博士論文

Possibilities to conversion of degraded Marginal Small Tea farm Holders (MSTH) plantations to fuelwood plantations in Sri Lanka: Case studies in Badulla and Matara Districts.

(スリランカの劣化した限界小規模茶園保有者による茶園から燃材林への転換可能性：バトゥーラ県とマータラ県の事例研究)

Indika Rohan Palihakkara

インディカ・ロハン･パリハッカラ

Department of Global Agricultural Sciences
Graduate School of Agricultural and Life Sciences
The University of Tokyo

Year of entrance for Doctor of Philosophy: 2012
Supervisor: Inoue Makoto (Professor)
Study on

Possibilities to conversion of degraded Marginal Small Tea farm Holders (MSTH) plantations to fuelwood plantations in Sri Lanka: Case studies in Badulla and Matara Districts.

(　スリランカの劣化した限界小規模茶園保有者による茶園から燃材林への転換可能性：バトゥーラ県とマータラ県の事例研究)

Dissertation submitted to Graduate School of Agricultural and Life Sciences
In partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY
The University of Tokyo
March-2016

Members of Examining Committee

Professor Inoue MAKOTO, Dept. of Global Agricultural Sciences, Graduate School of Agricultural and Life Sciences, The University of Tokyo

Professor Nobushiro SUZUKI, Dept. of Global Agricultural Sciences, Graduate School of Agricultural and Life Sciences, The University of Tokyo

Professor Kensuke OKANDA, Dept. of Global Agricultural Sciences, Graduate School of Agricultural and Life Sciences, The University of Tokyo

Associate Professor Yukie SAITO, Dept. of Global Agricultural Sciences, Graduate School of Agricultural and Life Sciences, The University of Tokyo

Professor Ganesh P. Shivakoti, School of Environment, Resources and Development, Asian Institute of Technology, Thailand

Acknowledgement

Many individuals and organizations have contributed in supporting my doctoral studies program at the University of Tokyo. First of all I would like to give my humble thanks to University of Ruhuna for nominating me for PhD program in The University of Tokyo. It is my great pleasure to thank Head of the Department and Dean of the Faculty Professor Mangala De Zoysa, and Vice Chancellor, of my home university for timely completion of all the necessary formalities. The study was supported by the Grants in Aid for scientific research supported by the Government of Japan. The University of Tokyo PhD grants, as well as partial grant supported by HETC project of the Government of Sri Lanka.

My special thanks goes to my thesis supervisor Professor Inoue Makoto for allowing me to pursue studies in his laboratory. During my stay at the GFES, his constructive advice and guidance as well as continuous encouragement in both academic as well as nonacademic activities from the beginning have been the source of inspiration for me. I would like to express my appreciation of thanks all the members of Inoue seminar giving constructive comments and providing guidance towards development of this dissertation. Especially the thanks goes to the visiting Professors and scholars including Dr. Ndan Imang, Professor Mustofa Agung Sardjono, Professor Mangala De Zoysa, Professor Karachepone Ninan, Professor Ganesh .P.Shivakoti for their valuable advices and encouragements. My special thanks goes to Dr.Abrar Juhar Mohammed for his continuous advice and support from the beginning of the research. I am very grateful for the members of the examining committee Professor Inoue MAKOTO, Professor Nobushiro SUZUKI, Professor Kensuke OKANDA, Associate Professor Yukie SAITO, and Professor Ganesh P. Shivakoti for their assessment of my research and comments. It is my duty to thank all the members of OICE and staff of our graduate school. It is my pleasure to thank Dr. Neelam from OICE and Ms Fujimori for their support and encouragement for various administrative work.

To conduct a field survey is not easy without support from institutions as well as from the individual interviewees. Therefore my special thanks for government institutions such as TSHDA, TRI, STC and NGOs, tea farmers, tea factory owners and managers, owners of small to medium scale cottage industries, and fuelwood suppliers for giving their valuable information and spending their time during the data collection period. I would like to extend my special thanks to the tea grower farmers of the study area who always opened their doors to welcome me. Studying towards a PhD is not an easy task, specially being away from the home country. I was very lucky to get all the support and encouragement from our lab friends from the beginning towards marking my life smooth and easy to be in Japan. My special thank for family members, father, mother, sisters, brother and in lows. Last but not the least I give my special thanks and recognize the sacrifice of my wife, Prasanganee, daughter Pasindhi and son Nihindu for their tremendous support, encouragement and patience given to me for during my study at The University of Tokyo.

Table of Contents

List of Tables

List of Figures

List of Photos

ACRONYMS

ANOVA : Analysis of Variance

COP : Cost of Production

DOA : Department of Agriculture

DS : Divisional Secretariat

FAO : Food and Agriculture Organization

GDP : Gross Domestic Products

GN :Grama Niladari

JEDB : Janatha Estate Development Board

LDO : Land Development Ordinance

LLH : Large Land Holders

MLH : Middle Land Holders

MPTs : Multipurpose Tree species

MSTH : Marginal Small Tea farm Holders

NCSD : National Council for Sustainable Development

Rs : Rupees (Sri Lanka)

SLA : Sustainable Livelihood Approach

SLH : Small Land Holders

SLM : Sustainable Land Management

SLTB : Sri Lanka Tea Board

SPC : State Plantation Corporation

STC : State Timber Corporation

TRI : Tea Research Institute

TSHDA : Tea Small Holder Development Authority

UNFCCC : United Nations Framework Convention for Climate Change

VP : vegetative propagated tea

VSLH : Very Small Land Holders

Summary

Possibilities to conversion of degraded Marginal Small Tea farm Holders (MSTH) plantations to fuelwood plantations in Sri Lanka: Case studies in Badulla and Matara Districts.

(スリランカの劣化した限界小規模茶園保有者による茶園から燃材林への転換可能性：バトゥーラ県とマータラ県の事例研究)

Summary

Tea plays pivotal role in Sri Lanka economy since it was introduced during the British colonial era. Thereafter with the independence in 1948 followed by introduction of new land reform act in 1970s tea cultivation was expanded into central and south-western parts of the country. Especially with the establishment of Tea Small Holder Development Authority (TSHDA) area of small holder tea plantations were further increased. Hence small farmers try their best to maximum utilization of their land with tea. Some farmers expand their tea cultivation in encroached or donated land for them under various development schemes introduced by the government, without considering overall land suitability to cultivate tea. With these reasons, farmers face problems such as soil erosion, poor productivity from their plantations and they were identified as marginal small holder tea plantations. These marginal tea land yielded comparatively low and as a result, land holder faces many problems for continuation of their livelihood condition. This has led these farmers to find other external alternative income source. Furthermore it will lead to either totally or partly negligence on the part of farmers on the plantation. As a result, this will create environmental problems, not only for tea plantations but also to surrounding environment. The other possibility of long term sustainability of Marginal Small Tea farm Holders (MSTH) is conversion of un- productive areas inside these plantations with sustainable income generating plants such as timber or fuelwood trees. There is a lack of comprehensive studies on MSTH farmer's problems as well as suggesting practical solutions for socioeconomic and environmental problems they have faced. To fill the gap this study focus on identification of unproductive areas inside these tea plantations and explore possibilities to convert it into fuelwood plantations in Matara and Badulla Districts in Sri lanka with six specific objectives. Starting from 1.To identify marginal tea plantations that socially, economically and bio-physically can be used for afforestation, 2.To identify marginal Small holder farmer's potential , willingness , benefits and attitude of tea farm/part of the farm conversion to fuelwood supply units. 3. To identify field level officers attitude/ suggestions on marginal tea plantations, futurity and possibility of conversion to fuelwood farming. 4. To identify the problems/ issues faced by marginal tea farmers for land conversion to fuelwood supply units. 5. To identify

fuelwood supply and demand of the area. 6. To policy recommend for improving fuel- wood supply from marginal tea plantations

To achieve these objectives, we used sustainable livelihood approach (SLA) to understand the current condition of the MSTH by using five livelihood capitals, identified as, Natural, Social, Human, Financial, and Physical used in SLA. To get a wider and clear understanding , literature survey was conducted with special reference to the importance of biophysical condition, farmers land property rights, role of renewable energy and its possibilities to supply fuelwood from MSHT to small to medium scale industries to fulfil their energy requirement. Furthermore we refer to the present land property rights in Sri Lanka, and its legal conditions on timber /fuelwood planting as well as possibility of getting harvesting and transporting permits. Before introduction of such land conversion program at a wider scale it is better to understand similar type of cases conducted elsewhere especially how local poor farmers overcome the problems and adopt to a better livelihood conditions in the tropical countries. Therefore, we highlighted the problems which are commonly faced by marginal farmers and summarized their experiences which can be applied for our research sites. On the other hand, the countries without or limited natural energy sources can achieve better results with the introduction of proposed land use conversion.

With these understanding we conducted a case study, designed with two embedded units of analysis was selected, based on livelihood conditions of small tea farmers of marginal tea growing areas in the country. These two embedded units of analysis represent low and high elevation areas in two selected Districts of the country. The two study sites were selected on the basis of preliminary discussion with staffs from Tea Small Holding Development Authority (TSHDA) and 81 farmers were randomly selected and 30 officers working in multiple disciplines were investigated for the detailed study in both districts. Sampled farmers and responsible TSHDA officers for these two Districts were interviewed to get their perception on present tea farming and possibility of conversion of uncultivated areas to fuelwood planting. In addition, fuelwood users (tea factories and medium scale cottage industries) and suppliers were also interviewed. Detailed qualitative and quantitative surveys were also conducted from tea farmers, THSDA officers, fuelwood users, fuelwood suppliers (private and State Timber Corporation STC). Data were also collected from government official in village, sub district, district, province and national level, NGO, and universities. The data was analyzed by using descriptive statistics, and SPSS ver. 17 to find out averages as well as statistical significance.

The findings on the farmer's five livelihood capitals, land is identified as the most important capital for tea farmers. Therefore, based on land size, farmers were devided into four main classes ranging from very small land holders (VSLH) to large land holders (LLH). The result showed inconsistent relationships between the land size of the MSTH and other capitals such as the number of trees planted and the income

from tea production. The district with the smaller average land size (Matara) and the very small and small land holders within the district were found to generate more income from tea production. Improving human capital through education was also found to contribute negatively toward labour contribution for tea production. Between districts, weather and elevation, two forms of natural capital that are mostly neglected in rural studies using the SL approach, were found to play important roles in determining the outcome from tea-based livelihoods. Formal property right document is important asset for farmers to apply loans from the banks, and getting legal permission to conduct their activities smoothly. With the comparison of farmer's different property right documents. Deeds were identified as the strongest document with legal power compared to permits issued by government authorities. Therefore, farmers with deeds were very keen on converting their land into fuelwood/ tree planting, aiming at future benefits of harvesting these trees and generate additional income.

Before introduction of any new technology or practice for any field, especially for the stakeholders, it is very important to understand their perception. To achieve research objectives, we investigate perception of tea farming in marginal land and the potential of conversion into fuelwood. The interview were conducted with TSHDA field level officers (20) and MSTH (30). The result shows that the perception in both districts respondents in most of the issues were similar. For physical constraints, interviewees from both district, agreed that soil erosion and heavy wind are vital problems while they disagreed on significance of the rockiness of the area for their farming. Landslide was perceived to be important factor by farmers in Badulla only. In both districts, they agreed government is playing a vital role in alleviating their problems than NGOs and private sectors. All the farmers from both districts, with the exception of Badulla farmers disagreed on the high cost of labor for tea faming, agreed on the problem associated with continuing tea farming such as labor shortage, high management cost and high labor cost. Stake holders from both district mentioned their dissatisfaction in the existing property right system which is vital for the implementation of long term investment such as fuelwood plantation.

