Economics of Commonly used and Proposed Agro Forestry Models for Fuel Wood Production

Final Report

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CONTENTS **Page No.**

1. Introduction …… 7

2. Commonly used agro forestry models and proposed models ……. 7

2.1 Farmer woodlots …… 7

2.2 Community woodlots…….. 7

2.3 Kandyan home gardens…… 7

2.4 Homesteads or home gardens…… 8

2.5 Fuel wood/timber production in plantation companies…….. 10

2.6 Dedicated Gliricidia…….. 10

2.7 Kandyan forest gardens & Gliricidia……. 10

2.8 Gliricidia and coconut plantations…… 10

2.9 Gliricidia and pepper cultivation……... 11

2.10 Cinnamon cultivation ……. 11

3. Objectives of the study……..... 11

4. Methodology…… 11

5. Assumptions and results of the study …… 11

5.1 Assumptions of commonly used agroforestry models…….. 11

5.2 Proposed agroforestry models……... 12

5.3 Results of the study…… 13

6. Proposed strategies…… 15

7. Way forward…… 16

References…….. 17

Annexes1-8 …….. 18

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Acronyms

ADB	-	Asian Development Bank
FD	-	Forest Department
LRC	-	Land Reform Commission
HG	-	Home Gardens
KFG	-	Kandyan Forest Gardens
SEA	-	Sustainable Energy Authority

TABLES

5.1 Economic values of the selected parameters of commonly used agroforestry models

5.2 Economic values of selected parameters of proposed agroforestry models

Executive Summary – Economics of Agro forestry Systems

Sri Lanka is endowed with a variety of agro forestry systems in different agro-ecological zones. These agro-economic systems provide fruits, vegetables, yams, timber, fuel wood etc. which are useful for their livelihood. The commonly used agro forestry models relating to this study are the Farmer's wood lot programme, Kandyan home gardens (KHG), Homesteads, and the fuel wood production units of the Plantation companies. Intercropping with Coconut, Pepper and Gliricidia, Cinnamon cultivation and dedicated Gliricidia are the proposed agroforestry systems. These agro forestry models are useful in terms of increasing fuel wood production.

The objective of this assignment is to conduct an economic analysis of the existing agro forestry models and proposed agro forestry models and their sustainability in increasing fuel wood production. The KHG system has been existed for centuries and it is a special type of home garden system. A variety of economically important crops, fuel wood, fruit crops, timber etc. is cultivated. The farmer's wood lot programme was established in early 80's with the assistance of Asian Development Bank in five districts aimed at producing timber and fuel wood in Government lease lands. Cultivation of Pepper and Gliricidia, Cinnamon, and intercropping in coconut lands are also popular agro forestry models. Dedicated Gliricidia, incorporation of Glricidia into KFG system, Cinnamon, GlIricidia and Coconut, Pepper and Gliricidia are also useful in increasing fuel wood production. Due to lack of production related data and information, two quick opinion surveys for farmer's wood lots in Badulla district, and Kandy for KHG system, and collecting secondary data such as publications of Ministry of Export Agriculture and the Coconut Research institute were the methods used in data and information collection.

Certain assumptions such as price of Gliricidia Rs3.50 per Kg, Ten year time period etc. were used as the assumptions. Preparing income and expenditure statements,detailed economic analysis for Net Present value, and Benefit Cost ratio were the major ones computed according to the TOR. In addition sensitivity analysis (10 % cost increase, 10% revenue decrease) were also calculated for proposed ones. The results of the analysis show that production of fuel wood alone is not profitable.

With regards to agroforestry models Coconut, Pepper and Gliricidia, Cinnamon, KHG and Gliricidia are economically viable. All these models fuel wood is a by-product. Dedicated Gliricidia is the only model for dedicated fuel wood production and it is also economically viable. The sensitivity analysis also shows that these models are acceptable.

Famer's perception on Farmers' woodlot is to continue it for the second round with short gestation. Dedicated fuel wood production models such as Gliricidia in marginal lands, encouraging Gliricidia in Coconut plantations are appropriate. Combined efforts on awareness programmers on fuel wood production by the SEA, Forest Department, Coconut Research Institute, Coconut Cultivation Board, Mahaweli Authority, and formulation and implementation of an incentive scheme for fuel wood production at the takeoff stage and establishment of marketing outlets and ensure reasonable price for fuel wood are other strategies recommended.

