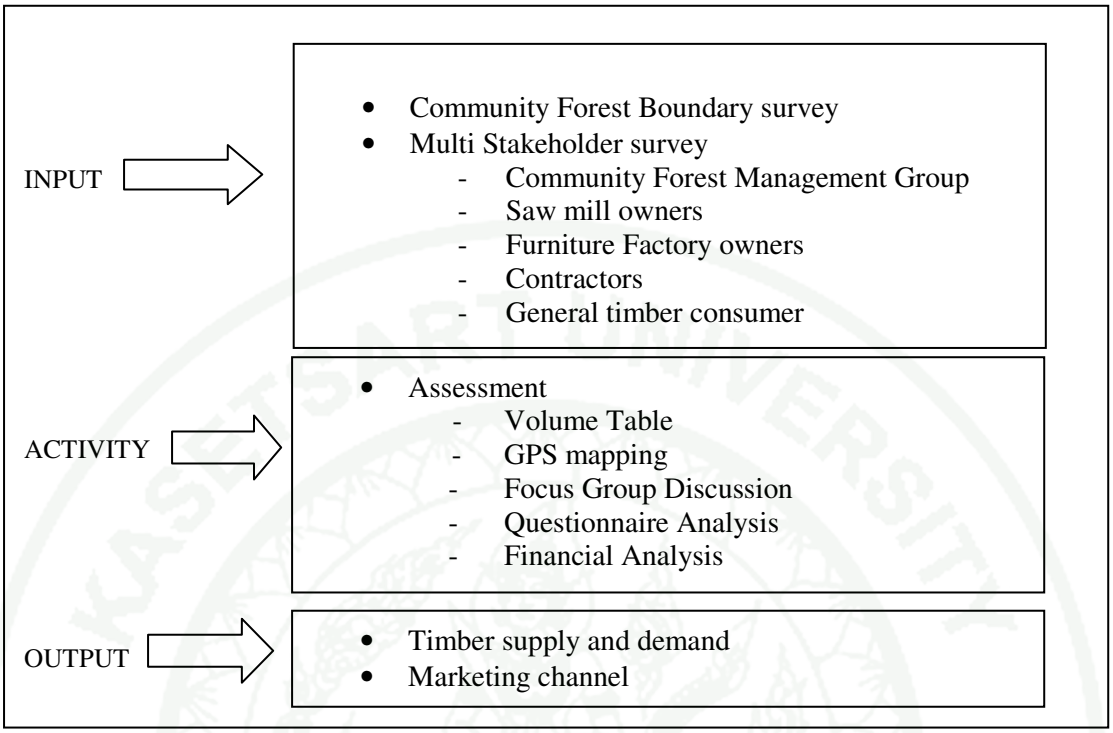

Figure 2 Conceptual frame work

3. Secondary Data Collection

The information used in this study was obtained from various secondary sources namely, Yargey CF management plan, Tsirang dzongkhag and Gyeltshen furniture house, Gelephu, Bhutan. The timber production from the CF was computed from the timber resource assessment data complied from the Yargey CF management plan. The total average timber volume production was calculated with the help of volume table from Forest Resource Development Division, in Thimphu.

The time series data covering the sample period 2005 – 2009 were used to determine demand and price relationship of timber in the CF, and to estimate the parameters of these relationships and also to predict the demand and price of timber for future.

To collect the information on the potential timber purchasers, the Forest Range office in Damphu, the Range manager's office in Gelephu and the office of chairman of Yargey CF in Patshaling village were visited. The data were gathered by employing questionnaire survey. This was because the timber buyers' main source of timber was from these offices.

4. Primary Data Collection

Various PRA (Participatory Rural Appraisal) tools such as semi structured interview, direct observation, participatory mapping and focus group discussions were applied for the study (Appendix A). Focus group discussion was conducted with the staff of Territorial forest, Royal Manas National Park, Dzongkhag and CFMG members. This was focussed to collect information on their perception for timber sale through auction or negotiation, opinion towards timber sale from CF, choice of timber species, timber preference in sawn or log forms and impact of timber marketing on the income for CFMG.

For the CFMG members, focus group discussion was deployed to gather information on community fund allocation for the benefit of them self and for the development of community forest at large. Again a semi structured interview was employed for the CFMG members, to collect data for their respective annual timber demand from their CF.

Semi structured interview was administered with the general timber consumer, contractor, sawmill and furniture house owners. This was focussed to collect information on their perception for annual timber demand, timber sale through auction or negotiation, opinion towards timber purchase from CF, choice of timber species, timber preference in sawn or log forms.

A questionnaire survey was employed to the Lucas mill owner and furniture house owner in Damphu to gather information on financial analysis from timber and furniture sale.

A GPS (Geographical Positioning System) survey was conducted to find out the boundary of the Yargey community forest by using materials such as GPS (Gramin 12 XL), suunto compass and scanned topographic map. This boundary survey helped the survey team to calculate the total area and located the exact CF boundary and accordingly a map for this CF was produced.

5. Sampling Method

The key respondents for the research were CFMG, Saw mill owner/Furniture factory owner, general timber consumer and contractors, which consisted of four stratums. Stratified random sampling was administered to find out the individual strata sample size to gather data for the study (Table 1). The optimal sample size (n) was fixed at 70, due to budget and time constraint. Thus for the sample allocation, proportional allocation was employed as follow:

$$n = 70$$

$$ni = \frac{Ni}{N} \times n$$

Where:

ni = Sample size in stratum

Ni = Number of sampling units in stratum

N = Population size

n = Optimal sample size

Table 1 Total sample size distribution

Respondents	Sample size	Population	Percent
Community Forest Management Group	8	44	11
Saw mill/Furniture factory owner	2	11	3
Contractor	10	57	14
General Consumer	51	294	72
Total	71	406	100

RESULTS AND DISCUSSION

Results

The results of this study were reflected below in a sequence in accordance to the above cited objectives. The data gathered from the study were computed with the help of tables and further analysed using both descriptive and quantitative statistical tool such as percentage and regression analysis.

1. Supply of Timber

The timber production from the CF was computed from the timber resource assessment data complied from the yargey CF management plan. The total average timber volume production was calculated with the help of volume table from Forest Resource Development Division, in Thimphu (Appendix Figure A3). It was found that the existing total timber stock within the community forest was 938,084.25 cubic feet in 2010 (Table 2).

Table 2 represented the individual species timber volume production in the Community Forest. As a result of computing from volume table, *Castanopsis* species had the highest timber volume with 40.34 percent, which was equivalent to 378,491.06 Cu. ft followed by, other timber species like *Helicia nilagirica* locally known as bandaray in southern Bhutan and *Bucklandia populnea* with 37.30 percent, which was equivalent to 349,864.18 Cu. ft. *Michelia cathcartii* has comparatively high timber volume production with 13.70 percent as well, which was equivalent to 128,543.93 Cu. ft. as compared to *Nyssa javanica* and *Daphnephyllum himalense.*

While *Daphnephyllum himalense* had the lowest timber volume stocks with 3.64 percent which was equivalent to 34,131.34 Cu. ft. Thus, this lead to the following order of abundance: *Castanopsis* species > Other species > *Michelia cathcartii* > *Nyssa javanica* > *Daphnephyllum himalense*.

Table 2 Individual species of timber standing (volume) in the community forest in 2010.

Type of timber species	Quantity of timber species (Cubic feet)	Percent
Castanopsis specie	378,491.06	40.34
Michelia cathcartii	128,543.93	13.70
Nyssa javanica	47,053.74	5.02
Daphnephyllum himalense	34,131.34	3.64
Others	349,864.18	37.30
Total	938,084.25	100

2. Demand for Timber

2.1 Demand for Timber from Stakeholders

Table 3 indicated the distributions of timber produced from community forest by type of demander. Based on the field survey, 71.83 percent of the General timber consumer liked to purchase timber from community forest. 14.08 percent comprise of contractor and consequently 11.27 percent by CFMG. The least timber buyers were saw millers and furniture house owners which shared only 2.82 percent. The reason for General Timber Consumer to buy timber in highest quantity among all other stake holders was due to their immediate timber needed to construct houses in urban areas like shops and residential building.

On the other hand, the least timber purchasers were saw millers and furniture house owners. This was because most of them were newly established and they require timber at a very small scale. Further they lacked carpentry skills.

Table 3 Distributions of timber produced from community forest by type of demander in 2010

Type of timber demander	No. of timber demander	Percent
General timber consumer	51	71.83
Contractor	10	14.08
Community forest management group	8	11.27
Saw miller/ furniture house	2	2.82
Total	71	100

Table 4 represented the actual quantity of timber consumption from the Community Forest. As determined from the field survey indicated that, the volume of timber consumption by the CFMG was the highest with 88.65 percent followed by the Contractor with 7.36 percent, which was equivalent to 4,663.74 Cu. ft and 387.10 Cu. ft respectively.

While the volume of timber consumption, by general timber consumer was the lowest with 3.99 percent, which was equivalent to 210.06 Cu. Ft. The timber consumption by contractor and general timber consumer was comparatively low since the community forest was established newly in 2008. However, the CFMG used the timber entirely for their domestic consumption such as new house construction and repair.

Table 4 Potential timber produces from the community forest by type of purchaser in 2010.

Type of timber purchaser	Quantity of timber species (Cubic feet)	Percent
Community Forest Management Group	4,663.74	88.65
Contractor	387.10	7.36
General Timber Consumer	210.06	3.99
Total	5,260.90	100

Table 5 represented the annual sawn timber demand from the Community Forest by type of timber consumer. As per the field survey, the annual sawn timber demand for saw millers and furniture house owners were the highest with 60.26 percent, which was equivalent to 48,000 Cu. ft followed by contractor with 24.11 percent, which was equivalent to 19,200 Cu. ft.

While the annual sawn timber demand for CFMG was the lowest with 15.63 percent, which was equivalent to 12,450 Cu. ft. Thus, this lead to the following order of demand: Saw miller and Furniture house owner > Contractor > General Timber Consumer. In case of CFMG, they obtained permit, fell the standing tree and sawn by themselves.

Table 5 Annual sawn timber demand for timber produced from the community forest by type of timber demander in 2010.

Type of timber demander	Quantity of timber demand (Cubic feet)	Percent
Saw miller/ Furniture house	48,000	60.26
Contractor	19,200	24.11
General Timber Consumer	12,450	15.63
Total	79,650	100

Table 6 illustrated the annual log demand from the Community Forest by type of log consumer. From the field survey it revealed that, the annual demand of log for saw millers and furniture house owner was the highest with 56.35 percent followed by CFMG with 38.75 percent which was equivalent to 89,000 Cu. ft and 61,204 Cu. ft respectively. General timber consumer had the lowest annual log demand with 4.90 percent, which was equivalent to 7,740 Cu. ft. Thus, this lead to the following order of log demand: Saw miller and furniture house owner > CFMG > General Timber Consumer.

Table 6 Annual log demand for timber produce from the community forest by type of timber demander in 2010.

Type of timber demander	Quantity of timber demand (Cubic feet)	Percent
Saw miller and furniture house	89,000	56.35
Community Forest Management Group	61,204	38.75
General Timber Consumer	7,740	4.90
Total	157,944	100

2.2 Choice of Timber Produce

Choices of timber produce for Saw miller and furniture house from Community Forest in 2010 revealed that, their choice was recorded the maximum which was 100% for timber both in the form of sawn and log. Out of these 65 percent comprise of timber produce in log form and 35 percent in sawn form. Their requirement in log form was for ply wood production and sawn timber for furniture making.

Table 7 indicated type of products from timber for general timber consumer from community forest by choice, which was significantly high with 74.51 percent in sawn form. This was due to the non availability of sawmill in the locality,

thus they required timber readily available in sawn for construction purpose. Interestingly their choice for timber in log was more than six times lesser than their choice for sawn timber, i.e. 11.76 percent. Further another 11.76 percent of them have no choice of timber either in sawn or log. This means they simply don't need timber or cannot predict their demand at present. However, their choice of timber in the form of both sawn and log was observed the lowest with 1.97 percent.

Table 7 Type of timber products for general timber consumer from community forest by choice in 2010.

Type of produce from timber	No. of Choice	Percent
Sawn	38	74.51
Log	6	11.76
Both sawn and log	6	11.76
None	1	1.97
Total	51	100

Table 8 indicated that, the contractor's choice of timber in sawn form was relatively high with 70 percent. They require timber readily available for construction purpose in order to complete their work in time and hand over to the concern agencies. They had no choice in log form since some of their construction sites were inaccessible in remote rural areas. In addition to this, 30 percent of their choice of timber was in both sawn and log form, which was more than two times lower than their choice in sawn timber form. Timber in log form was stored for future construction use.

Table 8 Type of timber products for contractor from community forest by choice in 2010.

Type of produce from timber	No. of Choice	Percent
Sawn	7	70.0
Both sawn and log	3	30.0
Total	10	100

2.3 Choice of Preferred Timber Species

Choices of preferred timber species for saw mill and furniture house from Community Forest in 2010 showed that, 100 % of them preferred only *michelia catcartii* or Titey champ as locally called in southern Bhutan. This was because the wood posses beautiful grains in the heart wood which looks attractive to the customers while making furniture. Further more; the timber from champ was durable and good for furniture making.

Table 9 displayed the choices of preferred timber species for general timber consumer from community forest. Regarding choices of preferred timber species for general timber consumer from Community Forest 76.48 percent of *Michelia cathcartii* timber species was preferred by general timber consumer followed by 9.80 percent *Castanopsis* species, 7.84 percent *Bucklandia populnea* and 5.88 percent *Nyssa javanica* which was rather low. Only slight differences among *Castonopsis species*, *Bucklandia populnea* and *Nyssa javanica* were observed. These species were locally called as titey champ, katus, piple and lekh chilawney in the southern Bhutan. This lead to the following order of species preference: *Michelia cathcartii* > *Castanopsis* species > *Bucklandia populnea* > *Nyssa javanica*.

Table 9 Type of timber species for general timber consumer from community forest by choice in 2010.