Results reveal that fuelwood price has continually increased during the recent past. Rubber is identified as most demanded fuelwood among the end users in both districts. The selection of species are highly dependent on the fuelwood qualities such as, high calorific value, availability, easy to collect and handle while transportation (no legal barriers). Fuelwood species such as *Albizia*, *Gliricidia*, which are grown in tea plantations, are popular with moderate price. Home gardens located more than 20 km away from marginal tea growing areas were identified as main suppliers with mixed type of fuelwood collected from different tree species, followed by large tea plantations, and State Timber Cooperation, contribution for the fuelwood supplier in the area is minimal in both districts. Furthermore by observing the present fuelwood supply and demand pattern, with possible increment in the future. Therefore MSTH was found to be ideal

candidate for supplying fuelwood for the future demand while sustainably managing the plantations and safeguarding surrounding environment.

Furthermore proper land utilization is important for long-term sustainability of small holder tea industry as well as safeguard for their livelihood conditions, where MSTH farmers gain lower income and leads further deterioration of the plantation. This needs identification of the real problems consulted with the stakeholders and turn it in to sustainable additional income generating units. In order to implement new proposed land use conversion, it is very important to understand demand and supply pattern, futurity of additional income generating and the way it helps balance three key sections as farmer, tea industry , and environment. Conversion of degraded MSTH plantations to fuelwood plantation can be applied with the stakeholders and government support. Therefore we conclude efficient utilization of marginal tea farms are important for their long term sustainability, protect tea plantations from soil erosion, landslides and furthers deterioration of the plantations. For doing this government support with strong supporting policy for land use conversion is much needed.

Chapter 1: Introduction

Summary

Tea is one of the main income generating crop of Sri Lanka. Once the land area for tea cultivation was expanded, marginalization of tea plantations became an important problem and eventually affected negatively the livelihood condition of Marginal Small Tea farm Holders (MSTH) as well as to the surrounding environment. There is a lack of comprehensive studies on MSTH farmer's problems as well as suggesting practical solutions for socio economic and environmental problems they have faced. To fill the gap this study focus on investigating the current socio-economic, biophysical and institutional condition of MSTH, problem they are facing and potential alternative land use to improve their condition. The study is conducted in Matara and Badulla Districts in Sri Lanka. The specific objectives of the study are : 1) to assess the current livelihood condition of MSTH using the livelihood capital approach; 2. To identify key issues faced by the MSTH on the perspective of major actors using the perception analysis approach; 3) To evaluate the potential of fuelwood plantation as an alternative land use in uncultivated marginal lands by emphasizing the current demand and supply gap; 4. To propose policy solution for sustainable use of marginal lands of small tea land holders.

1.1 Background of the research topic

1.1.1 Tea industry in Sri Lanka (Histry and present situation)

Tea (C*amellia sinensis* L.) as a plantation crop was first introduced to Sri Lanka by Sir James Taylor, a Scottish planter in 1867 and since then it continues to play a pivotal role in the economy of the country (Trixie 2014, Hand Book on Tea, 2006). With an increase in demand for the tea in the world market, more lands were cultivated by clearing the natural forests and other lands, initially in the central high land area of the country that later expanded to Uva province and south western low elevation areas of the country. That led Sri Lanka to become one of the oldest tea producing country in the world as well as home for some popular tea brand name such as "Ceylon Tea". According to the Department of Census and Statistics, and the Ministry of Plantations, currently there is total land area of 203,020 ha distributed in three different elevation zones.

After the independence of Sri Lanka in 1948, the property right system of the tea plantations was changed from private British owners to private local owners (Mendis1992). After three decades, the land reform in 1970s transferred larger portion of these private Tea land to the government and were made to be managed by number of public agencies. With the enactment of new policy in 1977, all the tea plantations owned by the government were brought and managed under two state corporations namely the State Plantation

Corporation (SPC) and Janatha Estate Development Board (JEDB). Due to higher demand from landless poor, some of the acquired tea plantations were redistributed among landless people during this period. Consequently, more than 8,000 hectares of cultivated tea lands were owned with the extent of less than 1 hectare per peasant. In addition to these crown lands (forest and scrub forest) were distributed in and around the tea growing areas under the village and tea planting expansion programs introduced by the government (Manikam, 1995).

With the introduction of new government policy decision in 1992 and 1995, state owned plantations SPC and JEDB were sold to private sector management companies with two major objectives. Firstly the policy of privatization of all public enterprises was a part of structural adjustment program aiming that privatization would bring new technology, competition and expertise management to the plantation sector, and secondly to minimize the losses from these plantations and convert them to profitable ventures. Hence, different types of tea factory owners such as large scale plantation companies, private, government and cooperatives can be found and, most of these tea factories use their own green tea leafs. But sometimes green tea leaves are collected from the small holders as well. More interestingly some of the factories (especially private factories) are totally depend on small tea farm holders to collect their produce (Ministry of Plantation Industries 2013) (Figure 1.1.). Sri Lanka tea board regularly monitors all of these factories and ensures price payment made for the green tea leaf producers are monthly basis including small tea farmers, while Tea Small Holders Development Authority (TSHDA) is totally focused on development activities of the small farmers.

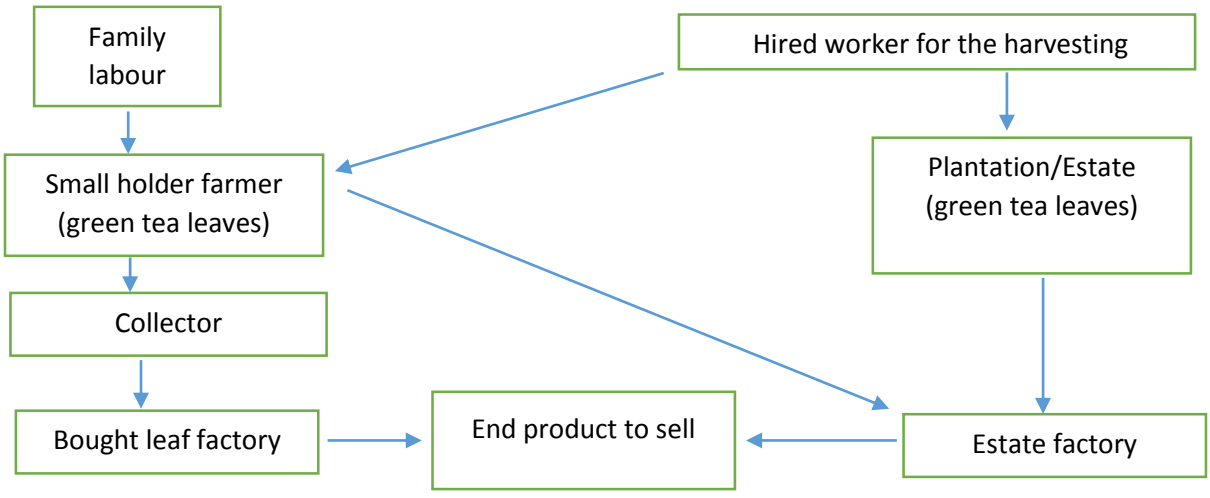

Figure 1.1. Tea (Green leaf) supply chain in Sri Lanka (developed by the author)

Currently, tea planting constitutes one of the major economic income for Sri Lanka's population in terms of employment and export earnings where tea industry is categorized as labour intensive and presently provides around 10% direct and indirect employment opportunities to the country (Perera 2014). Teas planted over 1200 m above mean sea level (m.s.l) is categorized as high grown (up country) teas mainly found in Nuwara-Eliya and Badulla districts. Low grown (low country) teas are planted below 600 m (m.s.l) and are mainly distributed in Galle, Matara, Rathnapura, Kegalle and Kalutara districts. Mid grown (mid country) tea are planted in between 600 and 1200 m (m.s.l) and are mainly found in Kandy, Matale and some parts of the Badulla district (Mendis 1992). In addition, Sri Lanka tea (Ceylon tea) is divided in to seven sub sections based on the agro climatic regions as Nuwara Eliya, Uva, Uda Pussellawa, Dimbula, Kandy, Ruhuna & Sabaragamuwa. The quality of the final product (made tea) such as variation in taste, aroma and appearance are attributed to these regions (Ministry of plantation industries 2013).

1.1.2 Small tea farming sector in Sri Lanka

After the introduction of new land reform act in early 1970s, number of new small tea farmers in all the tea growing areas were drastically escalated. With the objectives of facilitating these farmers to utilize their farms and increase production, marketing activities, improvement of productivity, and working for the welfare of the tea smallholders, government decided to form state controlled organization called Tea Small Holders Development Authority (TSHDA). TSHDA is directly involved in helping the farmers besides the research institutions such as TRI (Tea Research Institute), Sri Lanka Tea Board (SLTB) and Department of Agriculture (DOA). TSHDA was established on the 1st February 1997, under the tea small holdings Development Act No.35 of 1975. After that, tea small holder societies were formed under the Act No. 36 of 1991. With introduction of Act No.21 of 1997, legal status for these farmer societies were established.

Tea small holdings are considered when the land extent is less than 4.04 ha (10 acres) as per the tea control act. However the act of Ministry of plantation industries in January 1978 development action had delegated of tea lands between the 4.04 to 20.2 ha (10-50 acres) under the supervision of Sri Lanka Tea board. However, TSHDA provided services for the development of all the tea lands less than 20.2 ha under the category of private ownership until 2012. After 2012, provision of land development servicers and other agricultural advises and extension of tea lands more than 4.04 ha had been re entrusted under supervision of Sri Lanka Tea Board (SLTB) and TRI, while TSHDA will look after the lands below 4.04 ha (TSHDA 2012, Perera 2014). The present land area occupied by tea plantations were about 203,020 ha, and out of which 60 % are cultivated by small holders while 36% are owned by 20 regional plantation companies and the rest 5% are managed under the government institutions (Ministry of Plantations 2013) (Table 1, Figure 1.2, Figure 1.3).

Table 1.1 Tea small holders in different districts and categorized according to land size and the data were collected and presented using registered and unregistered small tea farmers in all the tea growing Districts in the country.

District & elevation group	**No of holdings**	**Hectares**	**Lands category/ha**						
			<0.5	**0.5-<1**	**1-<2**	**2-<3**	**3-<5**	**5-<10**	**>10**
Low grown	97,984	30,441	87,070	7,910	1,880	530	345	141	108
Rathnapura									
Galle	90,524	27,427	79,432	8,296	1,840	467	276	166	47
Matara	67,613	25,417	58,470	6,835	1,296	430	290	176	116
Kalutara	38,263	7,823	35,793	1,927	396	74	38	26	09
Kegalle	19,637	6,093	17,333	1,680	400	98	65	31	30
Hambantota	2,533	546	2,373	141	14	04	01	-	-
Moneragala	637	199	551	72	11	01	02	-	-
Colombo	491	246	423	35	22	04	04	02	01
Kurunegala	151	180	111	23	08	03	02	-	04
Gampaha	09	02	09	-	-	-	-	-	-
Mid grown	30,747	16,058	25,457	3,345	1,094	353	206	140	152
Kandy									
Matale	1,408	1,672	1,011	166	81	40	38	41	31
High grown	29,679	9,020	26,989	1,747	574	182	85	56	46
Badulla									
Nuwara Eliya	17,547	7,205	15,270	1,663	302	100	77	55	80
Total	397,223	132,309	350,292	33,840	7,918	2,286	1,429	834	624
Percentage			88.19	8.52	2.00	0.57	0.36	0.21	0.16