1. Introduction

As an island nation in the tropics, Sri Lanka is endowed with a large number of agroforestry systems that are intrinsically linked with country's ecological resources and the economy. These agroforestry systems exist for a large number of years providing fruits, vegetables, fuel wood, timber etc. for the community. Agro-ecologically the island is broadly classified into two agro-ecological zones as the wet zone and the dry zone based on the average annual rainfall. The wet zone receives relatively a high rainfall and many of the agroforestry systems are located in the wet zone. The commonly used agroforestry at present are the Farmer's woodlots, Community wood lots, Block Fuel wood plantations, Demonstration wood lots, intercropping with Coconut plantations, Export agricultural crops such as pepper and Gliricidia, Cinnamon cultivation, Kandyan Home/forest Gardens, and Homesteads. Kandyan Forest Gardens could be viewed as somewhat similar to homesteads are widely distributed all over the island. These agroforestry models can be considered as useful agroforestry models for increasing fuel wood supply in future.

Some agronomic information on these agroforestry models are available but information on detailed analysis on the economic viability of these agroforestry models in terms of fuel wood production is scarce. An economic assessment of selected existing agroforestry models and proposed suitable agroforestry models aimed at increasing fuel wood production is therefore appropriate.

2. Commonly used agroforestry models and proposed agroforestry models

2.1 Farmer's woodlots

Farmer's woodlots were established under the Community Forestry Project with the assistance of Asian Development Bank(ADB) during 1980's in five districts namely, Badulla, Kandy, Nuwara Eliya, Matale and Batticaloa. Each farmer was given a block of state land, on lease for the cultivation of fuel wood and timber. The average extent was 0.5 to 1 acre. Technical assistance on tree planting, forest seedlings, planting tools, and fertilizer were supplied by the Forest Department. Agroforestry practices such as cultivation of food crops, vegetables etc. were introduced in these wood lots to get an additional income for the farmers. However, after three years, when the forest trees were grown, there would not be enough sunlight for inter-cropping. The World Food Aid Programme provided food aid for the participants during the initial period of planting. These farmer's wood lots still exist in Badulla district even after 30 years of establishment and not yet harvested due to administrative issues.

2.2 Community wood lots

Community wood lots were given to societies and organizations and they were responsible for establishing community woodlots. There was a collective responsibility of the community on forest production and benefit sharing. The Forest Department provided the technical assistance at that time.

2.3 Kandyan home/forest gardens

Kandyan Home Gardens (KHG) is a special type of agroforestry model in Sri Lanka which has been in practice for several centuries. This system is essentially a mixed cropping with a variety of economically important valuable groups of tree crops such as spices, fruits, food crops, timber, fuel wood etc. This agroforestry system is generally a small homestead holding system and practiced in Kandy, Matale and Kurunegala districts in the Mid country of Sri Lanka.

2.4 Homesteads or home gardens

Homesteads or home gardens (HG) are also an important popular agroforestry system in all over Sri Lanka. Home gardens are the major source of timber and fuel wood supply at present. Home gardening is similar to Kandyan forest garden system as it includes cultivation of mixed crops. Households used to cultivate fuel wood species such as Glyricidia for fencing. The total land extent of home gardens in 1956 was 0.59 million hectares and this increased to 1.03 million hectares by 2007 (Source: Ministry of Environment,2011).

2.5 Fuel wood/ Timber wood lots of Plantation Companies

One of the distinct features of the Sri Lanka forestry resources is the existence of plantation forests by Plantation Companies. The history of the establishment of estate plantation forest goes back to British colonial period. A portion of the land in each estate is allocated for planting forest trees in prospect of timber and fuel wood for their requirements. As a result many estates are inherited with forest plantations.

All private estates were nationalized in 1976 and due to new reforms the state control was ended in 1992. Plantation estates were re-privatized and 22 Regional Plantations were formed for management and most of them have fuel wood plantations (Ministry of Plantation Industries, 2012).

Table 2.1 Timber and fuel wood extent in the Plantation Sector

Regional Plantation Companies and State Agencies	Timber Extent (hectares)	Fuel wood Extent(hectares)
Hapugastenna	1400	1059
Watawla	324	902
Balangoda	275	383
Kahawatte	1161	1543
Bogawantalawa	871	390
Lalan Rubber	169	-
Malwatte Valley	-	11163
Maskeliya	469	1590
Agalawatte	-	353
Talawakelle	75	720
Kelani Weli	669	-
Horana	-	275
Agrapatana	311	717
Maturata	652	364
Elpitiya	82	764
Madulsima	50	1439
Pussellawa	1004	448
Kotagala	703	408
Namunukula	129	651
Udapussallawa	267	-
Chilaw Plantations	-	10
Elkaduwa Plantations	108	36
JEDB	30	493
SLSPC	748	-
Total	9497	13717

Source: Ministry of Plantation Industries, 2012

In 2005 there were 17589 hectares were under forest trees by the Regional plantation companies and this increased to 23214 hectares by 2012. Chilaw, Elkaduwa, Jantha Estae

Development Board, and State Plantation Corporation are the plantation agencies under the Sri Lanka Government and the total fuel wood extent in both private and state agencies in 2012 was 13,717 hectares (Ministry of Plantation industries 2012).