Type of timber species	No. of Choice	Percent
Michelia cathcartii	39	76.48
Castanopsis species	5	9.80
Bucklandia populnea	4	7.84
Nyssa javanica	3	5.88
Total	51	100

Table 10 displayed the choice of preferred timber species for contractor from Community Forest. The field survey revealed that, their preference for *michelia cathcartii* was the highest with 70 percent. This was followed by *castanopsis* species with 30 percent.

Table 10 Type of timber species for contractor from community forest by choice in 2010.

Type of timber species	No. of Choice	Percent
Michelia Cathcartii	7	70.0
Castanopsis species	3	30.0
Total	10	100

2.4 Options for Timber Sale

The field survey revealed that, 100% of the foresters opted for auction as an option for timber produce sale from CF. This was because, auction would attract more customers from all walks of life with competitive bidding and ultimately gain comparatively higher timber price. This could develop a sense of transparency among

all the stake holders. All the extracted timber can be sold and disposed within a short span of time resulting into minimum loss from wastage, if the advertising through different media and the good timber quality is maintained. This has an advantage of selling smaller sizes of timber as well as bigger ones from their Community forest.

While 100 % of the CFMG members wanted to sell timber directly to the consumers in sawn form. This is mainly to avoid natural regeneration, soil erosion, ease transportation and for local employment. They strongly favour timber sale from their CF and they foresee high impact of timber marketing on their income. The author would like to recommend the time sale option favoured by CFMG since it was based on good scientific knowledge.

Table 11 represented the distribution of respondents by type of opinions towards timber sale from Community Forest. It was found that, 60 percent of the respondents (foresters) favoured towards timber sale from CF. While about 26.67 percent of them strongly favoured in this regard. However, 13.33 percent of them oppose for the same.

Table 11 Distribution of respondents by type of opinions towards timber sale from community forest in 2010.

Type of opinion	No. of respondent	Percent
Favour	9	60.00
Strongly favour	4	26.67
Oppose	2	13.33
Total	15	100

Table 12 illustrated the distribution of respondents by type of opinions towards timber produce sale from Community Forest. The respondents (foresters) opinion on timber sale in sawn and both sawn and log form was found equal with a figure of 40 percent each. However, their opinion on log was observed only 20

percent which was two times lower than their opinion on sawn and both sawn and log form of timber.

Table 12 Distribution of respondents by type of opinions towards timber selling from community forest in 2010.

Type of timber produce	No. of respondents	Percent
Log	3	20.00
Sawn	6	40.00
Both sawn and log	6	40.00
Total	15	100

2.5 Annual Income and Expenditure for CFMG

Table 13 illustrated the annual income of Community Forest Management Group (CFMG) by source of income. The annual income from sawn timber was the maximum with 96 percent that was equal to Nu. 141,936.40 followed by income from donation and membership fee with 2 percent and 1 percent that was equal to Nu. 3,000 and Nu. 2200 respectively. The minimum income was generated from fine and penalty with 1 percent that was equal to Nu. 2,000. This was partly attributed to the newly establishment and handing over of the CF to the community.

Table 13 Annual income of community forest management group (CFMG) by source of income in 2010.

Source of income	Total income (Nu)	Percent
Sawn timber	141,936.40	96
Donation	3000	2
Membership fee	2200	1
Fine/penalty	2000	1
Total		100

Remark: Nu.1 = US $ 44.45

Table 14 illustrated the annual expenditure of Community Forest Management Group. The annual expense for timber logging and sawing was the maximum with 92.71 percent that was equal to Nu. 44,506.32, followed by expenditure for stationary with 6.25 percent that was equal to Nu. 3,000. The maximum expense incurred while logging and sawing was mainly attributed towards the high cost for timber processing.

While, the minimum expenditure was incurred for refreshment with 1.04 percent that was equal to Nu. 500. This expenditure was incurred while conducting the general community meeting and working in the community forest plantation in the locality. This was partly attributed due to low participation of the community for those activities which involved manual work.

Table 14 Annual expenditure of community forest management group by type of activity in 2010.

Type of activity	Total cost (Nu)	Percent
Timber logging and sawing	44,506.32	92.71
Stationary	3000	6.25
Refreshment	500	1.04
Total	48,006.32	100

Remark: Nu.1 = US $ 44.45

2.6 Impact of Timber Produce Sale on CFMG

Table 15 illustrated the distribution of respondents (foresters) by type of opinions towards impact of timber produce sale on income from Community Forest in 2009. The majority of foresters, i.e. about 66.67 percent of them claimed that, the impact of timber produce sale on income of the community would be high and 33.33 percent also felt the impact would be just medium.

Table 15 Distribution of respondents by type of opinions towards impact of timber produce sale on income from community forest in 2010.

Type of timber sale impact	No. of respondent	Percent
High	10	66.67
Medium	5	33.33
Total	15	100

3. The Regression Coefficient Estimation

The demand, supply and price equation should be simultaneously determined because in the lumber market the equilibrium lumber price was not only determined

by the seller but also by the consumer. Consequently the quantity demanded, supplied are also determined by the price. Therefore, demand, supply and price equations should be combined as in the simultaneous equation system (Hoamuangkaew, 1978).

3.1 Estimated Regression Coefficient of Demand Function for Quantity of Demand for Timber in favour of Furniture house

Table 16 indicated that, the quantity of demand for timber in favour of furniture house was a function of price for timber. For the coefficient timber price was signification at 1 percent. The Pt variable showed that, the relation between price and demand for timber was positive (Figure 3), which mean that when timber price increased the quantity of demand for timber also increased. This was because the demand for timber has not met with market's true demand or the furniture was an essential product for market and price was not a matter for consumption of the market.

R^2 of this equation was 0.9373 which means that, the deviation of the dependent variable (Dt) could be explained by the explanatory variable (Pt) at about 93.73%. From the Durbin -Watson test for the serial correlation, the computed DW vale was equal to 1.8866 (Table 16). This indicated that, based on the table for DW critical value of 5 observations, which was almost equilibrium to 6 was the smallest number of observation, appeared in the DW table (Appendix Figure B4). Hence in this, coefficient could be interpreted that, there was no problem about serial correlation for the obtained demand function.

From the problem, there was no critical upper bound and lower bound for 5 observations at k = 1 (excluded intercept). The study had to consider from the suitability of r_a (autocorrelation coefficient) which was near to 0. The r_a for this equation was -0.4971 which was significant at $\alpha = 0.05$.

By including other factors, which indicate to suitability of equation such as F-value, P- value and standard error for estimation and visual fitness of line to plot on the graph (Appendix Figure B1).

Table 16 Estimated regression coefficient of demand function for timber in favour of furniture house.

Independent Variable	Constant Term	Coefficient	SE	t-ratio	R^2	DW	r_a
	-1895.783		1307.0438	-1.4504^{ns}	0.9373	1.8866	
Pt		60.3036	9.0027	6.6984**			-0.4917

** = Significant at 0.01 level
ns = Not significant at 0.05 level
R^2 = Coefficient of determination
SE = Standard error of estimate
DW = Durbin-Watson statistical test value
r_a = Autocorrelation coefficient

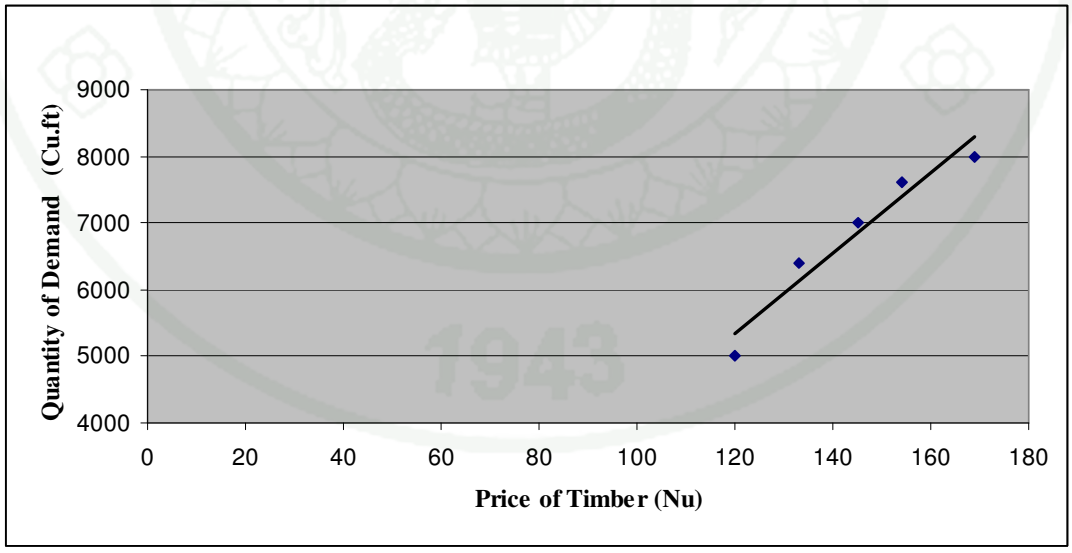

Figure 3 Relation between the quantity of demand and price for timber

As calculated by Computer Program, the relation between the quantity of demand and price for timber was expressed in linear equation form as:

$D_t = f(P_t)$

$D_t = -a + bP_t$

$D_t = -1895.7830 + (60.3036Pt)$….(1)

Where:

D_t = Quantity of timber demand for furniture house

P_t = Price of timber

a = Intercept

b = Coefficient or slope

Price elasticity of demand can be calculated as:

$$Ed = \frac{dQt}{dPt} \times \frac{\overline{Pt}}{\overline{Qt}}$$

$Ed = 60.3036 \times (144.2/6800)$

$= 1.2787$

Where:

Ed = Price elasticity of demand

dQt = Quantity of demand for timber

dPt = Demand price of timber

$\overline{Pt}$ = Average price of timber

$\overline{Dt}$ = Average demand for timber

It means that 1% of change in price for timber would have an effect to change of demand for timber with 1.2787% in a positive way. If the price for timber was increased by Nu. 1, the demand for timber would be increased by 1.2787 Cu.ft. On the other hand, if the price for timber was decreased by Nu. 1, demand for timber would be decreased by 1.2787 Cu.ft.

3.2 Estimated Regression Coefficient of Time Trend Equation for Price of Timber and Prediction of Demand for Timber of Furniture House

Table 17 indicated that, the price for timber was a function of time. For the coefficient time variable was signification at 1 percent. The time variable showed that, the relation between time and price for timber was positive (Figure 4), which means that, the price for timber increased through time. This was because of inflation rate and chance of merchant who see that, the demand for timber still increased and the timber remained as a necessary material for furniture production.

R^2 of this equation was 0.9670 which means that the deviation of the dependent variable (Dt) could be explained by the explanatory variable (Pt) at about 96.70%. From the Durbin -Watson test for the serial correlation, the computed DW vale was equal to 1.6361(Table 17). This indicated that, based on the table for DW critical value of 5 observations, which was almost equilibrium to 6 was the smallest number of observation, appeared in the DW table (Appendix Figure B4). Hence in this, coefficient could be interpreted that, there was no problem about serial correlation for the obtained demand function.

From the problem, there was no critical upper bound and lower bound for 5 observations at k = 1 (excluded intercept). The study had to consider from the suitability of r_a (autocorrelation coefficient) which was near to 0. The r_a for this equation was -0.3259 which was significant at $\alpha = 0.05$. By including other factors that indicated to suitability of equation such as F- value, P- value and standard error for estimation and visual fitness of line to plot and predict on the graph (Appendix Figure B2).

Table 17 Estimated regression coefficient of time trend equation for price of timber to predict quantity of demand for timber in favour of furniture house.

Independent Variable	Constant Term	Coefficient	SE	t-ratio	R^2	DW	r_a
	2.0711		0.0105	196.8493**	0.9670	1.6361	
T		0.2041	0.0218	9.3808**			-0.3259

** = Significant at 0.01 level
ns = Not significant at 0.05 level
R^2 = Coefficient of determination
SE = Standard error of estimate
DW = Durbin-Watson statistical test value
r_a = Autocorrelation coefficient

As calculated by Computer Program, the relation between timber price and time was expressed in Allometry equation form as:

$$\text{Log } (Pt) = 2.0711 + (0.2041(\log T)) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Where:

Pt = Price for timber
T = Time (n = 1, 2, 3,…; start year was 2005)

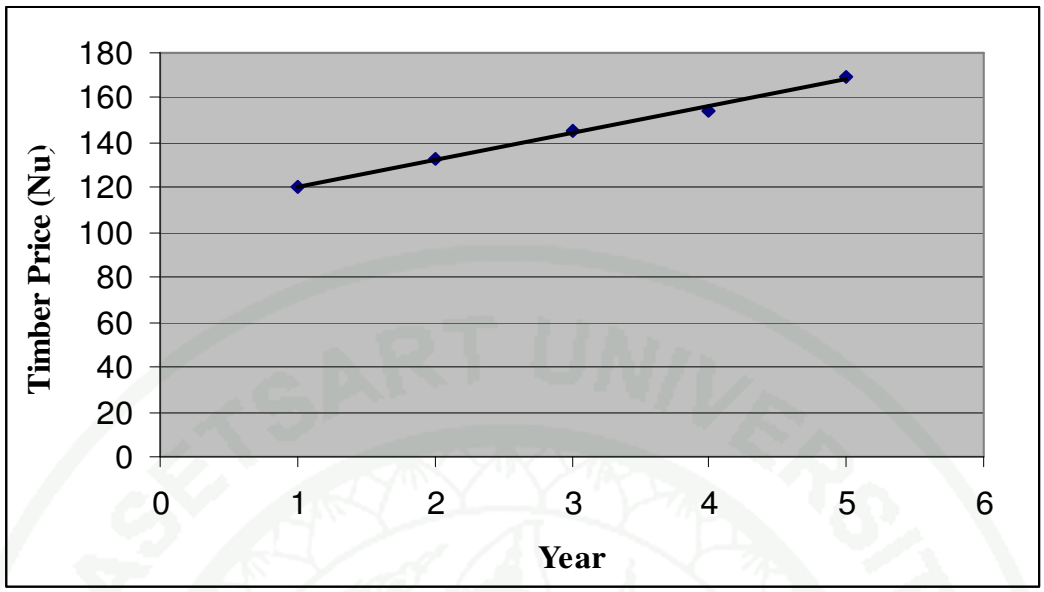

Figure 4 Relation between timber price and time.