Source- Census of tea Lands in Sri Lanka-2005

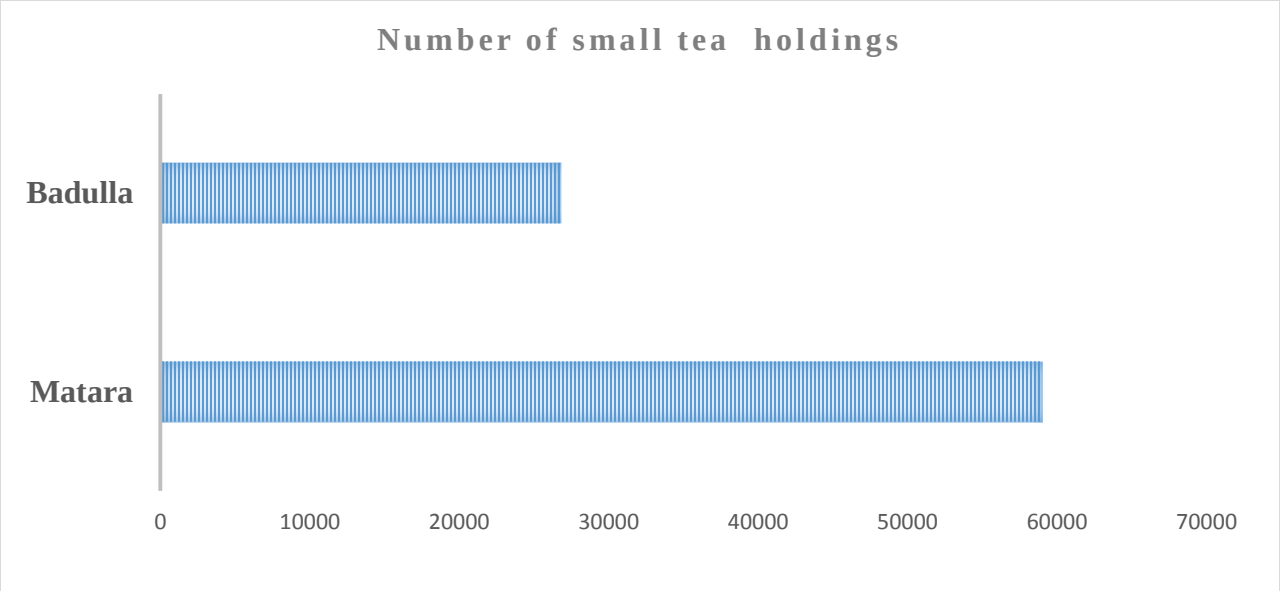

Figure 1.2 Number of small holdings in two districts (Source TSHDA data 2005)

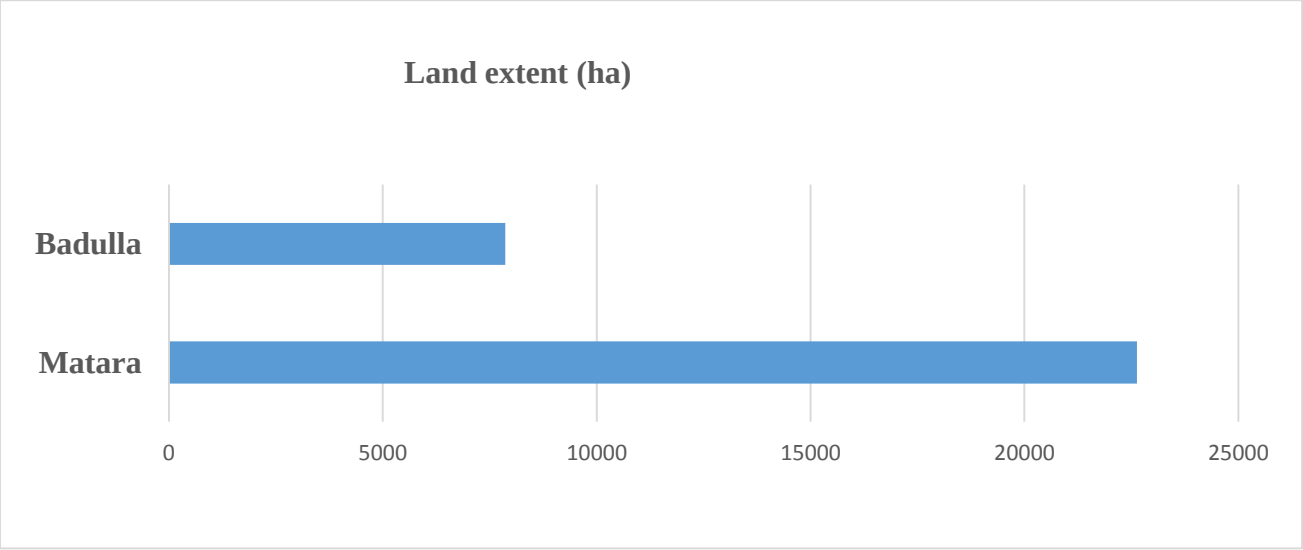

Figure 1.3 Number of small holdings land extent in two districts (Source TSHDA data 2005)

1.1.3 Marginal tea farmers

While the extent of cultivated land owned by the small holdings has expanded with 397,233 number of registered tea small holdings, many of these farmers are facing important problem with, i.e. marginality of their land and associated low productivity. The term marginal is commonly used in agriculture sector. For example according to FAO, if the main crop in a particular land covers less than 15% of the land surface or gives less economic revenue from the crops maintained in the particular land is termed as marginal land. In the case of multiple types of crops in a same field, a second and / or third crop type can be specified. These crops have a lower canopy than the main crop or they are a marginal crop, i.e., cover less than 15 percent of the surface or has a low economic revenue (FAO 1988).

The marginal farmlands of Sri Lanka are tea production lands with a yield below the national average tea yield, 1,615 Kg/made tea/ha /year, where average yield only for the small holder sector was 2,078 Kg/made tea/ha /year (Ministry of Plantations 2013). The negligence and abandonment of marginal tea lands especially in the sloped terrains, in addition to the socio economic drawbacks it create for the farmers, also contributes for environmental problems of the country. The forestry sector master plan of Sri Lanka has identified several environmental consequences such as irregular water flows, drying up of natural water streams; soil erosion and associated loss of soil fertility due to marginal level of agricultural activities including tea cultivation. There are two type of MSTH in the country, first type of farmer's main income source is tea and the second type of farmers with supplementary income source such as vegetable, paddy, spice, and fruit cultivation, permanent and temporary occupations (TSHDA 2013, Perera 2014).

Table 1.2 Criteria for classifying lands according to their suitability for tea

Climate Agro ecological region	Limiting factor				Degree of limitations	Specification
	Slope (%)	Soil depth (cm)	Surface rockiness (%)	Gravel (vol,%in top 50 cm)		
WU $_{2-3}$ IU $_{2-3}$	0-25	>90	0-10	0-10	None	Region above 900 m
IU $_{1}$	25-70	70-90	10-20	10-50	Moderate	
All other up country regions	>70	<70	>20	>50	Severe	
WM 3	0-25	>90	0-10	0-10	None	Region between 300- 900 m
WM2 &IM2	25-55	70-90	10-20	10-50	Moderate	
All other mid country regions	>55	<70	>20	>50	Severe	
WL 1	0-25	>90	0-10	0-10	None	Region below 300 m
WL2	25-70	70-90	10-20	10-50	Moderate	
All other low country regions	>70	<70	.20	>50	Severe	

Source TRI Advisory Circular (No.LU-1) 2002

1.1.4 Importance of fuelwood for the country

Biomass is the most common energy source in Sri Lanka, largely used by the domestic sector industries such as agro-industries, manufacturing industries and certain establishment in the commercial sector. Tea industry is one of the high energy intensive agro industries in Sri Lanka as well as in the world. Especially tea processing is required for withering, drying, rolling, grading and packing.To produce one kilogram of made tea it required 4-18 kWh. To cater the above required energy various type of feedstock and energy are used. Fuelwood, electricity, natural gas are highly used.

Fuelwood and agro-residues generally termed as solid-biomass play pivotal role as a source of energy for house hold cooking and heating to medium and large scale industrial energy requirements (Ravindranath et al. 2011). More than 80% of the tea factories use fuelwood for tea withering and drying

where these two processing steps constitute higher ratio of the total energy requirement of tea manufacturing (Clay 2004). Felling trees for collecting fuelwood is one of the most serious problem in Sri Lanka (University of Sri Jayewardenepura Sri Lanka 2007). Rubber wood is highly used and was popular as fuelwood among the tea factories for decades, but with the reduction of the rubber extent of the country and higher demand for rubber wood as a timber pushed the price of the product up (Ruwanpathirana 2012). In addition to rubber, other species such as *Albizia, Gliricidia* and mixed fuelwood species also provide fuelwood.

Apart from fuelwood and hydroelectricity, Sri Lanka is totally dependent on importing fossil fuel from other countries. Oil price fluctuation and its shows increasing price pattern especially during the recent decades have compelled the country to divert its scare budgetary resources to procure this basic need. Compared to the fossil fuels, fuelwood and bioenergy total requirement, produced with in the country will help to minimize the draining out the wealth of the country (Saracoglu et al, 2010). It also helps for the reduction of greenhouse gas emissions to the atmosphere , mainly because the carbon dioxide that emitted while fuelwood is being burned , were earlier trapped by the plants (Farrell et al. 2006). Once the fuelwood producing plants are grown in marginal lands with coping ability or parts of the plant is being used for the fuelwood extraction, with the perennial type of trees will certainly give very good results. (Lu et al., 2009 and Saracoglu et al. 2010) On the other hand most of the fuelwood suppliers (collectors and suppliers from the private plantations not from illicit collection from the conserved forests) are from rural areas, and most of the production are considered as rural poor farmers (Stupak et al. 2011 and Senanayake et al. 2009).

1. 2 Research problem

Tea industry is one of the main income generating crop of Sri Lanka. Currently small-holders constitute 60% of the total 212,700 ha of Sri Lankan tea farm area (TSHDA 2012), making them the major contributors for the tea industry. However, sizeable portion of the small tea farm holders are facing problem, namely marginalization of tea land. Once the land area for tea cultivation was expanded, marginalization of tea plantations became an important problem and eventually affected negatively the livelihood condition of Marginal Small Tea farm Holders (MSTH) as well as to the surrounding environment. Sri Lanka is facing environmental problems such as irregular rainfall, drying up of natural streams, soil erosion and associated loss of fertility etc., especially in tea producing areas (Mungai 2004). In addition, Marginal small tea farm holders (MSTH) face problems such as low income from the tea sector. There are evidences, but very limited, pointing to the unsustainability of MSTH land uses. For example, according to Dissanayake et al. (2013), tea bushes belonging to most of the tea plantations were planted more than 40 to 60 years ago with no new planting since then. Census taken in 2005 further strengthened the above argument by pointing that about 7310 hectares of the small holder plantations were abandoned. Therefore, understanding the

prevailing reality of marginal tea small holders is important to tackle the socio-economic as well as environmental consequences of existing tea-based land use systems (FAO 2012).

When the existing land use is unsustainable, land use conversion from unutilized or underutilized land use to economically profitable and environmentally sound ventures provide better results for the farmers as well as the country. However, except for limited number of researches including Dissanayake et al (2013), there is lack of information on current condition of the MSTH land use and potential of alternative land uses to make their land use economically profitable and environmentally viable.

1. 3 Research objectives

1. 3.1 General objectives

To fill the knowledge gap detailed in the research problem section, this study focus on investigating the current socio-economic, biophysical and institutional condition of MSTH, problem they are facing and potential alternative land use to improve their condition.

1.3.2 Specific objectives

1) To assess the current livelihood condition of MSTH using the livelihood capital approach;

2) To identify key issues faced by the MSTH form the perspective of major actors using the perception analysis approach;

3) To evaluate the potential of fuelwood plantation as an alternative land use in uncultivated marginal lands by emphasizing the current demand and supply gap;

4) To propose policy solution for sustainable use of marginal lands of small tea land holders.