2.6 Dedicated Gliricidia

At present a small number of dedicated Gliricidia plantations exist in Sri Lanka. Gliricidia crop is adapted to a wide range of agro-climatic conditions and can be cultivated as a dedicated fuel wood crop in all over Sri Lanka except in coastal areas. The most suitable species is the Gliricidia Sepium and historically it is grown as a boundary fence tree. It does not require any special silvo-agricultural management practices and has the capacity of fixing nitrogen from the atmosphere. Marginal tea and rubber lands in the mid country, upper and lower Mahaweli regions are the most potential areas to establish dedicated Gliricidia plantations. Majority of these lands are owned by the private sector and estate plantation companies.

2.7 Kandyan home gardens and Gliricidia

Kandyan forest garden system is also one of the important agroforestry models in the proposed agroforestry models. It can be extended as a home gardening system by mixing with suitable tree crops and fuel wood species such as Glricidia. The proposed system is only for the mid country region and can be extend to other areas of the country.

2.8 Gliricidia and coconut plantation

Coconut based Gliricidia agroforestry system is recommended by the Coconut Research Institute in coconut growing areas. It has been clearly demonstrated that Gliricidia could be grown successfully in coconut plantations without any detrimental effect on coconut yield. Gliricidia is a nitrogen fixing legume and offer opportunities to increase nitrogen levels. A study conducted in a 50 year old coconut plantation within a row giving a density of 3750 trees per hectare showed that Gliricidia in coconut lands have improved microclimate by increase utilization of sunlight, reduce soil temperature . High biomass production, nutrient recycling, atmospheric N fixation, reduce soil erosion, increase facility for macro and micro climate activity are the major advantages of Gliricidia based farming in coconut lands (Gunathileka, and Vasanthie Coconut Research Institute, 2015).

2.9 Gliricidia and pepper plantations

Pepper vines and Gliricidia agroforestry model is one of the well adopted agroforestry models in the wet zone and the intermediate zones of Sri Lanka. Pepper has a well-developed market both locally and in the international market. Gliricidia provides a stand/support for the pepper vines and provides a supplementary income for the farmers as a fuel wood.

2.10 Cinnamon cultivation

Cinnamon is one of the important export agricultural crops that cultivated by agricultural farmers. Cinnamon bark is the economically valuable product and leaves are also useful to produce cinnamon oil. After removing the bark sticks are used as a fuel wood. Cinnamon stick sticks have a high demand in the hotel industry due to its flavor. Cinnamon cultivation generates a high income to the cinnamon grower as well as cinnamon sticks help to increase the fuel wood supply.

3.0 Objectives of the Assignment

The main objective of this assignment is to conduct an economic analysis (Cost/benefit) analysis for the commonly used agroforestry models and proposed agroforestry models.

The other objective is to recommend suitable strategies based on economic viability of proposed agroforestry models.

3.0 Methodology

Assessment of economic viability is generally carried out by identifying, quantifying and valuing costs and benefits of each agroforestry system. In this study three commonly used agroforestry models such as Farmer's wood lot programme, Kandyan home gardens, and Plantation Company's fuel wood model were selected to assess the economic viability. The first two agroforestry systems have been existing for a long time. Due to absence of data and information on inputs, outputs and farmer perceptions, two quick opinion surveys were organized in Badulla and Kandy to collect costs and revenues of those agroforestry systems. Technical support was obtained from the senior forest officers in the Forest Department. Compounding was done to bring the past costs and revenues to present. The net present value, and the benefit ratio were the economic measures used to evaluate the economic viability.

With regards to Estate Plantations have dedicated timber/fuel wood production models. They do not have agroforestry models.

Secondary data and information from various sources were collected and applied to assess the economic viability of proposed agroforestry models. Dedicated Gliricidia cultivation, Kandyan forest garden system with Gliricidia, Gliricidia and Coconut lands, Pepper and Gliricidia, and Cinnamon cultivation were the selected agroforestry models for the proposed agroforestry models. In addition, for Estate Plantation Companies, the dedicated timber/fuel wood forest model may be useful. Discounting method was used to bring the future cost and revenue streams to the present.