Table 18 represented the current timber demand for furniture house, 2005 – 2009. The demand for timber was used in estimating the quantity of demand for timber during the year 2005 – 2009. The current and adjusted quantities of demand for timber were presented in table 19. It represented the highest and the lowest level of adjusted quantity of demand for timber, which were 5,341 Cu. feet in 2005 and 8,296 Cu. feet in 2009. This was also shown graphically (Figure 5).

Table 18 Current timber demand for furniture house, 2005 – 2009

Year	Quantity of timber demand (Cu. Feet)	Timber price (Nu/ft^3)	Furniture price (Nu/piece)
2005	5000	120	23400
2006	6400	133	24000
2007	7000	145	24500
2008	7600	154	25000
2009	8000	169	26000

Table 19 Current and adjusted quantity of timber demand for furniture house, 2005 – 2009

Year	Current demand for timber (ft^3)	Adjusted demand for timber	Price of timber (Nu/ft^3)
2005	5000	5341	120
2006	6400	6125	133
2007	7000	6848	145
2008	7600	7391	154
2009	8000	8296	169

Source: Estimated from Table 18

3.3 Function of Demand for Timber

By using the step wise method of regression analysis, it was found that, the demand function for the timber was depended on the price of the timber at R^2 value of 93.73 %. It was highly significant and had relationship in between function of timber demand and price of timber. However, the timber demand function was not depended on the price of the furniture. There was no significance and relationship in between timber demand function and price of furniture; instead the price of furniture was excluded.

As per demand theory, when there was an increase in price of any commodity, there was decrease in demand for that particular commodity. Nevertheless, in this study, it was revealed that, as the price increased, the demand also increased. This was mainly attributed due to the trend of timber demand, timber price and furniture price, as all these three parameters increased in the preceding years (Table 18).

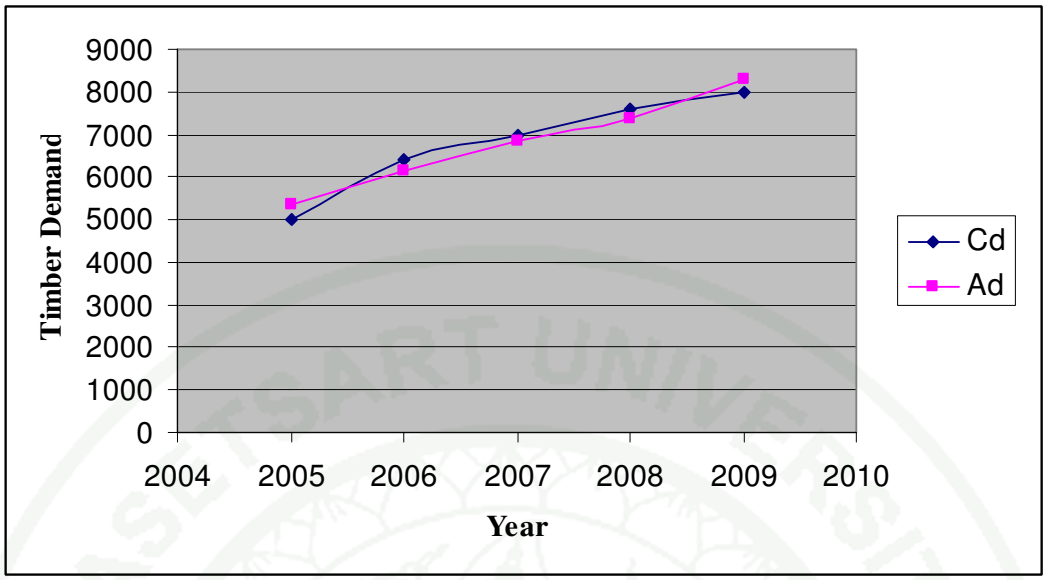

Figure 5 Current and adjusted quantity of demand for timber in favour of furniture house, 2005 – 2009

Source: Table 19

Where:

Cd = Current quantity of demand for timber

Ad = Adjusted quantity of demand for timber

Table 20 Current quantity of timber demand for furniture house, 2005-2009

Year	Dt (ft^3)	Pt (Nu/ ft^3)
2005	5000	120
2006	6400	133
2007	7000	145
2008	7600	154
2009	8000	169
SUM	34000	721
AVERAGE	6800	144.2

3.4 Prediction for Price and Demand of Timber in the next 5 years (2010-2014)

From table 20, we could create time trend equation of timber price to predict the demand of timber in the next 5 years 2005-2014 (Table 21). Further more, from the above equations 1 and 2, we predicted price and demand of timber for the next 5 years as presented in (Figure 6).

Table 21 Price and quantity of demand of timber in favour of furniture house in the next 5 years (2010-2014)

Year	Price for timber (Nu/(ft^3)	Demand for timber (ft^3)
2010	169.7883	8343.0676
2011	175.2150	8670.3143
2012	180.0557	8962.2306
2013	184.4365	9226.4061
2014	188.4454	9468.1609

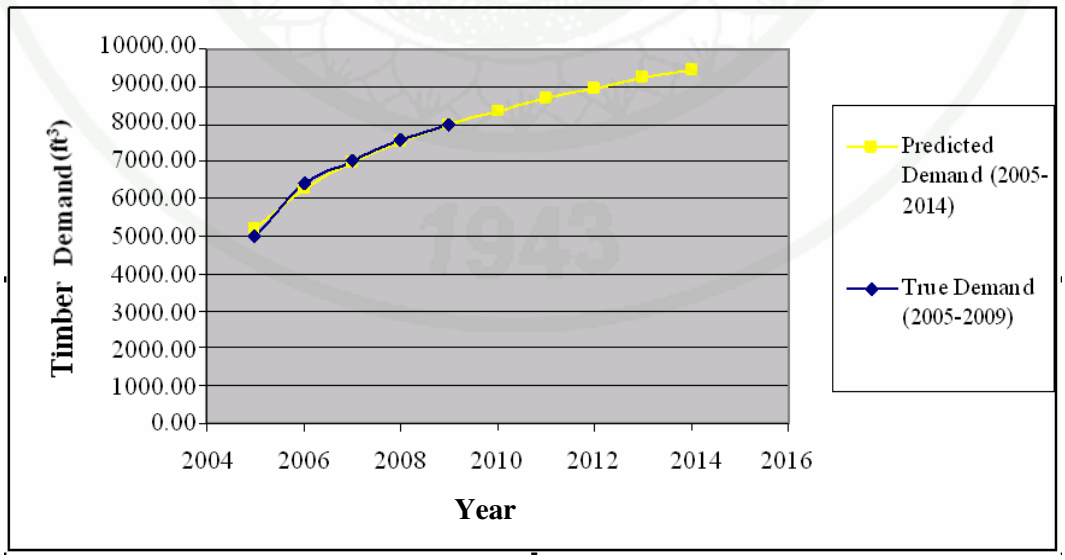

Figure 6 Predicted quantity of demand for timber compare with the true quantity of demand for timber.

4. Potential Timber Buyer and Determine Timber Marketing Channel

4.1 Potential Timber Buyer

Table 22 represented the potential timber consumer by type of timber demander. From the field survey it revealed that, the annual demand of timber for saw millers was the highest with 79 percent followed by contractor with 21 percent which was equivalent to 150,000 Cu. ft and 40,821.42 Cu. ft respectively. General timber consumer had the lowest annual timber demand, which was equivalent to 210.06 Cu. ft. Thus, this lead to the following order of timber demand: Saw miller > Contractor > General Timber Consumer. For the Yargey CF, the saw miller ranks the top most potential timber purchaser followed by contractor. The General Timber Consumers were also considered important as potential timber purchasers in future.

Table 22 Potential timber consumer by type of timber demander in 2010.

Type of timber demander	Quantity of timber demand (Cubic feet)	Percent
Saw miller	150,000	79.00
Contractor	40,821	21.00
General Timber Consumer	210.06	0
Total	191,031.06	100

4.2 Determine Timber Marketing Channel

This study employed market chain method to analyze the marketing process of commercial timber from community level to end users. The timber from the CF were supplied to three consumers namely, CFMG members at the local level, contractors and general timber consumers at the district level. The timbers purchased by the contractors were further consumed by the Government agencies for construction purpose. It was indicated that, out of 5260.90 cubic feet of timber

produced from the CF, 4663.74 cubic feet (89%) was consumed by the CFMG members for their domestic use, 387.10 cubic feet (7%) consumed by contractors and 210.06 cubic feet (4%) consumed by general timber consumers (Figure 7). The transportation from processing site to the road head was done by the community members manually on free of cost. While bringing this transportation cost to the monetary value, it amounts to Nu.2, 100.60. Therefore, the timber transportation cost was Nu. 10.00 per cubic feet. For the timber marketing, only the transportation to road head point had to be born by the CFMG and then it was further taken to the destination by the consumer themselves. The minimum marketing cost showed the best marketing performance of the timber trader (Table 24). Therefore, the marketing performance could be determined from the marketing cost.

Marketing channel was an empirical analysis method, through which, a commodity, such as timber passes, from harvesting through production to end user. It was a tool for understanding the benefits from natural resources, how benefits and how those patterns of benefit distribution might be changed (Ribot, 1998).

The efficiency of marketing performance with the contractor revealed that, from the sale of 113.44 cubic feet of timber @ Nu. 235/ cubic feet, a sum of Nu.25.60 was found as the profit after deducting the transportation and unloading cost. The contractor sold to the construction site of Government @ Nu. 276.82/cubic feet and it was also observed that the marketing cost was low for the contractor. The minimum marketing cost shows the best marketing performance of the timber trader (Table 26).

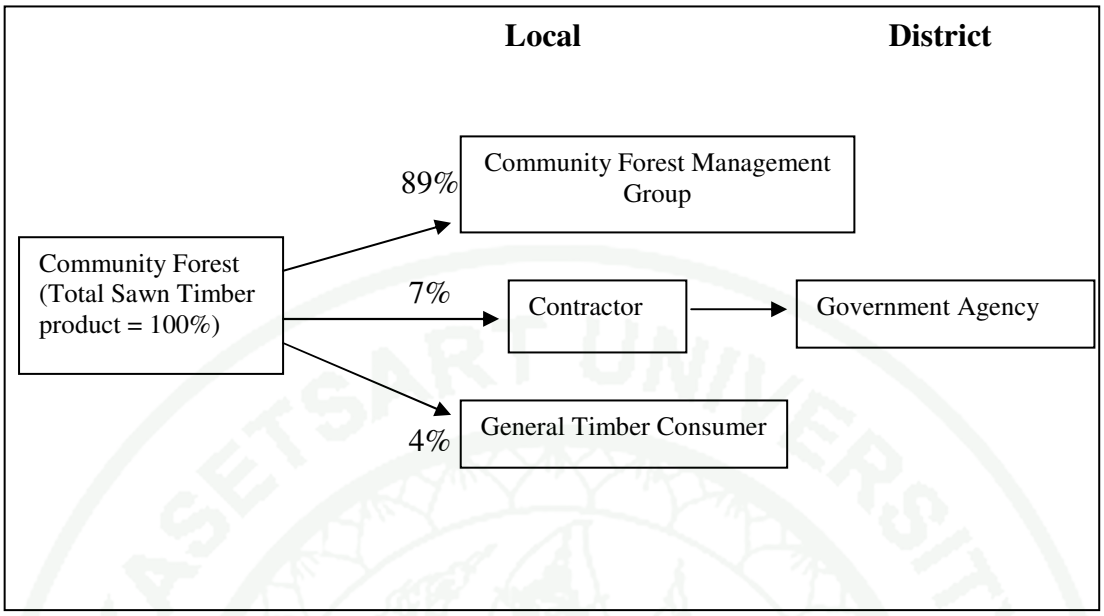

Figure 7 Marketing channel of sawn timber

Table 23 Production, price and value of timber products with the direct actor (CFMG)

Items	Quantity (Cu. ft)	Price (Nu/Cu.ft)	Value (Nu)
Total sawn timber production			
1. *Michelia cathcartii*	160.38	245	39,293.10
2. Other species	436.78	235	102,643.30
Total	597.16		141,936.40

Remark: Nu.1 = US $44.45

Table 24 Transportation, price and value of timber products with the direct actor (CFMG)

Items	Quantity (Cu. ft)	Price (Nu/Cu.ft)	Value (Nu)
Total sawn timber production			
I. Michelia cathcartii	160.38	245	39,293.10
2. Other species	436.78	235	102,643.30
II. Manual transportation	579.16	10	5,971.60
Total	597.16		141,936.40

Remark: Nu.1 = US $ 44.45

Table 25 Consumption, price and value of timber products with the indirect actor (Contractor)

Items	Quantity (Cu.ft)	Price (Nu/Cu.ft)	Value (Nu)
Total sawn timber consumption	113.44	276.82	31,402.46

Remark: Nu.1 = US $ 44.45

Table 26 Transportation, price and value of timber products with the indirect actor (Contractor)

Items	Quantity (Cu.ft/)	Price (Nu/Cu.ft)	Value(Nu)
Transportation by truck	113.44	1500/TL	1500.00
Unloading timber	113.44	3.00	340.32

Remark: Nu.1 = US $ 44.45

5. Analysis of Financial Return from Timber, lumber and Furniture Production

5.1 Analysis of Financial Return from Timber and lumber production

Table 27 illustrated the financial analysis for cost and return from timber and lumber production in 2009. It was divided into two parts. Firstly, in case of timber production cost which included labour cost, material cost and machinery cost were computed and totaled up and subtracted from the total revenue collected from timber production (Total revenue from timber production – Total cost for timber production = Profit).

Secondly, in case of lumber production cost which includes labour cost, material cost, transportation cost to site and machinery cost were computed and totaled up and subtracted from the total revenue collected from lumber production (Total revenue from lumber production – Total cost for lumber production = Profit).

The study found that, the profit obtained from 267 cu. ft of timber production was Nu. 4.30/cu.ft. While the profit from lumber production was Nu. 44.76/cu.ft. Thus, it was observed that, the profit from lumber production was much higher than timber production. This was mainly because of the added value for lumber production, which means that, they were converted into planks and battens.