Chapter 2 Literature review and Analytical framework

Summary

Sustainable Livelihood Approach (SLA), was used to understand the current condition of the MSTH by using five livelihood capitals, or Natural, Social, Human, Financial, and Physical capitals used in SLA and observed the type of farmer property rights as well as its effects on land use / land use change. To change the existing land use type in to other, evaluating stakeholder's perception is important to formulate future recommendations for the betterment of farmer's livelihood. Thus recommendations were practically viable once it has been carefully examined with the real world situation. Therefore I analyzed the fuelwood supply and demand in the area with highlighting possibilities and problems faced by MSTH and scope for totally or partially converting their land to fuelwood planting, while safeguarding the surrounding environment as well. Since such type of land conversion is new in the country, to get better understanding of similar type of cases conducted elsewhere especially how local poor farmers overcome the problems and adopted to a better livelihood conditions in the tropical countries, a literature survey was done

2.1 Literature review

2.1.1 Land and Land use

Land is classified as one of the important primary finite resource for production, which cannot directly consumed just as a food, but plays as an important platform for production of food and other important basic requirements such as environmental, economic, social especially for the humans as well as for the every living beings all over the world. According to some expert's classification, land is defined as non-reproducible consumption resource which can be used as an infinite resource of livelihood capital and some of them using it as a security (transferred as assets over generations) (Ellis 1992 cited by Niroula et al. 2005).In other word land use is classified as human involvement for a various purposes such as cultivation, human settlement, and recreation (Qi et al. 2012).

According to the FAO classification, land use is a function or purpose of the land used by the people for a certain activities which are directly related to land, utilizing and importance of the resources which are placed on either above (e.g. Crop yield), surface (e.g. Construction work) or below (e.g. Minerals) and classified in to 40 main categories, starting from, number one as virgin forests to number 40 water inland areas (Riccardo et al., FAO 2013, Anderson et al. 1976).

2.1.2 Global land availability

The total land area in the world would be 13.3 billion ha (excluding Antarctica), utilizing 11% for agricultural activities, 28 % under forests, another 35 % with grassland/ woodland, 22% either barren or scattered scrub vegetation, and the rest 3% is occupied with inland water resources , human settlements and their infrastructure facilities (FAO 2011).

Gradually after the human settlements established all over the world and with the increasing population, land ownership and land usage has became very complex, it depends on the economic situation of the people. Land or land use is an economically controlled factor with many influencing characters behind that such as productivity of the land, vulnerability to soil erosion and landslides, road accessibility, topography and positioning of the land in either dry or wet climatic conditions of the particular country or a region (Dale 1997). All of these discussed above has directly influenced our understanding, determination of land suitability for agricultural activities (Delden et al. 2010). According to the experts they explained land as "land may simultaneously pose characteristics that are favorable to and detract from its value for a particular use, creating tradeoffs in land- use decisions" (Vesterby et al. 1997). Land use for individual or collaborative, final goals are dependent on, his or her preferences, management strategies, how they cope up with the prevailing policies on land use, present situation of the land use, and level of risk avoidance to improve their present livelihood conditions (Soini 2005).

Land use and land use selection can be explained through number of theoretical approaches, highlighting the most important factors influencing land use. Special reference to the Von Thunen,s well known theory on " The Isolated State" Horvath (1969) clearly explains the reasons why human settlements are set up close to basic key resources such as suitable fertile lands for agriculture, water resources, road network and easy accessibility to any mode of

transportation system. With deeper analysis of factors influencing agricultural land use, it showed that both human and biophysical influenced factors play pivotal role.

All of these factors were commonly called livelihood capitals or livelihood building blocks, which includes five capitals which are Social, Physical, Financial, Human, and Biological (DFID 1997). Many researches have widely used these livelihood capital based models to understand the farmer's decision marking for their present land use and land use change. There were many other endogenous as well as exogenous factors directly or indirectly influencing land use and land use change.

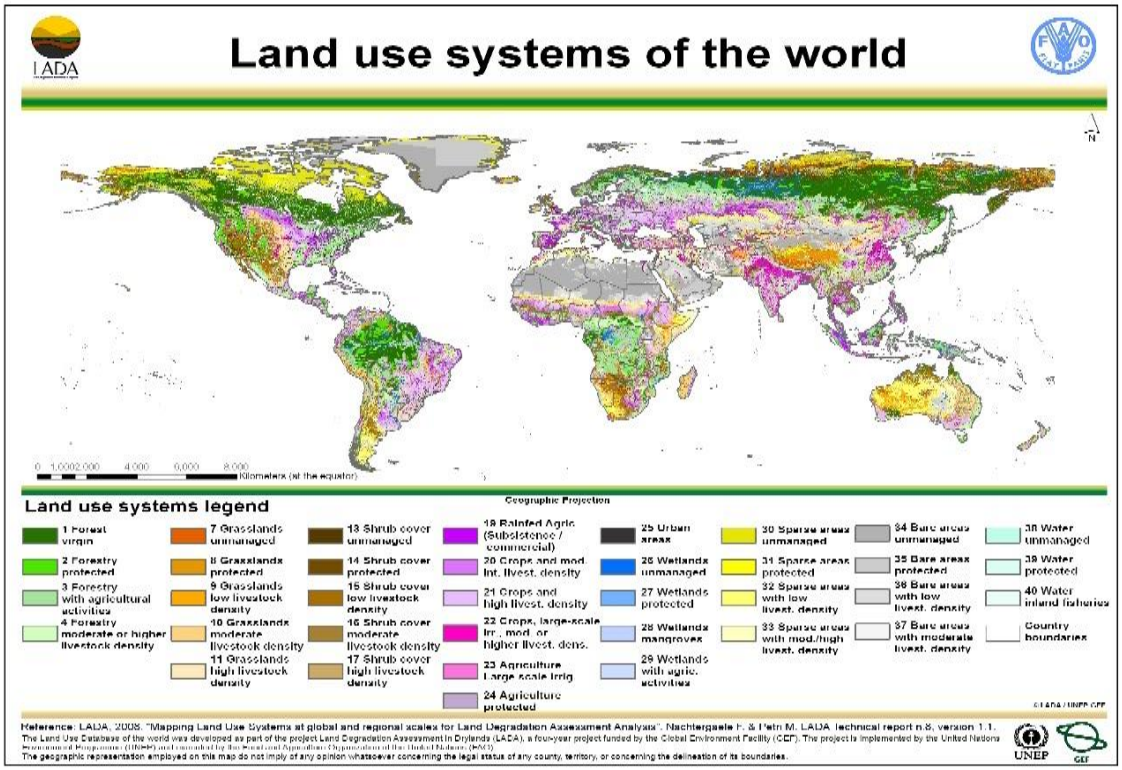

Figure 2.1: World Land use map (source: FAO 2013)

Table 2.1: Land use types in Sri Lanka (in ha).

Utilized land (agriculture and urban)	2 635 000
Forests, wildlife and catchment areas	2 000 000
Sparsely utilized land (under tea, Patna, etc.)	728 800
Reserved land (reservoirs, streams, roads etc.)	585 300
Steep land (sloping to excess for agriculture)	380 000
Barren land (rock, sand, poor vegetation cover)	77 000
Land over 5000 feet/1500 m altitude	76 400
Mangroves and marshes	70 000
Total land area	6 552 500

Land use types in Sri Lanka (source: World Bank report 1996)

Sri Lanka is identified as a country with high demand for lands according to per capita land use value (Central Bank of Sri Lanka 2014) and valuable land is maximally utilized for agriculture and other human activities (World Land use map 2013). While considering the total land extent of the country, Matara district represent 2% (128 300 ha) and Badulla District represent 4.4% (286 100 ha) (Survey department Sri Lanka 2014). The agricultural land were utilized according to the different priorities as identified by the government policy makers and farmer preferences. Table 2.2 shows the type of agricultural land use in Sri Lanka, according to the field survey conducted by the Department of Census and Statistics in year 2002.

Table 2.2 Area and percentage of agricultural land utilization in Sri Lanka

Type	Area (ha)	Percentage
Permanent crops	914 983	49
Cultivated paddy fields	497 052	27
Forest land	130 360	7
Lands under roads, buildings, etc.	78 266	4
Lands not classified elsewhere	61 470	3
Land not suitable for cultivation	29 910	2
Total agricultural land area	1 859 494	100

Source: Census of Agriculture land - 2002 Department of Census and Statistics

2.1.3 National Land use action plan of Sri Lanka

Sri Lanka has developed its national action plan for the Harita Lanka program (towards green environment) with the participation of number of relevant ministries aiming towards its sustainability into a practical reality (Ministry of Environment 2009). The importance of land use was highlighted by the national land use action plan and under its mission 5, Responsible use of the land resources, the following sub sections were carefully considered and the following 12 strategies were proposed with short, medium, long –term solutions to mitigate the economic and environmental challengers of the country (Ministry of Environment 2009).

1. Reduce land degradation in agricultural areas.

2. Rehabilitate deteriorated lands.

3. Develop and implement programs for the use of non-cultivated agricultural lands.

4. Optimize soil conservation through mandatory & other measures.

5. Promote precision farming, traditional verities of crops and crops to fit agro-ecological condition.

6. Conserve, restoring and improve important representative landscapes.

7. Integrate a system to restore, reclaim and rehabilitate mined areas

8. Carry out assessment on Forest cover of Sri Lanka, including different categories of forests.

9. Improve management of commercial plantations.

10. Promote the integrated management of upper watersheds.

11. Mitigate and adaptation to drought.

12. Review Land related Laws.

The progress of the implementations of the actions were monitored by the NCSD (National Council for Sustainable Development) under the patronage of Ministry of Environment and Natural Resources through the period from 2009-2016(Ministry of Environment 2009).

2.1.4 Land degradation

Many scientists all over the world are now seriously concentrating on how to control or minimize land degradation and related issues. Land degradation is defined as loss (or becoming loosening of the capacity) of a particular land to provide ecosystem services. There are many factors affecting land degradation such as physical, biological, natural as well as man influenced factors. Land degradation reduces both land productivity and beyond that it reduces the arable land area as well.

Throughout the world more than 1.5 billion people live on degraded lands and it is about 42% of the very poor people live on these type of lands (UNCCD 2012). On the other hand land degradation directly as well as indirectly influence change of the land use. In earlier days, where there was less demand for land, farmers abandoned their degraded land and found other sailable land for crop establishment (Bai et al. 2008). With the increasing population per capita arable land area in the world has decreased, it has highly effected in Asia, especially south Asia including Sri Lanka (UNCCD 2012). Demand of suitable land for agriculture and human settlement have also increased, as a result of that land price is also increased. Therefore most of the farmers tend to continuous their cultivation in the same land for years, without proper replacement of nutrients and without applying proper protection measures for the soil conservation. There are also other key factors influencing the land degradation, especially when the farmers set fire their land with crop residues as them for easy way of land preparation. For tea plantations it is prohibited for setting fire for land preparation, some farmers, illegally do it because it saves number of labour units for initial land preparation activities (Karsently et al. 2012, Spencer 1966).

2.1.5 Sustainable land use and management

Sustainable management of land (SML) is classified as “a system of technologies and / or that are planning to integrate ecological with socio-economic and political principles in the management of land for agricultural and other purposes to achieve intra and intergenerational equity” (Hurni et al. 1986). One can argued SML was based on the management skills and the way of management by the individual farmer or land user. Accordingly it is governed by the three development building blocks named as “technology, policy and land use planning” (Bouma 1997).

The term sustainable or sustainability is widely used in many disciplines, including organizations, and individuals, still there is no quantifiable method or definition to evaluate it (Slawomir et al. 2005). In general it means "ability to cater the needs of the present generation without effecting or compromising to the future generation to meets the needs". Therefore sustainable land use is a kind of dynamic process of balance in between present and future land use. It is easy to understand the term what is unsustainable land use and unsustainability of land use indirectly connected with ecological, social, and economical aspects, which are called the three dimensions of sustainability (John 1997, and, Wackernagel et al. 1997).

Sustainable land use and sustainable land management more or less give same understanding but can be easily separated into two. Sustainable land use especially in agricultural lands has focused on maintaining the production levels from a particular land for a longer periods (FAO 1993). Sustainable land management on the other hand has broader implication, management process plays key role in practicing sustainable land use system (Doran 2002). Land management in the areas with poor availability of natural and physical resources would be practiced with extreme care.