5. Assumptions and results of the study

5.1 Assumptions of commonly used agroforestry models

- The analysis period of the farmer's woodlot and the Kandyan forest garden agroforestry models is ten years.
- Input costs and revenues of the above agroforestry models are derived from the two opinion surveys conducted in Badulla and Kandy districts.
- The farm gate price of 1 Kilogram of Gliricidia is Rs.3.50.

- Costs and benefits were compounded using 10 % as practiced by the Department of national Planning to obtain 2015 market prices.
- Input costs were the labour used for land clearing, land preparation, planting etc. and maintenance cost. while revenue stream was the value of vegetables, cereals yams etc. during the initial stages of forest plants and food aid were given and treated as a cost.
- Farmers did not spend much money on planting material of the Kandyan Forest Garden system as it has been existing for centuries.
- An economic analysis for home garden was not conducted as it is almost similar to the Kandyan Forest garden system.
- The Net present value, Benefit Cost value were the parameters used to evaluate the economic viability.
- The profitability analysis prepared by the Finlay's used Rs.850 as the price of Cubic meter of fuel wood. Their fuel wood price is lower than the market price. The equivalent price of Glricidia is around Rs.2800. Also the value may be higher than the Glricidia due to composition of the fuel wood.
- Detailed analysis of the economic analysis is given in annexes attached to the report. In addition, income and expenditure statement for each agroforestry model is annexed.

5.2 Proposed agroforestry models

• The analysis period of the Dedicated Gliricidia, KFG and Gliricidia, Farmer's woodlots, Coconut-Gliricidia, Pepper-Gliricidia, and Cinnamon were based on the opinions of the experts views and availability of data and information.

• Input costs and revenues of the above agroforestry models were derived from the publications of the Coconut Research Institute, Department of Export Agriculture, and Expert views.

• Costs and benefits were discounted to obtain 2015 market values.

• Input costs were the labour used for land clearing, land preparation, planting, silvo – agricultural practices etc. while revenue stream were the value of timber and fuel wood, energy savings etc.

• Cost of the planting material was priced at the market rate and included in the cost stream.

• The economic analysis statement provided by the Finlay's Company was used as the economic as the fuel wood/timber agroforestry model for the Estate Plantation agroforestry model. It is not a agroforestry model.

• The Net present value, Benefit Cost value were the economic parameters used to evaluate the economic viability.

• The economic analysis statement provided by the Finlay's company was used as l wood/timber dedicated model for the Estate Plantation sector.

Pepper-Gliricidia, Coconut-Gliricidia, and Cinnamon agroforestry models, fuel wood value is depending on the main crop. Without having the main crop fuel wood value cannot be achieved.

Detailed analysis of the economic analysis is given in attached annexes.

5.3 Results of the Study

Table 5.1 shows the results of the economic values of selected parameters. .

Table 5.1 Commonly used agroforestry models

Agroforestry model	Net Present Value (Rs)	Benefit Cost ratio
Farmer's Wood lot		
Timber and fuel wood	35382	2.79
Fuel wood	-3186	0.84
Finlay's Company	-332778	0.46
Kandyan Forest/Home Garden	53,132	2.94

- The Net present value of the farmer's wood lot model which has both timber and fuel wood is positive and the Benefit cost ratio is greater than one. Only for fuel wood the NPV is negative and the B/C ratio is less than one.
- The Net Present value of the Finlay's model which is only for fuel wood is also negative and the B/c ratio is less than one.
- The Net present value of the Kandyan home garden agroforestry model is positive and the Benefit cost ratio is greater than one showing that the Kandyan homregarden agroforestry model is economically viable. The cost stream is relatively smaller than the revenue stream due to low level of inputs.

The revenue of the fuel wood generated from the farmers wood lot is smaller than the cost of the farmer's wood lot model. The total revenue both from timber and fuel wood of this model is viable. The fuel wood value of the Finlay's model is Rs.850 per cubic meter which is lower than the open market price. The equivalent price of Gliricidia is Rs. 2800 per cubic meter and with this value the model is profitable. The Kandyan home garden is a profitable agro forestry model due to low input cost and the high revenue due to other outputs in the model.

Table 5.2 Proposed agroforestry models

Agro forestry model	Net Present value (Rs)	Benefit Cost ratio
Dedicated Gliricidia	45116	1.13
Coconut and Gliricidia	17797	1.12
KFG and Gliricidia	24,109	1.91
Pepper and Gliricidia	1800287	3.38
Cinnamon	501157	1.30

- The Net present value of the all proposed agroforestry models are positive and the Benefit cost ratios are greater than one showing that these agroforestry models are economically viable..