Table 27 Financial analysis for cost and return from timber and lumber production in 2009

Item	Manday	Wage(Nu/manday)	Value (Nu)
1. Timber production			
1.1 Labour cost for felling, debranching and cross-section	17	120	2,040.00
Item	Quantity	Price (Nu)	Value (Nu)
1.2 Material Cost for power chain saw			
1.2.1. Patrol (liter)	40	43.39	1,735.60
1.2.2. Mobil (liter)	10	145	1,450.00
1.2.3. 2 T (liter)	2	174	348.00
Total			3,533.60
Item	No. of machine	Nu/day	Value (Nu)
1.3 Machinery cost/day			
1.3.1. Power chain saw	2	40	160.00
1.3.2. Saw chain sharpener (pieces)	2	0.66	2.64
1.3.3. Spare chain (piece)	1	7.70	15.40
Total			178.04
A. Total cost of timber production			5,751.64
Item	Quantity (ft^3)	Price (Nu)	Value (Nu)
1.4 Total revenue from timber production			
1.4.1 Total cost of timber production x 20% of profit	267	25.85	6,901.96
B. Profit for timber production = (1.4 – A)			1,150.32

Table 27 (Continued)

Item	Manday	Wage(Nu/manday)	Value (Nu)
2. Lumber production			
2.1 Labour cost for timber sawing	90	150	13,500.00
Item	Quantity	Price (Nu)	Value (Nu)
2.2 Material Cost for Lucas mill			
2.2.1. Timber (ft^3)	267	21.54	5,751.18
2.2.2. Patrol (liter)	160	43.39	6,942.40
2.2.3. Mobil (liter)	16	145	2,320.00
2.2.4. Saw chain sharpener (piece)	2	120	240.00
Total			28,753.58
Item	No. of machine	Nu/day	Value (Nu)
2.3 Machinery cost/day			
2.3.1. Lucas mill cost	1	450	3,600.00
2.3.2. Saw chain sharpener (pieces)	2	0.66	10.56
Total			3,610.56
Item	No. of trip	Price (Nu/TL)	Value (Nu)
3. Lucas mill transport to site	1	3500	3,500.00
B. Total cost of lumber production			35,864.14
Item	Quantity (ft^3)	Price (Nu)	Value (Nu)
1.4 Total revenue from lumber production			
1.4.1 Total cost of lumber production x 20% of profit	160.20	268.64	43,036.12
Profit for lumber production (1.4 – B)			7,172.98

Remark: Nu.1 = US $ 44.45

5.2 Analysis of Financial Return from Furniture production

The financial analysis for cost and return from furniture production in 2009 comprised of the informations about the labour cost, material cost, electricity cost and timber transportation cost were computed and totaled up and subtracted from the revenue collected from production of various furniture types (Total revenue collected from furniture production – Total production cost of furniture = Profit). The furniture included chair, cupboard, show case, book shelf, sofa set, centre table, single bed and double bed. Each type of furniture was made from 1 m^3 of lumber which was equivalent to 35.31 ft^3 of lumber.

The study found that, the profit obtained from the sale of sofa set was the highest with Nu. 3931.30/ set (Table 28) followed by show case with Nu. 2185.57/ piece (Table 29); book shelf with Nu. 1685.57/ piece (Table 30); double bed and cupboard with Nu. 1159.80 each / piece (Tables 32, 33); centre table with Nu. 759.46/ piece (Table 31); single bed with Nu. 685.57/ piece (Table 35). However, the profit from production of chair was found to be lowest with Nu. 443.33/ piece (Table 34).

The study indicated that, the profit obtained from furniture production such as sofa set, showcase and book shelf was higher than profit from lumber production. This was revealed from financial analysis for cost and return for timber and lumber production (Table 27) and furniture production in 2010 (Tables 28, 29, 30). This was mainly attributed because of the added value for furniture production.

Table 28 Financial analysis for cost and return from sofa set production in 2010

Item	Quantity of lumber (ft^3)	Men Days (unit)	Wage (Nu/man days	Value (Nu)
1. Labour Cost				
1.1 Furniture making (sofa set):				
1.2 sofa set making cost for carpenter	35.31	24	300	7200.00
1.3 sofa set making cost for helper	35.31	24	200	4800.00
Total				12000.00
Item	Quantity		Price (Nu/unit)	Value (Nu)
2. Material Cost:				
2.1. Lumber cost (ft^3)	35.31		250	8827.50
3. Electricity cost (kw)	30		0.85	25.50
4. Lumber transportation cost (ft^3)	35.31		10	353.10
5. Total sofa set production cost				21206.10
6. Total revenue from sofa set	3		11000set	33000.00
Profit = (6 – 5)				11793.90

Remark: Nu. 1 = US $ 44.45, 1 m^3 = 35.31 ft^3

Table 29 Financial analysis for cost and return from show case production in 2010

Item	Quantity of lumber (ft^3)	Men Days (unit)	Wage (Nu/man days	Value (Nu)
1. Labor Cost				
1.1 Furniture making (show case):				
1.2 show case making cost for carpenter	35.31	28	300	8400.00
1.3 show case making cost for helper	35.31	28	200	5600.00
Total				14000.00
Item	Quantity		Price (Nu/unit)	Value (Nu)
2. Material Cost:				
2.1. Lumber cost (ft^3)	35.31		250	8827.50
3. Electricity cost (kw)	24		0.85	20.40
4. Lumber transportation cost (ft^3)	35.31		10	353.10
5. Total show case production cost				23201.00
6. Revenue from show case	7 nos		5500/s.case	38500.00
Profit = (6 – 5)				15299.00

Remark: Nu. 1 = US $ 44.45, 1 m^3 = 35.31 ft^3

Table 30 Financial analysis for cost and return from book shelf production in 2010

Item	Quantity of lumber (ft^3)	Men days (unit)	Wage (Nu/men days)	Value (Nu)
1. Labor cost:				
1.1 Furniture making (book shelf)				
1.2 book shelf making cost for carpenter	35.31	28	300	8400.00
1.3 book shelf making cost for helper	35.31	28	200	5600.00
Total				14000.00
Item	Quantity	Price (Nu/unit)		Value (Nu)
2. Material cost:				
2.1 lumber cost (ft^3)	35.31	250		8827.50
3. Electricity cost (kw)	24	0.85		20.40
4. Transportation cost (ft^3)	35.31	10		353.10
5. Total book shelf production cost				23201.00
6. Revenue from book shelf	7 numbers	5000/ book shelf		35000.00
Profit = (6 – 5)				11799.00

Remarks: Nu. 1 = US $ 44.45, 1m3 = 35.31(ft^3)

Table 31 Financial analysis for cost and return from center table production in 2010

Item	Quantity of lumber (ft^3)	Men days (unit)	Wage (Nu/men days)	Value (Nu)
1. Labor cost:				
1.1 Furniture making (center table)				
1.2 center table making cost for carpenter	35.31	17	300	5100.00
1.3 center table making cost for helper	35.31	17	200	3400.00
Total				8500.00
Item	Quantity	Price (Nu/unit)		Value (Nu)
2. Material cost:				
2.1 lumber cost (ft^3)	35.31	250		8827.50
3. Electricity cost (kw)	10	0.85		8.50
4. Transportation cost (ft^3)	35.31	10		353.10
5. Total center table production cost				17689.10
6. Revenue from center table	17 numbers	5000/ table		30600.00
Profit = (6 – 5)				12910.90

Remarks: Nu. 1 = US $ 44.45, 1m3 = 35.31(ft^3)

Table 32 Financial analysis for cost and return from double bed production in 2010

Item	Quantity of lumber (ft^3)	Men days (unit)	Wage (Nu/men days)	Value (Nu)
1. Labor cost:				
1.1 Furniture making (double bed)				
1.2 double bed making cost for carpenter	35.31	20	300	6000.00
1.3 double bed making cost for helper	35.31	20	200	4000.00
Total				10000.00
Item	Quantity	Price (Nu/unit)		Value (Nu)
2. Material cost:				
2.1 lumber cost (ft^3)	35.31	250		8827.50
3. Electricity cost (kw)	24	0.85		20.40
4. Transportation cost (ft^3)	35.31	10		353.10
5. Total double bed production cost				19201.00
6. Revenue from double bed	5 numbers	5000/bed		25000.00
Profit = (6 – 5)				5799.00

Remarks: Nu. 1 = US $ 44.45, 1m3 = 35.31(ft^3)

Table 33 Financial analysis for cost and return from cupboard production in 2010

Item	Quantity of lumber (ft^3)	Men days (unit)	Wage (Nu/men days)	Value (Nu)
1. Labor cost:				
1.1 Furniture making (cupboard)				
1.2 Cupboard making cost for carpenter	35.31	25	300	7500.00
1.3 Cupboard making cost for helper	35.31	25	200	5000.00
Total				12500.00
Item	Quantity	Price (Nu/unit)		Value (Nu)
2. Material cost				
2.1 lumber cost (ft^3)	35.31	250		8827.50
3. Electricity cost (kw)	15	0.85		20.40
4. Transportation cost (ft^3)	35.31	10		353.10
5. Total cupboard production cost				21701.00
6. Revenue from cupboard	5 numbers	5500/cupboard		27500.00
Profit = (6 – 5)				5799.00

Remark: Nu. 1 = US $ 44.45, 1 m^3 = 35.31 ft^3

Table 34 Financial analysis for cost and return from chair production in 2010

Item	Quantity of lumber (ft^3)	Men days (unit)	Wage (Nu/men days)	Value (Nu)
1. Labor cost:				
1.1 Furniture making (chair)				
1.2 chair making cost for carpenter	35.31	28	300	8400.00
1.3 chair making cost for helper	35.31	28	200	5600.00
Total				14000.00
Item	Quantity	Price (Nu/unit)		Value (Nu)
2. Material cost:				
2.1 lumber cost (ft^3)	35.31	250		8827.50
3. Electricity cost (kw)	15	0.85		12.75
4. Transportation cost (ft^3)	35.31	10		353.10
5. Total chair production cost				23193.35
6. Revenue from chair	14 numbers	2100/chair		29400.00
Profit = (6 – 5)				6206.65

Remark: Nu. 1 = US $ 44.45, 1 m^3 = 35.31 ft^3

Table 35 Financial analysis for cost and return from single bed production in 2010

Item	Quantity of lumber (ft^3)	Men days (unit)	Wage (Nu/men days)	Value (Nu)
1. Labor cost:				
1.1 Furniture making (single bed)				
1.2 single bed making cost for carpenter	35.31	21	300	6300.00
1.3 single bed making cost for helper	35.31	21	200	4200.00
Total				10500.00
Item	Quantity	Price (Nu/unit)		Value (Nu)
2. Material cost:				
2.1 lumber cost (ft^3)	35.31	250		8827.50
3. Electricity cost (kw)	24	0.85		20.40
4. Transportation cost (ft^3)	35.31	10		353.10
5. Total single bed production cost				19701.00
6. Revenue from single bed	7 numbers	3500/bed		24500.00
Profit = (6 – 5)				4799.00

Remark: Nu. 1 = US $ 44.45, 1 m^3 = 35.31 ft^3

6. Map of Yargey Community Forest Area

Mapping of the community forest boundary was conducted with the help of GPS (Global Positioning system) survey. The completed GPS survey sheets and stored data in the GPS produced the map of the Community forest area with the help of OziExplorer. A CF boundary map was made by using GPS data (DoF, 2004). This CF had an area of 128 hectares (Figure 8).

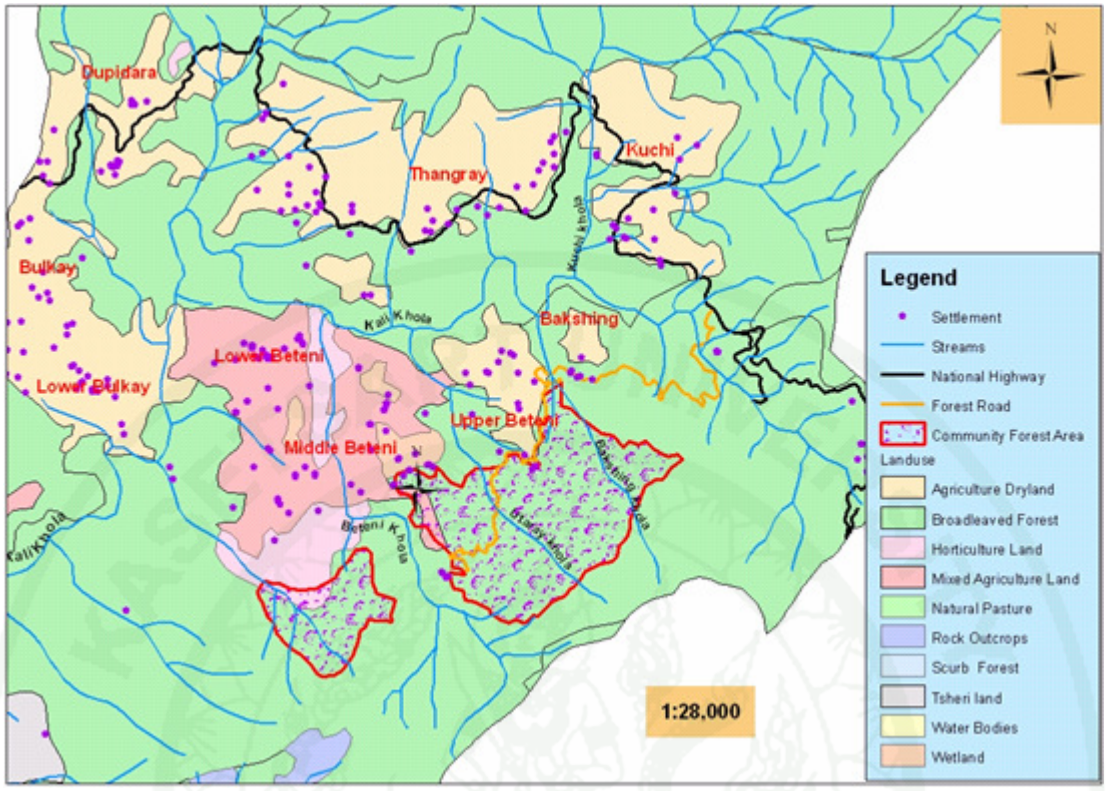

Figure 8 Map of Yargey community forest

Discussion

1. Supply and Demand of Timber

Majority of the timber consumers like sawmill/furniture house owners, general timber consumers and contractors demanded timber in sawn form. Except some few wanted additional timber in log form. Considering all these facts, a direct sale can be negotiated with the relevant timber buyers. Further more, an auction can also be arranged as per the prevailing market demand as well in order to obtain higher profit. Therefore, the CFMG had two options at hand for selling timber in the near future.