Within the near future, with the rapid increasing of the world population with the immense demand for the energy and human greediness for utilizing fossil fuels, which is going to exhaust resource and will certainly require to grow energy plantations (includes fuelwood plantations) or use other alternative resources. Therefor it is timely important for conduct agro- socio-ecological research on future sustainable land use and address future problems related in land degradation.

2.1.6 Land use and land cover change (LUC)

Land use and land cover change in general are termed as human involvement in modification of the ground surface of the earth (Campbell et al. 2008). Land cover is the term used for understanding the physical and biological condition of the surface of the soil, which includes natural and man-made vegetation, artificial structures, bare soil and water bodies. Land use is classified based on the different disciplines may slightly differ, for an example, natural scientists classified as human usage for Agricultural activities, maintain or planting forests, construct buildings and other type of soil surface usage for resources extraction (mining), as well as construct

or maintain water resources. On the other hand for social scientists, the land is creating benefits either economically or socially, if it is in economically, weather it gives subsistence level benefits or to large scale economic benefits. Some of the scientists argues that land use change is one of the key driving force which effect positive and negative influence for the agriculture sector. In countries with lack of natural resources, especially poor farmers are compelled to practice it for their survival, thus resulting in both positive and negative socioeconomic and environmental effects (Wakindiki et al. 2002).

Main reasons for modifying the prevailing condition of the existing land in to other is to obtain food, and other necessary requirements for the human being. This has been practiced science the beginning of human civilization. With the population increasement, LUC rates were also intensified by the humans, resulting irreversible changers in surrounding environment processers at the site specific to regional and global scales. As a result of that all the living world faces serious problems such as climatic, environmental and bio diversity changes accompanied with soil, water and air pollution (Ellis, et al. 2010).

Land use change has resulted in a number of problems as well as benefits to the world. Most importantly it affects the amount of carbon storage is the terrestrial ecosystem. Conversion of forest land in to cultivated land or other land use has affected for change of carbon storage per unit land area with compared to forest land. This problem can be rectified to a certain level by implementing the reverse action of converting abandoned crop land into forest plantation (Houghton et al. 1999 and Havlik 2011).

Most of the Asian countries including Sri Lanka, Europeans had earlier colonized and utilized/ extracted forest products and converted land into large scale agricultural activities (Sri Lanka REF, Williams (1990) cited by Goldewiik (2001). The review of the historical crop land extents used by the south Asian countries from the year 1700 to 1990 showed that there was a rapid increment of land use in the region starting from 49.6 to 212.6 million hectares (Goldewijk 2001).

Some scientists argue that land use change applied for agricultural lands have resulted in the heavy soil erosion due to economic and livelihood needs of the farmers in the marginal mountainous or semi mountainous or difficult to access areas where farmers with traditional or low input uses practiced (Loumou et al. 2003).

2.2 Bio physical factors for land degradation

2.2.1 Slope

Slope of the land, steepness of the slope and the slope length have significant relationship on soil erosion and land degradation. When the land parcel located in high rain fall effected areas, or with higher number of water streams are generated it will certainly increase the erosion. More the steepness and with the higher velocity of the water flow, this will be increases the rate of erosion (Posen 2003). Therefore slope plays pivotal role for erosion, and when selecting land especially for the agricultural purposes, sloped lands have to be carefully utilized and managed. Otherwise there will be yield loss and total or partial crop failure and finally it may badly effect the land quality as well.

The Universal Soil Loss Equation (USLE) clearly explains the role of slope. It explains the rate of soil loss in a unit area (A) is predicted by the rainfall (R), erodibility (K), length of the slope (L), degree of slope (S), cropping pattern (C), and soil conservation (P) (Phillips 1991). Slope length and the slope angle is difficult to change, practically it is very challenging, only by constructing terraces. However, making terraces is a time consuming, labour intensive and costly practice. Ultimately low quality terracing in sloped lands will create adverse impact for long term soil fertility. The other adverse impact of terracing is that dumping of the constructs of terraces, original top soil will be removed or buried under. Especially for tea plantations in sloped lands, physical soil conservation (e.g. Stone walls, couture drains with ditches, earth banks) are highly used instead of biological soil conservation (planting of creeping type plants, grass strips, barrier hedge rows) because planting of creeping type plants will adversely affect the tea yields (Hand book on tea TRI 2006).

Land slope basically creates many problems, such as soil erosion and landslides which are identified as the most influencing factors for sustainability of tea lands .The selected two study sites are located in intermediate agro ecological zone of Sri Lanka with identical dry and wet periods of the year (figure : Agro ecological map of Sri Lanka).

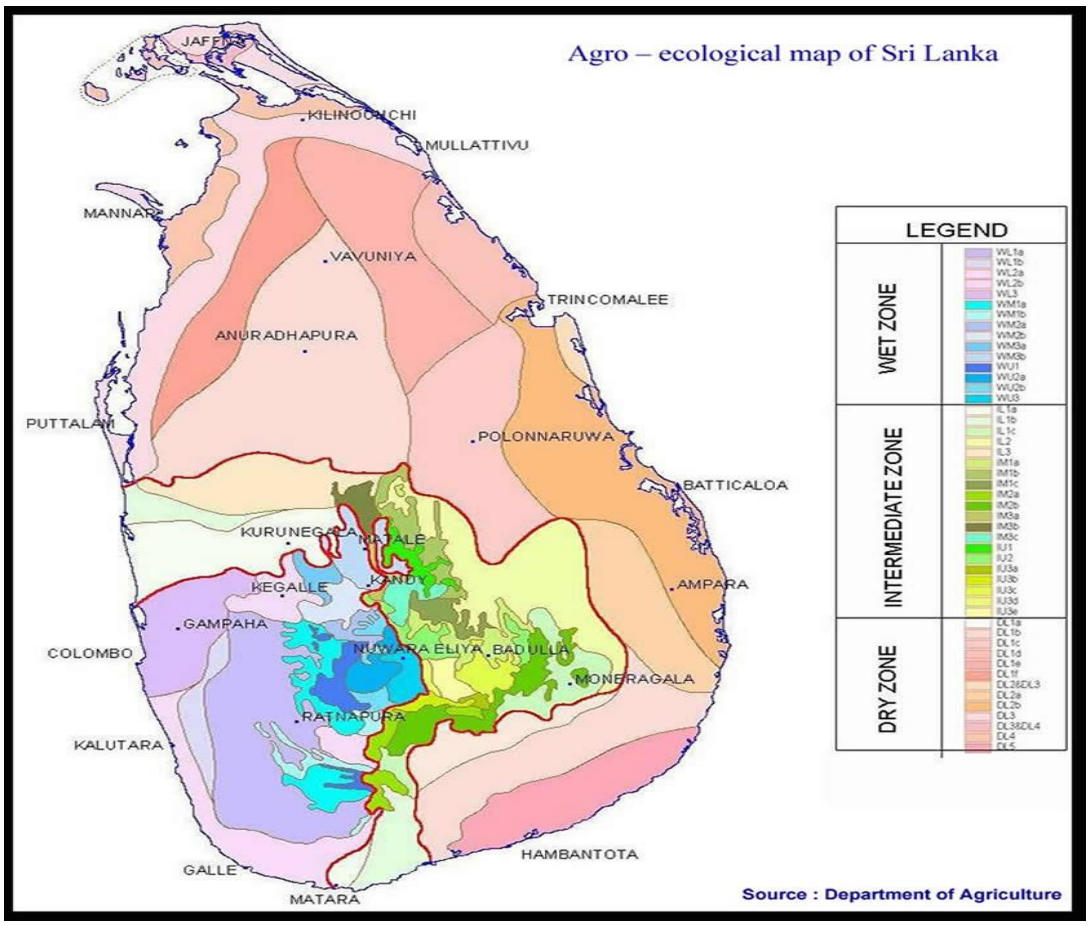

Figure 2.2: Agro ecological map of Sri Lanka (Department of Agriculture)
Source: Department of Agriculture Sri Lanka

2.2.2 Soil erosion & landslides:

The word "Erosion" comes from a Latin word with a meaning of eat away and then excavate, and nowadays it is highly used for the soil loss or destruction mainly due to water (Zachar 1982 Cited by Koulouri et al. 2007).Erosion is identified as mass movement and solution act to loss of material from the original location thus responsible for the quantitative soil degradation (Wijerathna et al. 2007). A major types of soil erosion categorized such as water- induced erosion (common in tropics) (Hudson 1971 cited by Jayasuriya 2003) has accelerated erosion such as rill, gully, tunnel, pedestal, pinnacle, vertical, valley trenching and landslides (Jayasuriya 2003).Soil erosion is a natural process found in every land including natural forests, in agricultural lands it is accelerated

by various human activities. Once activated it creates serious problem for the agricultural lands throughout the world, especially in the sloped terrains followed by heavy rain fall.

Soil erosion can threaten to the land productivity followed by loss of soil fertility and organic matter. Increase of salinization, soil crusting, compaction, and degradation of vegetation are some other important impacts. In some places permanent loss of soil fertility or soil productivity will take place and which can be one of the worst problem faced by many countries throughout the world (Jayasuriya 2003). It is estimated that considerably very high amount of fertile farmland soil all over the world are lost mainly because of erosion.(Pimentel et al. 1995). Some of the related problems can be reversible but with time consuming as well as will be a costly operation, while some of the other problems will even be irreversible (e.g. Heavy landslides). However it depends on the type of vegetation covers over the top soil, accordingly both the cultivated and natural environments it is scientifically prove in that the highest erosion is found out with the rotational horticultural crops, followed by small to medium sized permanent crop (e.g. Apple, *Malus sylvestris*) and lowest with the pasture plots (e.g. *Pennisetum clandestinum*). In natural conditions, lowest soil loss was observed under natural forest conditions (Sanchez et al. 2002).

Soil erosion and landslides occurs under the influence of the climatic variability as well as soil surface characteristics (Nunes et al. 2011). Bare or uncovered lands lead to heavy soil erosion. Fertile soil degradation in tea plantations could be controlled or halted by practicing good agricultural practices (GAP) with maintenance of proper tree cover over the plantation (Wijerathna et al. 2007).

Soil erosion occurring in tea plantation areas of Sri Lanka, compared with the other plantations in the country such as Rubber, coconut or oil palm are comparatively higher. This is mainly because of the management practices and other cultural practices among the crops. Location of the plantations plays major role, where tea plantations were situated in sloped terrains with relatively heavy rain fall areas with the mean annual rain fall ranging from 1500 mm to 5000 mm per year with high strong winds (Hand book on tea TRI 2006, TSHDA 2013). In the other plantation crops (rubber, coconut, and oil palm) planters have the potential to establish creeping/small bushy type of cover crops inside the plantation because of the plant structure

(perennial tall trees), but in the case of tea it is not easy to maintain creeping type of cover crops (tea plant is maintained in the field as a mini bush).

Eventhough there were recommended cover crops for tea, (*Desmodium, Stylanthus gracillis, Tephrosia vogellii*) but most of the farmers did not maintain these cover crops properly (TRI 2013, Palihakkara et al. 2006). Lesser number of cover crops or with no cover crops with higher percentage of vacant tea bushes in the plantation areas are certainly vulnerable for soil erosion due to the direct impact of heavy rain fall/ high intensity rain fall, sometimes with erratic precipitation patterns on the ground surface of these sloppy marginal tea plantations (Ziyad et al. 1996). The problem might be serious in the mid elevation and Uva (includes Badulla District) tea plantations situated in intermediate climatic zone of the country, facing the loss of soil moisture by evaporation under the extreme dry weather conditions. This has resulted many adverse effects for the plantations such as feather death of tea bushes and finally creating larger vacant areas inside the plantation with low soil organic matter. Soil organic matter plays pivotal role for improving soil physical, chemical and biological properties (Ziyad et al. 1996) which is important for the plant growth (including root development) , where well spread and distributed roots (either woody or non woody) will reduce soil erosion in sloppy tea plantations (Ziyad et al. 1996 and Reubens. et al. 2007).