The dedicated Gliricidia model is economically viable and useful for introducing marginal/uneconomic lands. Of all the other models fuel wood is a by product and a supplementary income which encourage the fuel wood production..

Table 5.3 Value of Fuel woods and main crop in proposed agro forestry models

Agroforestry Model	Fuel wood value	Main Crop value
Dedicated Gliricidia	345298	-
Pepper-Gliricidia	110413	144789
Cinnamon	101132	2083872
Coconut and Gliricidia	160707	n.a

- The highest fuel wood value is recorded in the Coconut and Gliricidia agroforestry model while fuel wood value. Cinnamon and Pepper are main crops and the fuel wood is a by product in these agro forestry models. Fuel wood, timber and other products are inter linked and provide supplementary income..

- Sensitivity analysis for all the proposed models were conducted by increasing 10% cost and decrease revenue by 10 % separately and the results shows that Except Coconut & Gliricidia all agro forestry models are viable. Please see table 5.3.

Table 5.3 Sensitivity Analysis of agro forestry modal

Agro Forestry Modal	10% Cost Increase		10% revenue decrease	
	NPV	B/C	NPV	B/C
Dedicated Gliricidia	11260	1.03	6749	1.02
Cinnamon	332771	1.18	114271	1.06
KFG and Gliricidia	16375	1.56	19036	1.7
Pepper and Gliricidia	1494775	2.86	1567948	3.1
Coconut and Gliricidia	12564	0.92	1727	1.0

According to the above except coconut-Gliricidia in 10 % cost increase all agroforestry models are economically viable.

6. Proposed strategies based on the results of the study

- Dedicated Gliricida is a useful model for increasing fuel wood production and recommended for un-economic/marginal lands in specially in the mid country, Upper Mahaweli and the lower Mahaweli region.
- The other proposed agroforestry models namely the Coconut-Gliricidia,pepper-Gliricidia, Kandyan forest garden and Gliricidia, cinnamon also economically viable. Therefore these models can be promoted in order to increase fuel wood production.
- The Forest Department shall continue the farmer wood lot programme with a short gestation based on the age of the species emphasizing fuel wood production as the farmer's wood lot programme is economically viable.
- The Sustainable Energy Authority (SEA) and the relevant authorities should promote the integration of fuel wood crops into the Kandyan forest garden system and the Homesteads. Of the proposed model it is shown that cultivation of 500 Glricidia plants inside and fences of KFG is profitable providing additional income to the farmers.
- SEA, Forest Department, and other relevant authorities shall discuss with senior officials of the Mahaweli and Environment Ministry on introducing fuel wood crops such as dedicated Gliricidia agroforestry model in the Upper Mahaweli catchment and the lower Mahaweli region.
- SEA shall discuss with the Coconut Research Institute and the Coconut Cultivation Board in introducing Gliricidia in coconut lands and implement the proposed model.
- SEA shall make arrangements with the Ministry of Export Agriculture in promoting Pepper and Gliricidia and Cinnamon cultivation aimed at increasing fuel wood supply.

- Provision of infrastructure facilities such as quality planting material, technical advice, and marketing facilities play a key role in success of the fuel wood production. SEA, FD with the assistance of the private sector these facilities have to be provided in all potential areas.

7. Way forward

Except very few locations and Plantation Companies fuel wood cultivation is not practiced at present. Fuel wood production is a by-product of timber or export agriculture in other agro forestry models. Fuel wood production itself does not generate sufficient revenue for its sustainability. A detailed benefit cost study on fuel wood production is also useful to make decisions.

Following approaches are suggested to expand fuel wood production.

1. Integrate fuel wood production in other agroforestry models such as pepper, cinnamon, Kandyan home gardens, coconut plantations. Provision of quality planting materials, technical support, necessary incentives, fair price and market outlets hsvr to be developed.
2. Encourage establishment of dedicated fuel wood plantation in marginal/uneconomic lands. It has been estimated that 0.64 million hectares of lands are potential for fuel wood production. A certain portion of this land can be devoted for fuel wood production. A Committee comprising high level of officials of the LRC, Land Ministry, SEA, FD, Mahaweli and Ministry of Environment and other relevant agencies shall be established to design, plan and implement fuel wood production in those lands.

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APP1-APP8

Commonly used and Proposed Agro Forestry Models