However, the current growth rate of timber species per unit area in the CF could not be accesses due to severe limit of data from the field. A good indicator of

timber supply was based on the growing stock in the current year minus growing stock for the last year.

The timber of *michelia cathcartii* had the maximum demand and preference from the consumers and subsequently the supply was comparatively high compared to other timber species. However, the abundance of the standing volume of this particular species was low compared to the *castanopsis* species. Therefore, creation of forest plantation of *michelia cathcartii* within the open and barren areas inside the CF must be initiated and encouraged for the future sustainability of this species in particular.

2. Timber Marketing Channel

As of now, the transportation of sawn timber from processing site to the road head and loading was purely done by the community members manually without any cost. While bringing this transportation cost to the monetary value, it amounts to Nu.2, 100.60. Therefore, the timber transportation cost was Nu. 10.00 per cubic feet. For the timber marketing, only the transportation to road head point had to be born by the CFMG and then it was further taken to the destination by the consumer themselves. The minimum marketing cost showed the best marketing performance of the CFMG.

However, the above activities like carriage and loading of sawn timber was not at all felt necessary. This was an extra burden for the community just in order to attract the timber consumer in the long run. It was not seen as a healthy practice. The CFMG were willing to ban this strategy from here after and instead charge for loading and transportation cost and earn some cash income.

3. Financial Analysis of Cost and Return

The Yargey CFMG members were never involved in producing and selling timber, they lacked the necessary organizational, technical skills and knowledge in

marketing. However, the study indicated a higher profit obtained from lumber production than timber production with 44.76/ ft^3 and 4.30/ ft^3 respectively. This was mainly attributed due to low cost and high benefit from the added value of lumber production. Nevertheless, the furniture house owners could make maximum profit from the production of sofa set, show case and bookshelf. But the availability of consumers for the same goods needs to be studied.

The CFMG could have made maximum profit had it been employed their own community members to work with power chainsaws and processing timber for marketing. This was clearly revealed from the financial analysis for 2009**.** So, it was felt important to build their capacity on financial analysis and development process to establish logs/timber interest groups who would gain marketing knowledge (Thoma and Camara, 2005) and understand the production and value chain of their products. Furthermore, they would realize and better understand their chances of establishing firm marketing structures in order to by pass middlemen would be much higher if they join forces to promote the formation of associations amongst forest committees to strengthen their capacity and their negotiation power, a bigger portion of the profit would be benefiting the CFMG and enhancing employment in the village.

3. Maximizing Economic Potential: Sand, Boulders and Forest Plantation

CF in Bhutan had an ideal place in the country's key planning policies with direct linkages to governance of renewable natural resources; decentralisation and devolution; commercial harvesting of NWFPs/Timbers, and poverty reduction (Gilmour, 2009). However, at present CFMGs do not totally own their CFs and it was under the states ownership. If there was any activity carried out without referring to management plan or the FNCR, then it would be reverted back to GRF.

As of now, many CFMGs could not make enough income from sale of either NTFPs or timber. This was mainly attributed due to the longer maturity period for timber and NTFPs. The forest and nature conservation act considers sand and boulders as forest produce, but the RGoB (2006) specified that, surface collection of

these products was not permitted for CFMGs. This contradicts to the ability of CFMGs to manage their CF with full ownership and effectively.

SFD (2010) argued that, all the forest resources like sand and boulders within the vicinity of CF must be allowed for surface collection by CFMGs, as long as this activity does not have any environmental effects and also to permit existing forest plantations to be included in CFs, if the forest plantations are located within the traditional boundaries of the village forest.

Currently, the income sources were in abundance, for instance, sand, boulder and forest plantations that falls within the CFs could be handed over to the community. This would result into immediate cash flow and lead towards greater positive impact to the livelihood development at the rural community level. They could sale sand, boulder and matured timber from plantations and generate good income at the same time without compromising the sustainable supply of timber resource and environmental effects.

4. Simple Annual Harvesting Limit Ensuring Sustainable Forest Management

The application of the principles of sustainable forest management was key for the achievement of the CF development and conservation goals. Forest management should be based on the application of good science about the ecology and silviculture of the main forest types of the country. At present, the annual harvest limit for timber was calculated in a rather formula based, and there were big concerns about the validity of its calculation. What was actually required were simple guidelines and utilisation procedures which would make sense and easy for CFMG members and extension staff so that, they could apply them in an adaptive manner to suite the particular local circumstances (DoF, 2009).

5. Income Generation

There was significant chance for the CFMGs to generate substantial benefits from the sustainable management of CFs through the sale of timber, firewood, NWFPs, enterprise development and marketing. To realise this potential, it was important to inculcate simple procedures for the communities while selling timber products.

Some CFs were set up purely to provide the institutional set up for the commercial use of NWFPs. Tremendous efforts were made across the country, due to the support from institutions and organisations, to promote NWFPs to generate income (Peldon, 2009). Similar institutional framework could be extended with the partnership from various institutions and enhance income generation from timber also.

There was significant potential for income generation through sale of timber by the CFMG. Till today, marketing of timber was solely done by NRDCL, which was highly regulated in nature. All the rural households were entitled to get a defined quota of volume of timber for their own new construction and repair at a subsidised royalty rate (RGoB, 2006). This prevailing policy affected the market and acts as barrier for the CFMGs to manage their CFs for timber production. The RGoB (Royal Government of Bhutan) had reviewed its policy regarding the marketing of timber. In future, it was intended to phase out the supply of subsidised rural timber and to meet the demand for rural timber from CFs.

Nevertheless, there was a promising potential for the CFMGs to generate significant income from the sale of timber in the long run. Until now, only a few CFMGs had started commercial use of timber. Some CFMGs had also expressed their interest in timber processing activities such as sawing and carpentry to add value to their products. Therefore, marketing and pricing and developing a viable timber business are new areas for the CFMGs, for which support must be rendered at all times by forestry extension staff (Beck, 2009).

Like in other countries, the Department of Forestry, in collaboration with international projects, could fully support the community's efforts in the sustainable harvesting, processing and marketing of timber from community forest (Veer, C. and *et al,*. 1997). Since the Department of Forest was purely involved in the forest products market and maintains a differential pricing policy for forest products in urban and rural areas, Government could also instruct NRDCL to assist the CFMGs in this regard.

The study on economic such as distribution of benefits and political equity like participation in decision making were found relatively high levels of equity in Bhutan, compared to reports from neighbouring countries. This was mainly explained by four factors such as ethnic homogeneity, active participation of women, supportive government policy and strong extension support (SFD 2010). Further more, a subsequent study (Namgay and Sonam, 2007) identified inequity in benefit sharing as an emerging issue in the country. This was highly experienced in Nepal and had serious burden at the individual as well as at the communal level. Time had also reached in Bhutan to explore and look into this matter.

7. Capacity Development

It was noticed that, the capacities for the implementation of CF programme had increased significantly at all levels over the last couple of years. The gradual increase in demand for CFs lead to more work loads for DoFPs staff and had, in some places, put a serious strain on foresters, especially on extension staff (Tshering, 2009). Due to the maturing of the CF programme and the emergence of new areas such as poverty reduction, income generation, gender and governance highlight the need for the continuation of the development of capacities for CFMGs. To address the increased workload of foresters, the DoFPs should explore possibilities to outsource some part of the work to private firms.

Another area for further capacity development included building capacities of the CFMGs to manage both forest resources as well as the group, and of

forestry extension staff to support the CFMGs in planning and management of CFs, and also in complex issues such as income generation and poverty reduction. Need was felt to further develop in-country training and research capacities, particularly to address and understand social and socio-economic aspects in rural communities within forestry officials (SFD,2010).

8. Monitoring and Evaluation System for the CF Programme

CF had become an important programme in Bhutan encompassing high expectations regarding its expected socio-economic impacts in the years to come. The numbers of CFs was expanding across all parts of the country very rapidly. This encouraging dynamic emphasises the need to monitor processes, activities and outcomes and to evaluate the impact of the CF programme to ensure its quality and benefit to the rural communities. Thus, it was felt necessary to monitoring and evaluation by the relevant Government agencies involved in CF program.

9. Timber Demand Fluctuation within CFMG

There would be demand fluctuation for timber consumption by the CFMGs in the long run. This was due to increase in population and house hold fragmentation. So, there would be drastic increase in demand for timber from the CFMGs. Therefore, CFMGs cannot sell enough timber even though the management plan allows them. This would directly lead to low income generation. So, a resource assessment in the CFs should be done to estimate the AHL. Thus, this would serve as a barrier for income generation. The suitable option for this would be to collaborate with health ministry and continue with family planning scheme and at least keep the population growth rate low.

CONCLUSION AND RECOMMENDATION

Conclusion

As per the present timber demand and prevailing market price, Yargey CF has good potential to generate income from the sale of excess timber in future. This study had proved that, economic potential from timber production within CF was possible without any compromise to sustainability of the timber supply. The study on Economic Potential of Timber Production from Community Forest under Tsirang District in Bhutan, was mainly focussed on four aspects. These included as follows:

The first aspect consisted of investigation of the supply and demand of timber from the CF. The major finding from study was that, CF had standing timber volume of 938,084.25 Cu. ft during field survey in 2009. Out of these, *Castanopsis* species had the highest timber volume with 378,491.06 Cu. ft (40.34 %) followed by, other timber species like *Helicia nilagirica* and *Bucklandia populnea* 349,864.18 Cu. ft. (37.30 %). *Michelia cathcartii* also had comparatively high timber volume production with 128,543.93 Cu. ft. (13.70 %). While *Daphnephyllum himalense* had the lowest timber volume stocks with 34,131.34 Cu. ft. (3.64%).

The volume of timber demanded by the CFMG was the highest with 4,663.74 Cu. ft (88.65 %) and the Contractor with 387.10 Cu. ft (7.36%). While the volume of timber consumption, by general timber consumer was the lowest with 210.06 Cu. Ft (3.99 %). The timber consumption by contractor and general timber consumer was comparatively low since the community forest was established newly in 2008. However, the CFMG used the timber entirely for their domestic consumption such as new house construction and repair.

The study showed that, *Michelia cathcartii* was the highly preferred timber species among the general timber consumers and contractors. During two different semi structured interviews administered. 70 percent of the contractors opted for

purchase of timber in sawn form. On the other hand, 74.51 percent of general timber consumers opted for sawn timber.

From the study, the Pt variable showed that, the relation among price and demand for timber was positive, which mean that when timber price increased the quantity of demand for timber also increased. This was because the demand for timber does not have met with market's true demand or the furniture was an essential product for market and price was not a matter for consumption of the market.

R^2 of this equation was 0.9373 which means that the deviation of the dependent variable (Dt) could be explained by the explanatory variable (Pt) about 93.73%. From the Durbin -Watson test for the serial correlation, the computed DW vale was equal to 1.8866; this indicated that, based on the table for DW critical value of 5 observations, which was almost equilibrium to 6, that was the smallest number of observation, appeared in the DW table. Hence in this coefficient could be interpreted that, there was no problem on serial correlation for the obtained demand function.

The time variable showed that, the relation among time and price for timber was positive, which means that the price for timber increased through time. This was because of inflation rate and chance of merchant who see that demand for timber still increased and the timber remained still as a necessary material for furniture production.

R^2 of this equation was 0.9670 which means that the deviation of the dependent variable (Dt) could be explained by the explanatory variable (Pt) about 96.70%. From the Durbin -Watson test for the serial correlation, the computed DW vale was equal to 1.6361; this indicated that, based on the table for DW critical value of 5 observations, which was almost equilibrium to 6, that was the smallest number of observation, appeared in the DW table. Thus, in this coefficient could be interpreted that, there was no problem on serial correlation for the obtained demand function.

The second aspect involved exploring the potential timber buyers. From this study it was indicated that, the annual consumption of timber for Saw miller was the highest with 150,000 Cu. ft (79%) and the contractor with 40,821.42 Cu. ft (21%). General timber consumer had the lowest annual timber demand with 210.06 Cu. ft. For the Yargey CF, the saw miller ranked the top most potential timber purchaser followed by contractor. The General Timber Consumers were also considered equally important as potential timber purchasers in the near future.

The third aspect included analyzing the timber marketing channel. The major findings of the study was that, the timber from CF were supplied to three consumers namely, CFMG members at the local level, contractors and general timber consumers at the district level. The timbers purchased by the contractors were further consumed by the Government agencies for construction purpose. It was indicated that, out of 5260.90 cubic feet of timber produced from the CF, 4663.74 cubic feet (89%) was consumed by the CFMG members for their domestic use, 387.10 cubic feet (7%) was consumed by contractors and 210.06 cubic feet (4%) consumed by general timber consumers. The minimum marketing cost of Nu. 10/Cu. ft of timber showed the best marketing performance of the CFMG in timber trade.

The fourth aspect consisted of analyzing the financial return from lumber and furniture production cost which includes labor cost, material cost, transportation cost to site and machinery cost were computed and totaled up and subtracted from the total revenue collected from lumber production. The study found that, the profit obtained from 267 cu. ft of timber production was Nu. 4.30/cu.ft. Where as, the profit from lumber production was Nu. 44.76/cu.ft. Thus, it was observed that, the profit from lumber production was much higher than timber production. This was mainly because of the added value for lumber production.

The study also indicated that, the profit from sofa set production was the highest with Nu. 3931.30/ set followed by show case with Nu. 2185.57/ piece, book shelf with Nu. 1685.57/ piece. However, the income from chair production was observed to be the lowest with Nu. 443.33/ piece.