Table 2.3 Annual rates of soil erosion in different countries in the different regions (ton/ha)

Country	Natural	Cultivated	Bare
China	0.1-2	150-200	280-360
USA	0.03-3	5-170	4-9
Australia	0.03-0.2	0.1-90	10-750
Nigeria	0.5-1	0.1-35	3-150
India	0.5-5	0.3-40	10-185
UK	0.1-0.5	0.-20	10-200

Source: Morgan 2005

Compared to natural lands, soil loss is higher in cultivated lands (table 2.3), but in the case of tea plantations which were in the sloppy terrains, these figures were much higher (TRI Sri Lanka 2012). Soil loss will directly affect the productivity of the land and for example if farmers were getting lower income, they will be abandoned the land or sell part of the land, will also be a reason for crop land fragmentation (Niroula et al. 2005).

2.3 Reasons for tea land degradation

Compared to high productive tea plantations, most of the existing marginal tea plantations in Sri Lanka are with less number of tea bushes per unit area. The Tea Research Institute of Sri Lanka recommended 13,500 tea bushes per hectare (Hand book on tea TRI 2006, TSHDA 2012 and 2013). Due to less planting density there were two types of management problems identified, firstly less soil surface coverage and secondly clean weeding practices in these vacant areas (TSHDA 2012 and Sivapalan et al. 2006). Most of the tea land owners are interested to replant or fill in their marginal plantation with tea or suitable other compatible crops which are well adapted to local conditions.

These agricultural practices not only increase to generate their income but also intensify the ecological balance. The failure on proper land utilization and land management activities leads to increase the soil erosion (Sanchez et al. 2002**)**. It was scientifically proven that de-intensification of land use in most of the sloppy marginally cultivated agricultural lands has highly reduced the erosion and related issues (Bakker et al. 2008). Although continuous farming or any type of human disturbance will certainly deteriorate land productivity through soil erosion and landslides, especially in the tropical region (Parrotta et al. 1997). Landslides were classified as either natural or man-made geographic process or a "natural hazard" (Bryant 2005) or downward slope movement of a mass of soil (with rocks, surface plant or animal debris) with the external forces (Schulz et al 2009).

The external landslide stimulant factors could be natural factors like, earthquake, fluvial erosion and man influenced factors named as various kind of agricultural activities, deforestation, excavation of slopes for building and road construction works (Schulz et al. 2009).Once increasing of human population and their activities expands more and more over the surface areas of sloppy lands that will increase the number of landslide incidences year by year throughout the world (Schulz et al. 2009 and Dai 2002).

Once the land is being eroded or degraded it is very difficult to rectify and bringing back as close as to its original condition (Pimentel et al. 1995). It is difficult to find all details and information on physical measures of losses and lower productivity of cultivated lands (Tesfaye et al. 2014). Land degradation effects are inter connected in to number of sectors, such as economic, social conditions of the farmers as well as the country, and as a country it directly effect for the costs and benefits of the rectification of the erosion and related problems (Jayasuriya 2003 and Kuriakose 2010). It is obvious good soil condition is required for any type of crop for getting better performances, for tea it is a key factor especially for the vegetative propagated tea (VP tea) the bushes without a tap root (Reubens et al. 2007 and TRI 2006).

2.3.1 Rockiness, hard pans inside the plantation.

In order to utilize crop land effectively and efficiently for achieving farmers goals, there are number of factors to be considered, such as environmental, biophysical, and man influenced factors (Sanchez 2002).Once the land is not suitable for crop establishment with special reference to the physical quality of the surface soil, will certainly effect for the performance of the established plants (Sanchez et al. 1997, Sanchez 2002).

Rocks or hard parental materials in the farms can be categorized in two main forms, above soil surface and below soil surface. Especially closer to the surface areas in sloppy topography has adverse effect on land productivity (Daniels et al. 1985). In the context of sloppy lands, it is frequently found out rocks and hard materials on the soil surface mainly because of the soil erosion is comparatively high in these areas.

Rocks and hard materials on the soil surface will reduce the effective soil surface crop establishment and finally for its yield, especially for the small to medium sized plants with shorter spacing (e.g. Tea) will reduce its planting density per hectare, but for some crops with wider spacing will moderately effect for its tree density per hectare (e.g. Rubber) where this plant spacing is comparatively higher.

Secondly the rocks and hard materials below the soil surface are situated in effective root zone of the plants which will badly effect for plant growth and its performances. According to scientific classification hard materials were categorized within the effective root zone area of the

soil (up to first 80 cm) as hard materials such as gravels (0.2- 6 cm), cobbles (6-20 cm), hard stone (20-60 cm) and boulders (more than 60 cm) (Laffan 2000). Furthermore hard pans inside the tea plantations adversely affect the growth performance of the tea plants, especially for the vegetatively propagated tea (VP) compare to seedling tea, where the seedling tea has the tap root which can penetrate through these hard pans (TRI 2006).

2.3.2 Uncultivated areas inside the plantation

Every farmer in the world has his or her ultimate objective of utilizing the whole land for gaining maximum benefits out of the land. But in the real world the situation is quite different. Eventhough farmers do not like, some portions of agricultural lands cannot be utilized up to its maximum potential. This is because some of the lands are not suitable or poor capacity to grow crops. This is due to lack of top soil, lack of fresh water for plant requirement to the entire cropping duration or excess water stagnating within the crop land or saline water inside the land, unfavorable environmental conditions, Excessive steep angle of the land, and with hard materials such as stones.

Once uncultivated areas inside the agricultural lands are badly affected, these areas cannot be cultivated, for example, in US around 59 % of the non-federal pasture, unfrosted lands were not suitable for cultivation of crops (USDA 2010). Hence some of these lands were converted in to other type of land use, such as cultivating pasture, forests species throughout the world (USDA 2010). In Sri Lanka,s plantations sector, major crops such as Tea, Rubber, shows similar problems in their plantations, such as abandonment of lands and uncultivated areas inside the plantations especially in the large-scale plantations (Silva 2001 and Nasstrom et al. 2011). According to recent observations, small holders also faces the same problem of uncultivated areas inside the plantations, these incidences were higher in mid elevational zone tea plantations in Sri Lanka (Silva 2001, and TSHDA 2013).

Once these uncultivated areas are not properly utilized (without cultivating or utilized it for planting other tree species). This will adversely affect for biodiversity or environmental condition of the land as well as surroundings of these land areas (Shanker 2003). These type of issues will increase with the time unless proper actions were under taken by the land users or

relevant authorities. It is important to introduce, or implement complementary actions to protect and improve long term sustainability, ecological balance inside the land as well as outside of the plantation as proposed by Shanker (2003). The other advantage of utilizing these uncultivated areas inside the land will create financial benefits for the farmers as well, especially with the areas with favorable weather for planting non intensified trees (local or introduced) with a demand of timber and usage with bio energy, with additional labour for handling these operations, will be one of the suitable solution for these lands (Malik et al. 2009)

2.3.3 Road accessibility (location of the plantation) to the market

In the context of farm land or any agricultural land, its location plays important role. For example value of the farm land or how easy or difficult to manage the land and once harvested, how to access to the proper market. (Alonso 2005) According to him there are positive as well as negative points that the distance and the accessibility of the land play important role. On the other hand market accessibility plays important role for the agricultural crops for the small scale farmers in the remote locations with poor transportation and market infrastructures for selling their products (Reardon and Timmer 2007). Transportation costs of course directly depend on the distance from the production unit (farm) to processing place (factory) and up to final consumer (Makhura et al. 2001).

Most of the developing countries larger portions of the small holder farmers depends on government involvement to provide better road accessibility/ facilities for their farm lands with the aim of sending their products to the markets or to collecting points as early as possible. Most of the cases, small scale farmers find common transportation facilities provided by middle- men, or trading partners or common farmer group organizations than their own individual transportation (Holloway et al. 2000).

2.3.4 Rain fall and wind pattern of the area

Influence of rainfall and strong winds patterns for marginal tea plantations in Sri Lanka is comparatively very high, especially the effect of rainfall is identified as one of the key environmental factor which determined the tea yield per unit land area.

2.3.4.1 Rain fall

Agriculture crop management can be divided in to two sections based on availability of water either as rain fed or irrigated crop management. Tea cultivation in Sri Lanka is highly depend on rain fall (TRI 2006). Some of the tea plantations situated in between wet and dry zone areas called intermediate zone, face problems of water availability during some dryer months of the year. During the lesser rainfall period especially the crop yield which are highly sensitive for rainfall were badly effected or faced high risk for continuation of even yield throughout the year.

For tea plantations it is very important to have continuing year round rainfall to have good yield throughout the year. In any type of crops erratic nature of rainfall and variation of rainfall will influence the yield as well as living conditions of farmers (Lobell et al. 2010 and TRI 2006)

2.3.4.2: Wind pattern

Strong and dry winds always have negative effect on for plant growth and eventually reduce its yield. For tea in Sri Lankas condition, it is highly effected except especial dry season with moderate speed wind helps for quality tea production in Uva region in Bdulla District with its elevation (Ilukpitiya et al. 2004), but such situations are not found in the other tea growing areas of the country. Overall strong winds affects drying or desiccation of immature tissues, reduces the plant growth and reduction of yield, increase evapotranspiration, if the wind speed is extremely high, will damage high and medium shade trees inside the plantation and as a result of that tea bushers will also get damaged, and tender tea leaves tear in to small pieces and will badly effect the quality tea production. Once the tea leaves get damaged (before the process of manufacturing in factory), pre fermentation will start in the field and finally effect made tea quality (TRI 2006 and Jayasekera et al. 2011). In general strong winds in marginal tea growing areas effect low yields and finally effects the farmer's income.

2.4. Fuelwood as Energy supplier in Sri Lanka

Fuelwood plays key role for Sri Lanka,s energy supply, especially rural household's and small to medium scale industries. With refers to available scientific findings sri Lankas commercial scale

fuelwood planting is not popular and larger portion of the requirement supplying from available trees in home gardens, plantations (mainly from rubber, tea and coconut), forest plantations and some illicit extractions from government owned natural forests (which were not yet documented), (SLSEA 2011, Perera et al. 2003, and Perera et al. 2005). This study is focused on Badulla and Matara districts, and therefore we used following data to understand different energy sources used southern and Uva provinces of Sri Lanka.

Table 2.4 Types of energy sources used in two Districts (as a percentage)

Sources of Energy for Lighting	Southern province (Matara)	Uva province (Badulla)	All Sri Lanka
	%	%	%
Electricity	91.1	78.9	85.3
Kerosene	8.4	17.1	12.8
Solar Energy	0.4	4	1.8
Sources of Energy for Cooking			
Fuelwood	87.6	95.9	80.5
Gas	10.7	3.6	16
Kerosene	0.3	0.1	2.5
Other	1.4	0.5	0.9

Source: Household Income and Expenditure Survey 2009/10, Department of Census and Statistics

The following flow diagram explains that different fuelwood end users, existing in the market to fulfill the available resources efficiently and effectively. This simply explains the basic demand and supply economic model for the any type of commodity (SLSEA 2011).Eventhough there is

high demand for fuelwood, it has number of restrictions applies for cutting and transportation of fuelwood in Sri Lanka depend on the fuelwood species, type of land property rights, and the area where the trees are exists (Perera et al. 2005, SLSEA 2011).

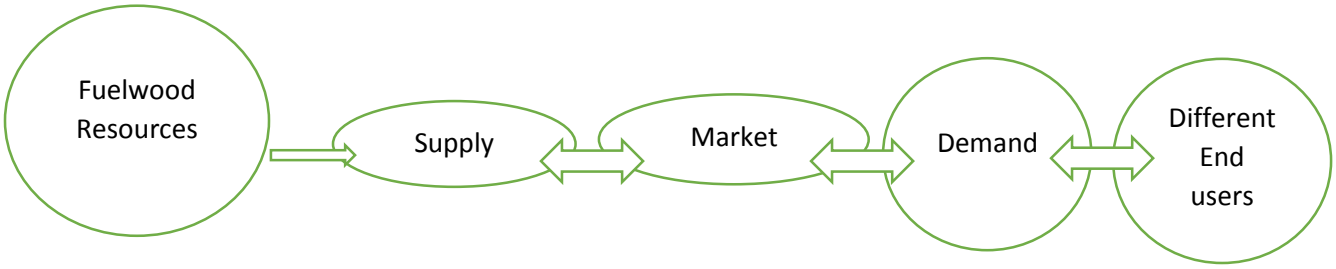

Figure 2.3 Fuelwood supply and demand chain
Source: Researcher

To get permits for felling and transporting of some of the selected trees for timber and fuelwood (including Jack fruit) inside plantations as implemented by the Government of Sri Lanka, following steps have to be followed.