Recommendation

1. To encourage the CFMGs to sell their timber through auction to gain wider experience and further more to obtain higher price for the timbers coming from their community forest. This could be collaborated by the Dzongkhag forest office, Territorial forest office and NRDCL together.

2. Due to the lack of forest growth rate data within the CF, there was uncertainty in the annual growth rate of various tree species. Thus the exact timber growing in the CF could not be calculated. This was an area that clearly needs further study.

3. At present only timber and some NTFPs were included in the CF management regimes. It was recommended to include surface collection of stones and sand, forest plantation and eco-tourism such as tourism, bird watching, botanical excursion, recreation and also water resources to cater for other beneficial goods and services to the local communities.

4. Additional research was required for long term data collection and analysis of permanent sample plots in CFs which could help Department of Forest and Park Services to be in a better position to suggest management options for the communities, particularly for the commercial timber utilization matters.

5. To initiate and encourage the need to monitor on socio-economic impacts of the CF programme to ensure its quality and benefit at the local community level and as well as to the individual house hold level. This could be carried out by the agencies working directly for CF program.

6. There was need for further capacity development which includes both capacities of the CFMGs to manage both forest resources as well as the group, and of Dzongkhag forestry staff to support the CFMGs in complex issues like income generation aspects.

7. To link CFMGs with private entrepreneurs in order to facilitate processing and marketing of forest products. Further more, to build capacity on income generation with particular focus on product development and marketing aspects enhancing added value for future. Since the study indicated *Michelia cathcartii* as the highly preferred timber species among the general timber consumers and contractors, encouraging plantation of this species within CF was recommended as well.

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APPENDICES

Appendix A

List of Questionnaires for the Relevant Stakeholders.

Appendix A1. SSI (Semi structured Interview) questionnaires for Community Forest Management Group Members, Yargey Community Forest, Patshaling block, Tsirang District, on annual timber demand from their Community Forest.

1. Date of interview:

a) Location:

b) Name of respondent:

c) Sex: Male ☐ Female ☐ (Tick)

d) Age: years

e) Marital Status: Married ☐ Unmarried ☐ (Tick)

f) What is your Education qualification?

2. What Type of house do you have? (One storey/two storey/Cement and wood /wood and mud or others, please specify).

3. How many numbers of houses do you have?

4. What is your annual Timber requirement for new house construction in Cu. ft?

5. What is your annual Timber requirement for house repair in Cu. ft?

6. What is your annual Timber requirement for other uses such as shingle, cattle shade, agriculture store, poultry, pigsty, agriculture tools, furniture making, toilet construction and firewood shade etc in Cu. ft?

Appendix A2. SSI questionnaires for General Timber Consumers, Damphu town on annual timber demand from Community Forest.

1. Date of interview:

a) Location:

b) Name of respondent:

c) Sex: Male ☐ Female ☐ (Tick)

d) Age: years

e) Educational qualification:

1. Do you find it easy or difficult to get timber these days?
   Difficult ☐ Easy ☐ (Tick)
2. If you face difficulty, please justify?
4. If you find easy, please justify?
5. Where do you buy timber from?
6. Do you like to buy timber from Community Forestry in Patshaling block, Tsirang?

a) Yes ☐ No ☐ (Tick)

7. If yes, what are your choices of timber species from Tite champ/katus/pipli/ Lekh chilaunay, bandaray, lal chandan etc present in the CF?
   a. Highly preferred species:
   b. Medium preferred species:
   c. Least preferred species:
8. If no choices, please justify?

Note:

1. Tite champ = *Michelia Cathcartii* *4.* Lal chandan = *Daphnephyllum himalayense*
2. Katus = *Castonopsis species* *5.* Lekh chilaunay = *Nyssa javanica*
3. Pipli = *Bucklandia populnia* *6.* Bandaray = *Holicia nilagirica*

9. Do you prefer timber in sawn form or log form?

a) Log ☐ Sawn ☐ Both ☐ (Tick)

b) Why?

What is your preference of timber in log form?

a) High preference ☐ Medium preference ☐ Low preference ☐ (Tick)

What is your preference of timber in sawn form?

a) High preference ☐ Medium preference ☐ Low preference ☐ (Tick)

What is you annual timber requirement in cubic feet in case of sawn form?

What is you annual timber requirement in cubic feet in case of log form?

Would you like to transport timber by yourself or can CFMG assist to transport timber for you?

10. Do you find it far or near to buy timber from Yargey CF?

a) Near ☐ Far ☐ (Tick)

11. What is your choice of timber purchase, on fixed prevailing price or sit for auction?
12. What are the reasons for your above choice?

Appendix A3. SSI questionnaires for Saw mill owner, Damphu and Gelephu towns on annual timber demand from Community Forest.

1. Date of interview:
   a) Location:
   b) Name of respondent:
   c) Sex: Male ☐ Female ☐(Tick)

d) Age: years

e) Educational qualification:

2. Do you find it easy or difficult to get timber these days?

Difficult ☐ Easy ☐ (Tick)

3. If you face difficulty, please give reasons?
4. If you find easy, please give reasons?
5. Where do you buy timber from?
6. Do you like to buy timber from Community Forestry in Patshaling block, Tsirang?

   a) Yes ☐ No ☐ (Tick)

7. If yes, what are your choices of timber species from Tite champ/katus/pipli/ Lekh chilaunay, bandaray, lal chandan etc present in the CF?

   a. Highly preferred species:
   b. Medium preferred species:
   c. Least preferred species:

8. If no choices, please justify?
9. Do you prefer timber in sawn form or log form?

a) Log ☐ Sawn ☐ Both ☐ (Tick)

b) Why?

10. What is your preference of timber in log form?

a) High preference ☐ Medium preference ☐ Low preference ☐ (Tick)

11. What is your preference of timber in sawn form?

a) High preference ☐ Medium preference ☐ Low preference ☐ (Tick)

12. What is you annual timber requirement in cubic feet in case of sawn form?
13. What is your annual timber requirement in cubic feet in case of log form?
14. Would you like to transport timber by yourself or can CFMG assist to transport timber for you?
15. Do you find it far or near to buy timber from Yargey CF?

    a) Near ☐ Far ☐ (Tick)

16. What is your choice of timber purchase, on fixed prevailing price or sit for auction?
17. What are the reasons for your above choice?

Appendix A4. SSI questionnaires for Furniture House owner, Gelephu town on annual timber demand from Community Forest.

1. Date of interview:

a) Location:

b) Name of respondent:

c) Sex: Male ☐ Female ☐ (Tick)

d) Age: years

e) Educational qualification:

2. Do you find it easy or difficult to get timber these days?

Difficult ☐ Easy ☐ (Tick)

3. If you face difficulty, please give your reasons?
4. If you find easy, please give your reasons?
5. Where do you buy timber from?
6. Do you like to buy timber from Community Forestry in Patshaling block, Tsirang?

   a) Yes ☐ No ☐ (Tick)

7. If yes, what are your choices of timber species from Tite champ/katus/pipli/ Lekh chilaunay, bandaray, lal chandan etc present in the CF?

   a. Highly preferred species:
   b. Medium preferred species:
   c. Least preferred species:

8. If no choices, please justify?
9. Do you prefer timber in sawn form or log form?

a) Log ☐ Sawn ☐ Both ☐ (Tick)

b) Why?

10. What is your preference of timber in log form?

a) High preference ☐ Medium preference ☐ Low preference ☐ (Tick)

11. What is your preference of timber in sawn form?

a) High preference ☐ Medium preference ☐ Low preference ☐ (Tick)

12. What is you annual timber requirement in cubic feet in case of sawn form?
13. What is you annual timber requirement in cubic feet in case of log form?
14. Would you like to transport timber by yourself or can CFMG assist to transport timber for you?
15. Do you find it far or near to buy timber from Yargey CF?

    a) Near ☐ Far ☐ (Tick)

16. What is your choice of timber purchase, on fixed prevailing price or sit for auction?
17. What are the reasons for your above choice?

Appendix A5. SSI questionnaires for Contractors in Tsirang and Gelephu towns on annual timber demand from Community Forest.

1. Date of interview:

a) Location:

b) Name of respondent:

c) Sex: Male ☐ Female ☐(Tick)

d) Age: years

e) Educational qualification:

2. Do you find it easy or difficult to get timber these days?

Difficult ☐ Easy ☐ (Tick)

3. If you face difficulty, please give your reasons?
4. If you find easy, please give your reasons?
5. Where do you usually buy timber from?
6. Do you like to buy timber from Community Forestry in Patshaling block, Tsirang?

   a) Yes ☐ No ☐ (Tick)

7. If yes, what are your choices of timber species from Tite champ/katus/pipli/ Lekh chilaunay, bandaray, lal chandan etc present in the CF?

   a. Highly preferred species:
   b. Medium preferred species:
   c. Least preferred species:

8. If no choices, please give reasons?
9. Do you prefer timber in sawn form or log form?

a) Log ☐ Sawn ☐ Both ☐ (Tick)

b) Why?

10. What is your preference of timber in log form?

a) High preference ☐ Medium preference ☐ Low preference ☐ (Tick)

11. What is your preference of timber in sawn form?

a) High preference ☐ Medium preference ☐ Low preference ☐ (Tick)

12. What is you annual timber requirement in cubic feet in case of sawn form?
13. What is you annual timber requirement in cubic feet in case of log form?
14. Would you like to transport timber by yourself or can CFMG assist to transport timber for you?
15. Do you find it far or near to buy timber from Yargey CF?

a) Near ☐ Far ☐ (Tick)

16. What is your choice of timber purchase, on fixed prevailing price or sit for auction?

17. What are the reasons for your above choice?

Appendix A6. Focus Group Interview with CFO Staff and DzFO Staff, (Damphu) and Park Staff, (Gelephu), on timber sale from Community Forest (Auction or direct sale).

1. Date of Focus group discussion:

a) Location:

2. What is your opinion towards timber sale from community forest?

Strongly favour ☐ Favour ☐ Strongly oppose ☐ Oppose ☐ (Pl.Tick in box

b) Why?

3. What will be the impacts of timber marketing on the incomes for the community group?

High ☐ Medium ☐ Low ☐ (Pl. Tick in box)

b) Why?

3. What timber sale options do you advice for the Community Forest Management Group?

Auction ☐ Direct sale ☐ (Pl. Tick in box)

a) Why?

4. In what forms the timber should be sold?

Log ☐ Sawn ☐ Both ☐ (Pl. Tick in box)

b) Why?

6. What is your preference of timber sale in log form on behalf of CFMG?

a) High preference ☐ Medium preference ☐ Low preference ☐ (Tick)

7. What is your preference of timber sale in sawn form on behalf of CFMG?

a) High preference ☐ Medium preference ☐ Low preference ☐ (Tick)

8. Who should do the loading of timber in the forest?

CFMG ☐ buyer ☐ (Tick)

a) Why?

9. Who should carry out the transportation of timber from community forest to the consumer's destination?

CFMG ☐ Buyer ☐ (Pl. Tick in box)

a) Why?

10. What are the challenges that CFMG come across while harvesting the timber?

11. What suggestions do you have to make the timber harvest more effective and efficient?

12. What are the challenges that CFMG come across while processing the timber in the community forest?

13. What suggestions do you have to make the timber processing more effective and efficient?

14. What are the challenges that CFMG come across while marketing the timber?

15. What suggestions do you have to make the timber marketing more effective and efficient?

Note:

CFO Chief Forestry Office

DzFO Dzongkhag Forestry Office

CFMG Community Forest Management Group

Appendix A7. Focus Group Discussion with CFMG members on timber sale from Community Forest through Auction or direct sale.

1. Date of interview:

a) Location:

b) Name of respondent:

c) Sex: Male ☐ Female ☐(Tick)

d) Age: years

2. What is your opinion towards timber sale from community forest?

Strongly favour ☐ Favour ☐ Strongly oppose ☐ Oppose ☐ (Pl.Tick in box

b) Why?

3. What are the impacts of timber marketing on the incomes for the community group?

High ☐ Low ☐ medium ☐ (Pl. Tick in box)

c) Why?

4. What timber sale option do you like for the Community Forest Management Group?

Auction ☐ Direct sale ☐ (Pl. Tick in box)

b) Why?

5. In what form the timber should be sold?

Log ☐ Sawn ☐ Both ☐ (Pl. Tick in box)

a) Why?

6. What is your preference of timber sale in log form on behalf of CFMG?

a) High preference ☐ Medium preference ☐ Low preference ☐ (Tick)

7. What is your preference of timber sale in sawn form on behalf of CFMG?

a) High preference ☐ Medium preference ☐ Low preference ☐ (Tick)

8. Who should do the loading of timber in the forest?

CFMG ☐ buyer ☐ (Pl. Tick in box)

a) Why?

9. Who should carry out the transportation of timber from community forest to the consumer's destination?

CFMG ☐ Buyer ☐ (Pl. Tick in box)

a) Why?

10. What are the challenges that you have come across while harvesting the timber?

11. What suggestions do you have to make the timber harvest more effective and efficient?

12. What are the challenges that you have come across while processing the timber in the community forest?

13. What suggestions do you have to make the timber processing more effective and efficient?

14. What are the challenges that you have come across while marketing the timber?

15. What suggestions do you have to make the timber marketing more effective and efficient?

Appendix A8. Focus Group Discussion with CFMG members on community fund allocation.

1. Date of interview:

a) Location:

b) Name of respondent:

c) Sex: Male ☐ Female ☐(Tick)

d) Age: years

2. Do you have any fund raising sources for the development of community forest?

a) Yes ☐ No ☐ (Tick)

b) If yes, what fund sources do you have for raising community forest fund?

3. How much fund is collected till now?

4. Where is your fund at present?

5. How much is the interest rate per annum?

6. Do you allocate fund for the development of CF and the community livelihood?

a) Yes ☐ No ☐ (Tick)

b) If yes, in which areas do you allocate the fund?

6. How much percent is allocated for each area?

Area	**Budget amount**
a) Loan disbursement	
b) Plantation and fencing work	
c) Development of CF nursery	
d) Construction of CF office	
e) Reward for CF committee members	
f) Logistic arrangement to guest/visitors.	
g) Poor and needy's Welfare	

9. Did you already invest some cash for the community forest development?

a) Yes ☐ No ☐ (Tick)

b) If no, please mention the reasons?

c) If yes, for what purpose? (please specify the amount of budget used)

10. Did you already invest some cash for the development of community livelihood?

a) Yes ☐ No ☐ (Tick)

b) If no, please mention the reasons?

c) If yes, for what purpose?

Appendix A9. Questionnaires for Financial Analysis of Timber logging work with Lucas mill owner

1. Date of interview:

a) Location:

b) Name of respondent:

c) Sex: Male Female (Tick)

d) Age:

I. Labour Cost

2. How many man days are required for felling a matured tree?

a) What is the cost per man day or hour?

b) How many man days are required for cross cutting the tree?

c) What is the cost per man day or hour?

d) How many man days are required for sawing 1m cube of log?

e) What is the cost per man days or hour?

f) How many man days are required for sorting and staking of $1m^3$ of sawn lumber?

g) What is the cost per man days or hour?

II. Machinery Cost

3. What types of other machines are used with your Lucas mill?

a) What are the current prevailing prices of your Lucas mill and other machines?

b) What are the life spans of your Lucas mill and other machines?

III. Material Cost

4. How much litre of oil is consumed for sawing $1m^3$ of log?

a) What is the price of oil per litre?

b) What other materials cost do you have?

c) What are their prices?

IV. Transportation Cost

5. What is the transportation cost of Lucas mill and other machines to the work site per km?

6. Do you have any comments?

Table 1 Labour cost for timber logging work per cu. ft

Activity	Quantity (man day)	Wage (Nu/man day)	Value (Nu)
1. Timber logging cost			
2. Timber processing			

Table 2 Machinery cost for timber logging work per cu. ft

Type of machine	Quantity (number)	Price (Nu)	Value (Nu)	life span (Year)
1. Lucas mill				
2. Power chain saw				

Table 3 Material cost for timber logging work per cu. ft

Type of material	Quantity (Cu. ft)	Price (Nu/litre)	Value (Nu)
1. Patrol (Lucas mill)			
2. Mobil (Lucas mill)			
3. Petrol (Power chain saw)			
4. Mobil (Power chain saw)			
5. 2 T (Power chain saw)			
6. Chain (Power chain saw)			
7. Saw sharpener (Power chain saw)			

Table 4 Transportation cost of timber from processing site to road head per cu. ft

Type of transportation	Quantity (Cubic feet/Truck load)	Price (Nu/cubic feet)	Value (Nu)
1. Manual			

Table 5 Transportation cost of lucas mill to the logging site

Type of transportation	Quantity (Cubic feet/Truck load)	Price (Nu/cubic feet)	Value (Nu)
1. DCM Truck			

Appendix A10. Questionnaires for Production, transportation, price and value of timber products with the direct actor (Chairman, Community Forest Management Group)

1. Date of interview:
a) Location:
b) Name of respondent:
c) Sex: Male ☐ Female ☐ (Tick)
d) Age: years
2. What timber products did you sell?
3. What is your timber product cost per cubic feet?
4. To whom did you sell the timber products?
5. What is the total quantity (cubic feet) of timber that you sold by timber products types (beam and planks)?
6. What is your timber products transportation cost (cubic feet) to the road head point?
7. What are you opportunities that you observe while participating in timber product marketing chain?
8. What are you constraints that you observe while participating in timber product marketing chain?

Table 6 Production, price and value of timber products with the direct actor (chairman, community forest management group)

Type of timber product	Quantity of total Production/annum (Cu.feet)	Price (Nu/cu.feet)	Value (Nu)
1. Sawn timber (beam)			
2. Sawn timber (plank)			

Table 7 Transportation, price and value of timber products with the direct actor (chairman, community forest management group)

Type of transportation	Quantity of total Production/annum (Cu.feet)	Price (Nu/cu.feet)	Value (Nu)
1. Manual			

Appendix A11. Questionnaires for consumption, transportation, price and value of timber products with indirect actor (Contractor).

1. Date of interview:
a) Location:
b) Name of respondent:
c) Sex: Male ☐ Female ☐ (Tick)
d) Age: years
2. What timber products did you buy?
3. What is your timber product cost per cubic feet?
4. To whom did you sell the timber products?
5. What is your timber products selling price by timber products types (beam and plants)?
6. How do you transport the timber products?
7. What is your transportation cost of timber product per cubic feet?
8. How much sale tax (%) do you pay when you buy the timber products?
9. What is your final profit margin?
10. What are you opportunities that you observe while participating in timber product marketing chain?
11. What are you constraints that you observe while participating in timber product marketing chain?

Table 8 Consumption, price and value of timber products with the indirect actor (contractor)

Type of timber product	Quantity of total Consumption/annum (Cu.feet)	Price (Nu/cu.feet)	Value (Nu)
1. Sawn timber (beam)			
2. Sawn timber (plank)			

Table 9 Transportation, price and value of timber products with the indirect actor (contractor)

Type of transportation	Quantity of total Consumption/annum (T/L)	Price (Nu/cu.feet)	Value (Nu)
1. Truck			

Appendix A12. Questionnaires for consumption, transportation, price and value of timber products with indirect actor (General Consumer).

1. Date of interview:
a) Location:
b) Name of respondent:
c) Sex: Male ☐ Female ☐ (Tick)
d) Age:
2. What timber products did you buy?
3. What is your timber product cost per cubic feet?
4. To whom did you sell the timber products?
5. What is your timber products selling price by timber products types (beam and plants)?
6. How do you transport the timber products?
7. What is your transportation cost of timber product per cubic feet?
8. How much sale tax (%) do you pay when you buy the timber products?
9. What is your final profit margin?
10. What are you opportunities that you observe while participating in timber product marketing chain?

11. What are you constraints that you observe while participating in timber product marketing chain?

Table 10 Consumption, price and value of timber products with the direct actor (general timber consumer)

Type of timber product	Quantity of total Consumption/annum (Cu.feet)	Price (Nu/cu.feet)	Value (Nu)
1. Sawn timber (beam)			
2. Sawn timber (plank)			

Table 11 Transportation, price and value of timber products with the direct actor (general timber consumer)

Type of transportation	Quantity of total Consumption/annum (T/L)	Price (Nu/cu.feet)	Value (Nu)
1. Truck			

Appendix A13. Questionnaire for Range office, Damphu, to explore potential timber consumer.

1. Date of interview:

a) Location:

b) Name of respondent:

c) Sex: Male ☐ Female ☐ (Tick)

d) Age:

2. Does the Range office supply timber on commercial basis?

Yes ☐ No ☐ Both ☐ (Tick)

3. If yes who are the main timber consumers?

4. Where are the timber consumers from?

5. What are their preferred timber species?

Broad leaf species ☐ Conifer species ☐ (Tick)

6. What are their annual timber demands as per their choice of species (Cu. ft) in 2009?

7. Is the Range office able to supply adequate timber from your jurisdiction to the consumers?

Yes ☐ No ☐ (Tick)

8. If no where do the consumers get their timber from?

Yes ☐ No ☐ Don't know ☐ (Tick)

Appendix A14. Questionnaire for Range Manager, NRDCL, Gelephu, to explore potential timber consumer.

1. Date of interview:

a) Location:

b) Name of respondent:

c) Sex: Male ☐ Female ☐ (Tick)

d) Age:

2. Does the Range office supply timber on commercial basis?

Yes ☐ No ☐ Both ☐ (Tick)

3. If yes who are the main timber consumers?

4. Where are the timber consumers from?

5. What are their preferred timber species?

Broad leaf species ☐ Conifer species ☐ (Tick)

6. What are their annual timber demands as per their choice of species (Cu. ft) in 2009?

7. Is the Range office able to supply adequate timber from your jurisdiction to the consumers?

Yes ☐ No ☐ (Tick

8. If no where do the consumers get their timber from?

Yes ☐ No ☐ Don't know ☐ (Tick)

Appendix A15. Questionnaire for Chairman, Yargey Community forest, Patshaling geog, to explore potential timber consumer.

1. Date of interview:

a) Location:

b) Name of respondent:

c) Sex: Male ☐ Female ☐ (Tick)

d) Age:

2. Does the Range office supply timber on commercial basis?

Yes ☐ No ☐ Both ☐ (Tick)

3. If yes who are the main timber consumers?

4. Where are the timber consumers from?

5. What are their preferred timber species?

Broad leaf species ☐ Conifer species ☐ (Tick)

6. What are their annual timber demands as per their choice of species (Cu. ft) in 2009?

7. Is the Range office able to supply adequate timber from your jurisdiction to the consumers?

Yes ☐ No ☐ (Tick)

8. If no where do the consumers get their timber from?

Yes ☐ No ☐ Don't know ☐ (Tick)

Appendix B

Figures.

SUMMARY OUTPUT

Regression Statistics	
Multiple R	*0.9682*
R Square	*0.9373*
Adjusted R Square	*0.9164*
Standard Error	*339.5825*
Observations	*5*

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	5174051.1667	5174051.1667	44.8684	0.0068
Residual	3	345948.8333	115316.2778		
Total	4	5520000.0000			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-1895.7830	1307.0438	-1.4504	0.2428	-6055.3797	2263.8137
Pt	60.3036	9.0027	6.6984	0.0068	31.6530	88.9543

Appendix Figure B1 Computer statistical program calculation result for the relation between quantity of timber demand and price of timber

RESIDUAL OUTPUT

Observation	*Predicted Dt*	*Residuals*
1	5340.6522	-340.6522
2	6124.5994	275.4006
3	6848.2429	151.7571
4	7390.9755	209.0245
5	8295.5299	-295.5299

PROBABILITY OUTPUT

Percentile	*Dt*
10	5000
30	6400
50	7000
70	7600
90	8000

DURBIN-WATSON

Residuals	*$(e_i-(e_{i-1})^2)$*	*(e_i^2)*
-340.6522		116043.9452
275.4006	379521.1183	75845.5007
151.7571	15287.7200	23030.2170
209.0245	3279.5505	43691.2244
-295.5299	254575.1423	87337.9460
Sum	652663.5312	345948.8333
D.W.	1.8866	

Appendix Figure B1 (Continued)

SUMMARY OUTPUT

Regression Statistics	
Multiple R	*0.9834*
R Square	*0.9670*
Adjusted R Square	*0.9560*
Standard Error	*0.0120*
Observations	*5*

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.0127	0.0127	88.0000	0.0026
Residual	3	0.0004	0.0001		
Total	4	0.0131			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	2.0711	0.0105	196.8493	0.0000	2.0376	2.1046
T	0.2041	0.0218	9.3808	0.0026	0.1349	0.2733

Appendix Figure B2 Computer statistical program calculation result for the relation between price of timber and time

RESIDUAL OUTPUT

Observation	*Predicted T*	*Residuals*
1	2.0711	0.0081
2	2.1325	-0.0087
3	2.1685	-0.0071
4	2.1940	-0.0064
5	2.2137	0.0141

PROBABILITY OUTPUT

Percentile	*T*
10	2.0792
30	2.1239
50	2.1614
70	2.1875
90	2.2279

DURBIN-WATSON

Residuals	*$(e_i-(e_{i-1})^2)$*	*(e_i^2)*
0.0081		0.0001
-0.0087	0.0003	0.0001
-0.0071	0.0000	0.0001
-0.0064	0.0000	0.0000
0.0141	0.0004	0.0002
Sum	0.0007	0.0004
D.W.	1.6361	

Appendix Figure B2 (Continued)

Ministry of Agriculture
Forest Resources Development Division

Volume Table (m^3)