2.4.1 Procedures to follow to get permit for felling trees (applies for timber as well as fuelwood):

1. Copy of the deed/approved legal document of the land certified by the Grama Niladari (GN) as a true copy.

2. When the land does not belong to applicant, letter of consent given by the owner and certified by Grama Niladari.

3. If there are more owners for the land, an affidavit should be provided by the land owners.

4. If felling is for a new construction, plan of the construction

5. If felling is due to danger, the letter informing to remove it by urban/municipal council

6. Court order, if any

7. If the tree is obstructing electricity / telephone lines the letter of informing such

8. If the tree is located in the boundary of the land, a letter written in front of Grama Niladari by the owner of the adjacent land to confirm that there is no objection

2.4.2 Permit for transporting selected (Timber and fuelwood)

1. Complete the application form

2. Grama Niladari report on logs, swan timber or furniture

3. For Jak, Bread fruit or female Palmyra, permit issued for felling of the same

4. The list of the timber certified by the Grama Niladari

5. Recommendation of the forest department

6. For re -transport timber/furniture transported by train, original copy of transport permit and receipt issued by railway department. (Do not need Grama Niladari report or pay for the permit)

7. Purchasing receipts of logs, swan timber or furniture

8. Except the furniture made of Ebony, Calamander. Sandal wood, Stain wood, Nadun, all the other furniture do not need permit to transport, from 11th of June, 2012

2.4.3 Role of fuelwood and trees inside tea plantations

Fuelwood has been identified as the traditional energy supplier for tea drying in the country, since the industry began and most of the tea factories at that time in these plantations were self- sufficient in their requirement of fuelwood. It was met with the trees that were grown for the shade trees in the plantations as well as trees maintained as shade belts along the estate boundaries. These

practices were gradually neglected and given up by the plantation management, only for targeting to increase the number of tea plants per unit area to increase the tea yield. On the other hand fuelwood demand from other various users especially from the domestic and small scale industries were also increased, as a result of that fuelwood price increased.

Nowadays some of the tea factories have been replaced by fossil fuels for various reasons such as scarcity and poor supply chain of quality fuelwood, even though oil price is comparatively higher than fuelwood for its easy handling, storage, and better temperature control, some of the tea factories used oil based energy for tea drying (TRI 2006 and TSHDA 2013).

According to Gaffar et al. 1981 and TRI scientists, once the tea plantation produce an average green leaf yield around 7000 kg per ha/year, having 10% of the tea land area of fuel wood producing trees with the rotation period of ten years would be self-sufficient for drying of the tea. Therefor unsuitable areas for cultivating tea inside the plantations can be utilized for planting fuelwood producing trees.

In good tea producing plantations it is better to continue with planting tea, while concentrating on planting fuelwood trees in the low yielding plantations, under such circumstances, marginal tea plantations are suitable for diversifying fuelwood planting in order to cater the demand in the area and on the other hand it will reduce the fuelwood transporting cost as well.

2.5 Importance of sustainable management of MSTH (Marginal Small Tea farm Holders)

Sustainable management of land (SML) is classified as "a system of technologies and / or that are planning to integrate ecological with socio-economic and political principles in the management of land for agricultural and other purposes to achieve intra and intergenerational equity" (Hurni et al.1986). One can argued that MSTH is based on the management skills and the way of management by the individual farmer or the land user, but it is governed by the three development building blocks named as " technology, policy and land use planning" (Bouma 1997).

2.5.1 Main problems faced by marginal tea farmers

Literature survey based on discussions with Farmer's and focused groups with special reference to their three key issues highlighted.

2.5.1.1 Statement 1: erosion and landslides

Soil erosion in agricultural lands is a serious problem throughout the world, especially in sloppy terrains followed with heavy rain fall. However it depends on the type of vegetation covers over the top soil, influence of the climatic variability as well as soil surface characteristics (Nunes et al. 2011). Bare or uncovered lands leads to heavy soil erosion. Most of the existing marginal tea plantations in Sri Lanka are with less number of tea bushes per unit area.

The tea research institute of Sri Lanka recommended 13,500 numbers of tea bushes per hectare (Hand book on tea TRI 2006). Due to lesser number of bushes per unit area, most of the tea land owners are interested to replant or filled in their marginal plantation with tea or with suitable other compatible crops which are well adapted to local conditions. These agricultural practices not only help to generate their income but also intensify the ecological balance. The failure on proper land utilization and land management activities leads to increase the soil erosion. It was scientifically proven that de-intensification of land use in most of the sloppy marginally cultivated agricultural lands has highly reduced the erosion and related issues (Bakker 2008). Although continuous farming or any type of human disturbance will certainly deteriorate land productivity through soil erosion and landslides, especially in the tropical region (Parrotta et al. 1997).

2.5.1.2 Statement 2: Eroded tea lands are common in marginal tea farming area

Soil erosion is a global problem, faced by most of the agricultural lands since it degrades the land condition in all forms including physical, chemical and biological and social values (Dharmasena, 2011), will certainly decrease the land productivity of any cultivated crops, and therefore it finally reflects badly on the livelihood conditions of the farmers (Miller et al. 2011 and Jayasuriya 2003). Most of the tea plantations in Sri Lanka are planted in sloppy terrains of the country which includes high, mid and low elevation areas. Tea was firstly introduced to Sri Lanka during the British colonial era and thereafter gradually expanded in central high lands and south western parts of the country (Ganewatta 2000). Before introduction of tea, the lands were covered with natural vegetation, coffee plantations or home gardens. Due to the demand and increasing interest of

Ceylon tea gradually other crops area were replaced by large scale or small scale small holder tea plantations (TSHDA 2012 and TSHDA 2013).

Land use change through deforestation and change of existing land use faces new challenges on biodiversity, fertile soil and ecosystems. As a result of that deterioration of soil which leads to erosion, which is a major problem related to land use changes (Dharmasena et al. 2011). On the other hand in Sri Lanka mostly tea were grown in sloppy wet zone areas with reasonably higher rain fall which managed under rain fed conditions (Hand book on tea TRI 2006) have been critically facing the problem.

When comparing to the vegetation condition of forest and home gardens, tea plants are comparatively maintained at low level in height, except few number of the shade trees are managed and maintained inside the tea plantation. Due to low level of vegetative cover it is highly exposed to erosion which leads to reduce the land productivity (Jayasuriya 2003). Nevertheless natural forest cover in the tea growing areas especially in sloppy mountains areas showed decreasing trend mainly because of anthropogenic activities such as intensive agricultural practices, expanding settlements areas and other several unplanned development activities (Hewawasam 2010, Seeger et al. 2008).There are many direct and indirect soil erosion related problems created by the humans (tea farmers and non-tea farmers in the area) Such problems faced are siltation of the eroded materials in the low line agricultural lands which impacts the water reservoirs which is one of the major issue (Hewawasam 2010, Johnson et al. 2007). Scientific research conducted in the sloppy agricultural areas in the country showed that oil loss and erosion rates were more than 100 times when compare to the natural erosion in the forest land in same area (Hewawasam,2010 , Bahrami et al. 2010, and Miller et al. 2011). Therefore, it is essential to find out the actual problems faced in the ground level, pave out the solutions for the improvement and well-being to the local farmers. (Van, et al. 2008). Therefore in this study we observed the farmers perception and the officer's views and their suggestions to find out and propose suitable solutions for minimize/ control soil erosion in future.

2.5.1.3 Statement 3: Labor cost for tea plucking is very high

Tea cultivation is one of the high labour intensive plantation crop in the world as well as in Sri Lanka as compared to other plantation crops such as rubber, coconut and oil palm. For tea plantations, there were special routine of works to be practiced to get better yield and income from the plantation, such as harvesting of tender tea leaves within 4-10 days interval (harvesting frequency depends on temperature, climatic conditions of the growing region and management practices). Sri Lanka is world famous for its quality tea, and one of the main reason behind was manual harvesting with selected tender shoots from the bushes. This way of manual harvesting is termed as tea plucking and the workers who engaged this type of work known as tea harvesters (Maina & Kaluli 2013). For practicing manual harvesting large number of skilled harvesters are needed. These labour has quicker ability to correctly recognize and collect tender shoots which are ideal for processing for a quality end product for the final consumers. Shortage of skilled harvesters is a major problem in Sri Lanka and threat for the country's tea industry (Wijerathne et al. 2007), and it will be effected severely in future for all tea growing countries where little or less adopted for mechanized harvesting. (Illukpitiya et al. 2004).

2.6 Analytical framework (Developed with the use of SLA)

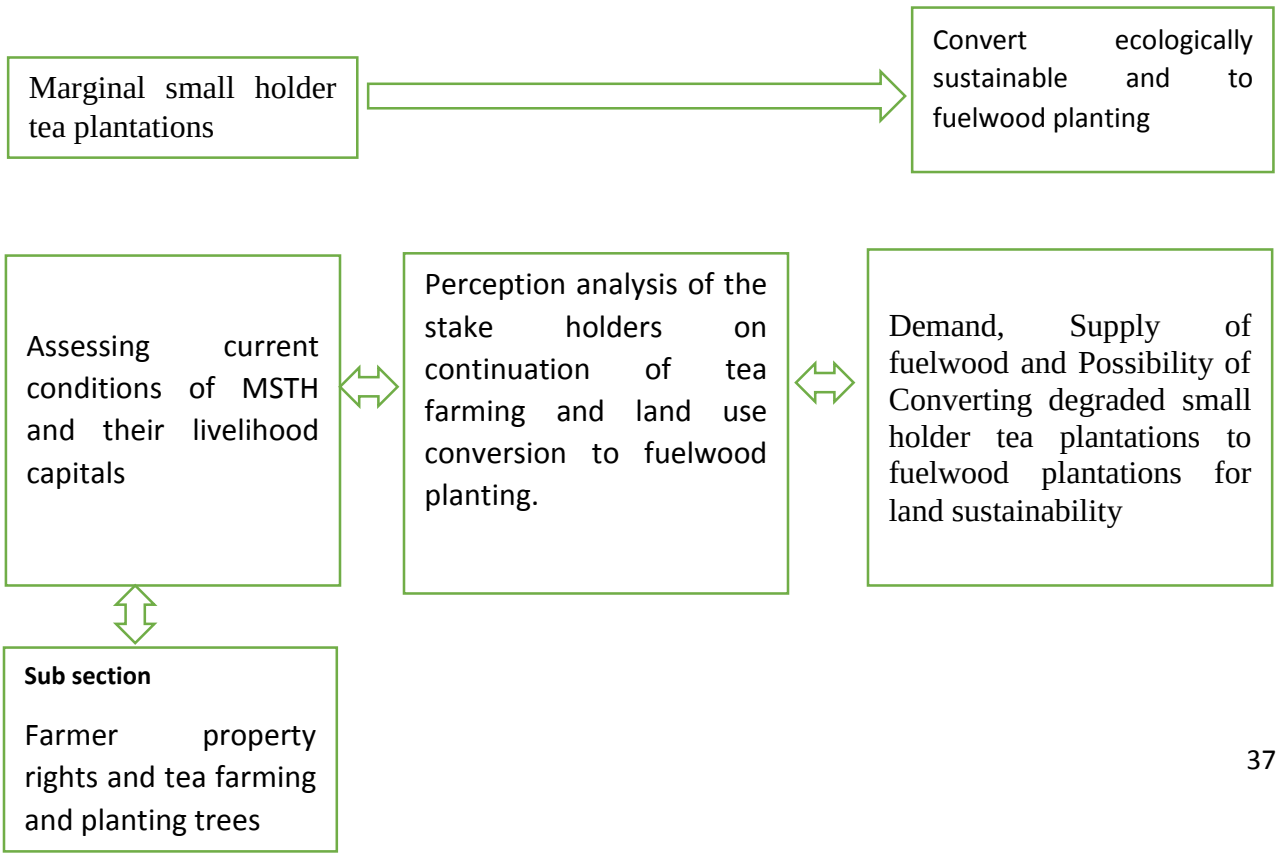

Figure 2.4 Analytical frame used for the research
Source: Researcher

By observing the present condition of the small holder tea plantations, two main types were identified. Firstly, good income generating plantations and secondly marginal income generating plantations (TSHDA 2012). Marginal income generating tea farmers faces difficulty for getting adequate income for continuation of their livelihood. Hence marginal tea farmers either totally or partially pays less interest for further development of the plantations. As a result of that farmers income became lower and finding difficult for them to continuing good living slandered. Improving the productivity of these plantations and will helps to generate higher income for them and finally improve the farmer's livelihood. By converting marginal tea plantation to an additional income generating unit while properly managing the existing marginalized tea plantation. For these reason we observe the possibility of converting uncultivated /un productive areas inside the plantation for fuelwood planting.