Dbh (Cm)	Girth (Inches)	Conifer								Broadleaf																
		Bluepine	Chirpine	Fir	Hemlock	Juniper	Larch	Spruce	Oth. Conifers	Acer	Betula	Beilschmiedia spp.	Cinnamomum spp.	Litsea spp.	Michelia spp.	Oak spp. (W)	Oak spp. (C)	Oak spp. (E)	Oak spp. (S)	Oth. Broadl. (W)	Oth. Broadl. (C)	Oth. Broadl. (E)	Oth Broadl. (S)	Persea spp.	Rhododendron spp.	Schima spp.
10 - 14	12.4 - 17.3	0.056	0.030	0.091	0.044	0.050	0.054	0.063	0.050	0.073	0.057	0.051	0.037	0.047	0.052	0.054	0.057	0.053	0.058	0.049	0.046	0.043	0.053	0.052	0.045	0.053
15 - 19	18.5 - 23.5	0.135	0.080	0.195	0.098	0.122	0.126	0.148	0.114	0.152	0.134	0.120	0.094	0.107	0.120	0.132	0.134	0.124	0.137	0.113	0.110	0.102	0.124	0.120	0.104	0.125
20 - 24	24.7 - 29.7	0.260	0.167	0.344	0.179	0.238	0.239	0.281	0.211	0.262	0.252	0.228	0.191	0.198	0.225	0.256	0.255	0.233	0.260	0.211	0.213	0.197	0.234	0.223	0.193	0.239
25 - 29	30.9 - 35.9	0.438	0.299	0.542	0.290	0.406	0.397	0.469	0.345	0.406	0.417	0.382	0.336	0.323	0.369	0.434	0.426	0.387	0.435	0.347	0.361	0.332	0.388	0.367	0.317	0.399
30 - 34	37.1 - 42.0	0.675	0.485	0.792	0.433	0.633	0.606	0.717	0.520	0.584	0.635	0.585	0.537	0.485	0.559	0.673	0.652	0.590	0.666	0.527	0.559	0.512	0.591	0.555	0.478	0.614
35 - 39	43.3 - 48.2	0.980	0.734	1.094	0.612	0.926	0.870	1.033	0.739	0.797	0.911	0.843	0.803	0.688	0.796	0.982	0.940	0.846	0.961	0.752	0.814	0.743	0.848	0.791	0.680	0.886
40 - 44	49.4 - 54.4	1.356	1.055	1.453	0.827	1.292	1.194	1.422	1.005	1.046	1.248	1.161	1.142	0.933	1.086	1.365	1.293	1.160	1.324	1.027	1.131	1.029	1.163	1.079	0.926	1.222
45 - 49	55.6 - 60.6	1.810	1.456	1.868	1.080	1.737	1.583	1.888	1.321	1.333	1.650	1.542	1.562	1.224	1.431	1.830	1.718	1.537	1.760	1.355	1.515	1.374	1.541	1.421	1.218	1.627
50 - 54	61.8 - 66.8	2.347	1.947	2.343	1.374	2.267	2.039	2.437	1.690	1.657	2.123	1.992	2.070	1.562	1.833	2.382	2.218	1.978	2.274	1.739	1.970	1.783	1.984	1.821	1.559	2.104
55 - 59	68.0 - 72.9	2.973	2.534	2.879	1.710	2.888	2.568	3.074	2.113	2.020	2.669	2.513	2.673	1.950	2.297	3.028	2.798	2.489	2.870	2.182	2.501	2.258	2.496	2.281	1.951	2.658
60 - 64	74.2 - 79.1	3.691	3.228	3.477	2.090	3.606	3.171	3.802	2.594	2.421	3.291	3.110	3.380	2.390	2.824	3.772	3.462	3.072	3.553	2.686	3.113	2.805	3.081	2.805	2.396	3.293
65 - 69	80.4 - 85.3	4.508	4.035	4.138	2.515	4.425	3.854	4.627	3.134	2.863	3.994	3.787	4.197	2.883	3.418	4.619	4.213	3.731	4.327	3.253	3.811	3.427	3.742	3.393	2.896	4.013
70 - 74	86.5 - 91.5	5.427	4.964	4.865	2.987	5.352	4.618	5.552	3.735	3.344	4.781	4.545	5.132	3.432	4.080	5.576	5.057	4.468	5.195	3.887	4.597	4.127	4.481	4.050	3.454	4.822
75 - 79	92.7 - 97.7	6.454	6.023	5.657	3.507	6.391	5.467	6.581	4.401	3.866	5.654	5.390	6.191	4.038	4.813	6.647	5.995	5.287	6.162	4.590	5.477	4.908	5.303	4.778	4.071	5.723
80 - 84	98.9 - 103.8	7.591	7.220	6.517	4.076	7.548	6.405	7.718	5.132	4.430	6.617	6.324	7.381	4.702	5.620	7.838	7.033	6.191	7.231	5.364	6.454	5.774	6.210	5.578	4.749	6.721
85 - 89	105.1 - 110.0	8.845	8.564	7.445	4.696	8.827	7.434	8.968	5.930	5.035	7.672	7.350	8.709	5.428	6.502	9.152	8.173	7.182	8.407	6.211	7.532	6.729	7.205	6.453	5.490	7.818
90 - 94	111.3 - 116.2	10.218	10.061	8.443	5.367	10.234	8.557	10.334	6.798	5.681	8.823	8.471	10.183	6.215	7.463	10.595	9.419	8.264	9.691	7.133	8.715	7.775	8.290	7.405	6.295	9.018
95 - 99	117.4 - 122.4	11.715	11.720	9.511	6.092	11.773	9.777	11.818	7.737	6.371	10.073	9.691	11.808	7.066	8.503	12.171	10.774	9.438	11.089	8.133	10.007	8.916	9.468	8.437	7.167	10.324
100 - 104	123.6 - 128.6	13.340	13.550	10.651	6.871	13.449	11.097	13.426	8.749	7.103	11.423	11.013	13.592		9.624	13.885	12.241	10.708	12.603	9.212	11.411	10.154	10.743	9.549		11.739
105 - 109	129.8 - 134.7	15.096	15.556	11.863	7.705	15.266	12.519	15.160	9.835	7.879	12.877	12.438	15.541		10.830	15.742	13.824	12.076	14.237	10.373	12.930	11.493	12.116	10.745		13.268
110 - 114	136.0 - 140.9	16.988	17.749	13.149	8.595			17.024	10.998	8.698	14.437	13.971			12.122	17.745	15.525	13.544	15.994	11.617	14.570	12.935	13.589	12.025		14.912
115 - 119	142.2 - 147.1	19.019	20.134	14.508	9.543			19.020	12.239	9.561	16.105	15.613			13.501	19.898	17.348	15.116	17.877	12.947	16.332	14.483	15.166	13.393		16.674
120 - 124	148.3 - 153.3	21.193		15.943	10.549			21.153	13.559	10.468	17.885	17.368			14.971	22.208	19.296	16.793	19.889	14.363	18.220	16.141	16.849			18.559
125 - 129	154.5 - 159.5	23.513		17.454	11.615			23.425	14.960	11.420	19.779	19.237			16.531	24.676	21.371	18.577	22.034	15.869	20.238	17.911	18.640			20.568
130 - 134	160.7 - 165.7	25.983		19.041	12.741			25.840	16.443	12.417	21.788				18.184	27.308	23.576	20.471	24.313	17.465	22.389	19.795	20.541			
135 - 139	166.9 - 171.8	28.607		20.706	13.928			28.400	18.010	13.459	23.916				19.933	30.107	25.915	22.477	26.731	19.154	24.675	21.796	22.555			
140 - 144	173.1 - 178.0	31.388		22.449	15.178			31.108	19.663	14.546	26.164				21.778	33.078	28.389	24.598	29.290	20.936	27.101	23.918	24.684			
145 - 149	179.3 - 184.2	34.329		24.272	16.491			33.968	21.402	15.679	28.535				23.721	36.224	31.002	26.835	31.993	22.815	29.670	26.161	26.929			
150 - 154	185.4 - 190.4	37.433		26.173	17.868			36.982								39.549	33.756	29.191	34.842	24.791	32.384	28.530	29.294			
155 - 159	191.6 - 196.6	40.705		28.156	19.310			40.154								43.058	36.654	31.668	37.841	26.866	35.246	31.027	31.780			
160 - 164	197.8 - 202.7	44.147		30.219	20.818			43.485								46.753	39.698	34.267		29.042	38.260	33.654	34.390			
165 - 169	204.0 - 208.9	47.762		32.364	22.392											50.639	42.892	36.991		31.320	41.429	36.413	37.124			
170 - 174	210.2 - 215.1	51.553		34.592	24.034											54.720		39.842			44.755	39.307	39.986			
175 - 179	216.3 - 221.3	55.524		36.903	25.744											58.998		42.822			48.242	42.339	42.978			
180 - 184	222.5 - 227.5	59.678		39.297	27.523											63.478		45.933			51.892	45.511	46.100			
185 - 189	228.7 - 233.6	64.018		41.776	29.372											68.163		49.176				48.824	49.356			
190 - 194	234.9 - 239.8	68.546		44.339	31.292											73.057		52.554					52.747			
195 - 199	241.1 - 246.0	73.267		46.988	33.283											78.163		56.068					56.276			
200 - 204	247.2 - 252.2			49.723	35.346											83.484		59.720								
205 - 209	253.4 - 258.4			52.545	37.482											89.025		63.513								
210 - 214	259.6 - 264.6			55.454	39.691											94.789		67.447								
215 - 219	265.8 - 270.7			58.451	41.975																					
220 - 224	272.0 - 276.9			61.536	44.334																					
225 - 229	278.1 - 283.1			64.710	46.769																					
230 - 234	284.3 - 289.3			67.973	49.280																					
235 - 239	290.5 - 295.5			71.326	51.868																					
240 - 244	296.7 - 301.6				54.533																					
245 - 249	302.9 - 307.8				57.278																					
250 - 254	309.1 - 314.0				60.101																					

Appendix Figure B3 Volume table (m^3)

	k'=1		k'=2		k'=3		k'=4		k'=5		k'=6		k'=7		k'=8		k'=9		k'=10	
n	d_L	d_U	d_L	d_U	d_L	d_U	d_L	d_U	d_L	d_U	d_L	d_U	d_L	d_U	d_L	d_U	d_L	d_U	d_L	d_U
6	0.610	1.400	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
7	0.700	1.356	0.467	1.896	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
8	0.763	1.332	0.559	1.777	0.367	2.287	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
9	0.824	1.320	0.629	1.699	0.455	2.128	0.296	2.588	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
10	0.879	1.320	0.697	1.641	0.525	2.016	0.376	2.414	0.243	2.822	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
11	0.927	1.324	0.758	1.604	0.595	1.928	0.444	2.283	0.315	2.645	0.203	3.004	-----	-----	-----	-----	-----	-----	-----	-----
12	0.971	1.331	0.812	1.579	0.658	1.864	0.512	2.177	0.380	2.506	0.268	2.832	0.171	3.149	-----	-----	-----	-----	-----	-----
13	1.010	1.340	0.861	1.562	0.715	1.816	0.574	2.094	0.444	2.390	0.328	2.692	0.230	2.985	0.147	3.266	-----	-----	-----	-----
14	1.045	1.350	0.905	1.551	0.767	1.779	0.632	2.030	0.505	2.296	0.389	2.572	0.286	2.848	0.200	3.111	0.127	3.360	-----	-----
15	1.077	1.361	0.946	1.543	0.814	1.750	0.685	1.977	0.562	2.220	0.447	2.471	0.343	2.727	0.251	2.979	0.175	3.216	0.111	3.438
16	1.106	1.371	0.982	1.539	0.857	1.728	0.734	1.935	0.615	2.157	0.502	2.388	0.398	2.624	0.304	2.860	0.222	3.090	0.155	3.304
17	1.133	1.381	1.015	1.536	0.897	1.710	0.779	1.900	0.664	2.104	0.554	2.318	0.451	2.537	0.356	2.757	0.272	2.975	0.198	3.184
18	1.158	1.391	1.046	1.535	0.933	1.696	0.820	1.872	0.710	2.060	0.603	2.258	0.502	2.461	0.407	2.668	0.321	2.873	0.244	3.073
19	1.180	1.401	1.074	1.536	0.967	1.685	0.859	1.848	0.752	2.023	0.649	2.206	0.549	2.396	0.456	2.589	0.369	2.783	0.290	2.974
20	1.201	1.411	1.100	1.537	0.998	1.676	0.894	1.828	0.792	1.991	0.691	2.162	0.595	2.339	0.502	2.521	0.416	2.704	0.336	2.885
21	1.221	1.420	1.125	1.538	1.026	1.669	0.927	1.812	0.829	1.964	0.731	2.124	0.637	2.290	0.546	2.461	0.461	2.633	0.380	2.806
22	1.239	1.429	1.147	1.541	1.053	1.664	0.958	1.797	0.863	1.940	0.769	2.090	0.677	2.246	0.588	2.407	0.504	2.571	0.424	2.735
23	1.257	1.437	1.168	1.543	1.078	1.660	0.986	1.785	0.895	1.920	0.804	2.061	0.715	2.208	0.628	2.360	0.545	2.514	0.465	2.670
24	1.273	1.446	1.188	1.546	1.101	1.656	1.013	1.775	0.925	1.902	0.837	2.035	0.750	2.174	0.666	2.318	0.584	2.464	0.506	2.613
25	1.288	1.454	1.206	1.550	1.123	1.654	1.038	1.767	0.953	1.886	0.868	2.013	0.784	2.144	0.702	2.280	0.621	2.419	0.544	2.560
26	1.302	1.461	1.224	1.553	1.143	1.652	1.062	1.759	0.979	1.873	0.897	1.992	0.816	2.117	0.735	2.246	0.657	2.379	0.581	2.513
27	1.316	1.469	1.240	1.556	1.162	1.651	1.084	1.753	1.004	1.861	0.925	1.974	0.845	2.093	0.767	2.216	0.691	2.342	0.616	2.470
28	1.328	1.476	1.255	1.560	1.181	1.650	1.104	1.747	1.028	1.850	0.951	1.959	0.874	2.071	0.798	2.188	0.723	2.309	0.649	2.431
29	1.341	1.483	1.270	1.563	1.198	1.650	1.124	1.743	1.050	1.841	0.975	1.944	0.900	2.052	0.826	2.164	0.753	2.278	0.681	2.396
30	1.352	1.489	1.284	1.567	1.214	1.650	1.143	1.739	1.071	1.833	0.998	1.931	0.926	2.034	0.854	2.141	0.782	2.251	0.712	2.363
31	1.363	1.496	1.297	1.570	1.229	1.650	1.160	1.735	1.090	1.825	1.020	1.920	0.950	2.018	0.879	2.120	0.810	2.226	0.741	2.333
32	1.373	1.502	1.309	1.574	1.244	1.650	1.177	1.732	1.109	1.819	1.041	1.909	0.972	2.004	0.904	2.102	0.836	2.203	0.769	2.306
33	1.383	1.508	1.321	1.577	1.258	1.651	1.193	1.730	1.127	1.813	1.061	1.900	0.994	1.991	0.927	2.085	0.861	2.181	0.796	2.281
34	1.393	1.514	1.333	1.580	1.271	1.652	1.208	1.728	1.144	1.808	1.079	1.891	1.015	1.978	0.950	2.069	0.885	2.162	0.821	2.257
35	1.402	1.519	1.343	1.584	1.283	1.653	1.222	1.726	1.160	1.803	1.097	1.884	1.034	1.967	0.971	2.054	0.908	2.144	0.845	2.236
36	1.411	1.525	1.354	1.587	1.295	1.654	1.236	1.724	1.175	1.799	1.114	1.876	1.053	1.957	0.991	2.041	0.930	2.127	0.868	2.216
37	1.419	1.530	1.364	1.590	1.307	1.655	1.249	1.723	1.190	1.795	1.131	1.870	1.071	1.948	1.011	2.029	0.951	2.112	0.891	2.197

Appendix Figure B4 Durbin -Watson Statistic (Savin - White) 5 Per Cent Significance Points of d_L and d_U

CURRICULUM VITAE

NAME : Mr. Gem Tshering

BIRTH DATE : August 03, 1969

BIRTH PLACE : Samthang, Bhutan

EDUCATION :

YEAR	INSTITUTE	DEGREE/DIPLOMA
1994	NEFR College	B.Sc.(Forestry)
2005	Wolverhampton Univ.	PG.Diploma

POSITION/TITLE : Forestry Officer

WORK PLACE : Tsirang district

SCHOLARSHIP/AWARDS : Swiss Development Co-operation