Before introducing such an innovative land use change for the marginal tea farmers it is important for assessing current conditions of MSTH and their livelihood capitals. Compared with tea plant, fuelwood producing tree, planting, management and harvesting is different, especially harvesting and transporting the final product to the final market has to follow government rules and regulations. Getting permits for felling and transportation of fuelwood producing trees and fuelwood, type of land ownership plays a key role (FSMP 1995). Therefor we investigate farmer property right and possibility of converting uncultivated areas inside the MSTH to fuelwood tree planting.

For implementing the proposed type of land use change, observation and analysis of Perception of the stake holders is very important, by doing this researcher can get real practice picture (tea farmers and field level TSHDA officers) of possibilities and weaknesses of the proposed new implementation

Finally long term sustainability of proposed land use change (uncultivated areas inside the MSTH conversion into fuelwood planting) is determined by fuelwood demand and supply of the area. By investigating all the above discussed, with the present government policies as well as new proposed policies from this research will help to determine the proposed land use conversion of MSTH to an ecologically sustainable and to fuelwood planting.

Chapter 3: Methodology

Summary:

As a case study design, a single case study with two embedded units of analysis were selected, based on livelihood conditions of small tea farmers of marginal tea growing areas in the country. These two embedded units of analysis represent low and high elevation areas (Matara and Badulla Districts respectively) located in sloppy terrains with environmentally, ecologically vulnerable areas. After preliminary discussion with staffs from Tea Small Holding Development Authority (TSHDA), 81 farmers were randomly selected and 30 officers working in multiple disciplines were investigated for the detailed study in both districts. In addition, fuelwood users (tea factories and medium scale cottage industries) and suppliers were also interviewed. Detailed qualitative and quantitative survey were also conducted to tea farmers, THSDA officers, fuelwood users, fuelwood suppliers (private and State Timber Corporation STC). Data was also collected from government official in village, sub district, district, province and national level, NGO, and Universities. The data was analyzed by using descriptive statistics, and SPSS ver. 17 to find out averages as well as statistical significance

3.1 Introduction

This chapter explained the methodology used for my research and explained why it was used, and justification of the methods used for collecting data. After reviewing literature, methodology was designed, how to address the research question and type of data to be collected for the argument, such as quantitative or qualitative or the both. The research approach was case study focused on one of the burning problem faced by the small tea frame holders. Therefore it is important to understand farmers present livelihood condition, problem they faced and practical problems they faced because of their marginalized plantations. In this study our main focus is to understand the problems faced by the marginal small tea farmers, and the stakeholder's perception on present condition and the futurity of these plantations with the present prevailing policies. The recommendations and the findings of the research, can be applied not only for marginal tea farmers but also all the other marginalized farmers.

On the other hand based on these findings will help to protect countries environment as well as enhance economic benefits to the country as well. Therefore the research was designed, the way how to achieve these specific and overall objectives. The core of the research based on the Sustainable Livelihood Approach (SLA), it was described in the literature review (chapter 2), and research frame was developed by the researcher based on the SLA based on the problems and issues applicable for the marginal tea farmers in Sri Lanka and were represented by these two selected study sites.

3.2 Research Approach

3.2.1 Research strategy: Case study

In social science studies, to understand the field problems and get real picture of it, using variety of qualitative as well as quantitative data, case study could be the ideal strategy. Also it can be used for the researchers to investigate and collect scientific data either from individuals or organizations as simply or through complex interventions, relationships, communities, or programs (Yin 2003 cited in Pamela and Susan 2008). It also allow researchers to investigate the problem using variety of data sources which are directly and indirectly related to the research problem (Yin 2003 cited in Pamela and Susan 2008).

3.2.2 Case study Integration with qualitative and quantitative research approach:

In this research we collect data from two type of data collection methods highly used in social science as any other type of scientific research (David Hulme 2007). Even though qualitative and quantitative research often identified as two fundamental different paradigms in the social science studies (Julia Brannen 2007).Nevertheless some of the researches argues using both of these approaches for a one study will gives better results, as expertise says, “using one eye rather than two eyes” always gives better results, presently number of scientist are trying to use both of these methods.

In quantitative studies, it is highly used statistical analysis to the data collected by using different survey methods, using standardized questionnaires and representation of broader

population or broader aspects, but in qualitative studies, focused on narrative analysis by collecting the data through discussions, conversations, interviews, life histories and observations, focus group discussions, community mapping, participatory problem or opportunity analysis, institutional analysis, sometimes it represents non–numeric values from relatively small data sets(David Hulme 2007).With these reasons we argue case study is ideal tool for investigate our research objectives.

3.3. Research method and study site selection

3.3.1 Study site selection criteria:

Firstly, two study districts were selected based on literature survey and the recommendations given by TRI and TSHDA, the main government institutions responsible for research and extension of tea farming in Sri Lanka. We observed while referring with the records of these two districts, larger number of marginal small tea farmers with lower income followed by lower productivity in their plantations and faced many difficulties for their livelihood.

Secondly the two study areas were chosen with the basis of one from each district, located in a sloped and undulating terrains experience with prolonged droughts and strong winds in some months of the year. In addition to that tea factories and other commercial scale fuelwood end users in these two areas had faced difficulty in finding quality and their desired fuelwood species, continues inflation of price and higher transportation cost due to collecting fuelwood from longer distances for their factories.

Therefore to propose and find long term sustainable solutions for the above discussed problems mainly with aiming to increase livelihood conditions of marginal tea farmers, highlighting present policies involved in the small tea farming sector. We selected above two study sites for the proposed case study as a model to represent marginal small holder tea planting sector in Sri Lanka.

3.3.2 Data collection methods & sampling strategy

This study has collected both primary and secondary information for analysis. For primary data analysis, sample householders were investigated using questionnaire. In this study we used both random and purposive sampling techniques. Both of the study sites are located in sloppy intermediate tea growing areas and farmers are facing common type of problems such as soil erosion, landslides, land property rights etc.

3.3.3 Primary data collection

Field work was carried out in four times during July-September 2013, February- March 2014, August – September 2014, and February-March 2015, in the two tea growing districts selected out of 14 tea growing districts in the country, namely Matara District: In Southern Sri Lanka and Badulla District: in central hilly areas.

A. Transect walk:

Transect walk was conducted across the roads in both study sites with the participation of TSHDA officers those who are in charge of the area, before conducting the main field survey to understand the farmers land use pattern, vegetation types and major tree species inside their tea plantations, road network, living condition of the farmers and their main livelihood capitals, general problems faced by the farmers especially due to topography of the area (mainly soil erosion and landslides).

B. Questionnaire survey:

For the questionnaire survey both open and close ended type of questions were used. The questionnaire was prepared to collect information regarding farmer's livelihood characteristics, land characteristics, stakeholder's perception on tea farming, continuation of tea farming, timber /fuelwood tree planting uncultivated areas inside their plantations, fuelwood suppliers and end users perception were investigated. For the development of the questionnaire, documentary studies, recommendations of the TSHDA, TRI and other government and private organizations as well as comments of the supervisors were used.

The questionnaire validity was confirmed by Cronbach's alpha coefficient. The questionnaire was prepared initially in English and translated in to "Sinhala" language especially for the farmers to understand and this increase their confidence by providing reliable answers. The Questionnaire was administrated on randomly selected farmers, fuelwood suppliers and end users as well as TSHDA officer's attached to different ranks in the two study areas. Two enumerators were trained and accompanied with the researcher for the final survey.

The data that requires farmers opinion such as their way of evaluating the plantations and, their opinion about futurity tea based livelihood was measured using a Likert scale ranging from 1 = strongly disagree to 5 = strongly agree

C. Group discussion

Eight group discussions were conducted, consisting of three members each of young farmers, women, farmer society leaders, elderly retired professionals (such as school teachers), TSHDA officer in charge for the area, two representatives from fuelwood supplier and end users were held to get deeper insight on the impacts of the proposed land use conversion to fuelwood planting.

D. Key informant interview

Key informant interview was conducted with the two regional managers and other divisional heads of TSHDA Matara and Badulla Districts and officer in charge of TRI sub stations at Deniyaya (Matara District) and Passara (Badulla District), Divisional secretariat (DS) of the two districts and their staff (responsible for handling farmers land properties), Grama Niladari (GN or grass root level government administrative officers), Regional officers of the State Timber Corporation (STC) of two Districts. The interviews explored information regarding the objectives of the study, processes, possibilities of implementation, constrains as well as impacts of the soil erosion and landslides incidences faced by the farmers.

3.4. Direct field observations

To calculate the percentage slope of the entire plantations is very challenging. Some of the farmers having very undulated areas inside their plantation. Therefore after the preliminary field observations with the support of farmers and TSHDA field staff, we randomly select most unproductive areas of the plantation located in very high sloped terrain of the plantation, and calculate the slope angle by using the following explained simple method which is highly used by TSHDA officers.

3.4.1 Slope of the plantation

Slope angle of the plantations was calculated using the equation: $v = \sin^{-1}(h/l)$, where v is the slope angle, h is the measured height, and l the length along the slope. The length (l) was fixed at two meters for ease of calculations. (Yang et al. 1997).

3.4.2 Trees inside the plantation

Trees inside the plantations were identified with the support of local farmers and TSHDA officers. Identification of shade trees introduced by Tea Research Institute (TRI) is simple and easy, where officers and most of the farmers familiar with the common or sometimes with the botanical name. The other local tree species were identified with the local name and there after we collect live plant samples such as leaves, flowers and small branches and were identified with the support of expert of TRI, TSHDA as well as University of Ruhuna.

3.4.3 Fuelwood demand and supply in the area

Fuelwood end users in the study area were selected by referring with the Divisional secretarial (DS) records in the areas and other available reports maintained by the Ministry of Environment and Renewable Energy Sri Lanka (SLSE 2007). For the research twelve tea factories were selected in each study sites for the detailed survey with in the 20 km radios of the study sites referring with the tea board recommendations for tea factories to collect green leaf from the growers with in this limit to minimizing the transport damage to the green leaf (Sri Lanka Tea board 2010). In Sri Lanka there are 713 tea factories were presently in operation, out of that 97 &76 were operating in Matara and Badulla district respectively (Sri Lanka tea board 2010).There were 20

medium/small scale cottage industries used fuelwood as its energy supply, were randomly selected in each district.

Fuelwood transporters were selected by reviving the records maintained by these selected tea factories & other fuelwood users in the study areas with the consultation of TSHDA officers. There were 20 fuel wood transporters were selected for the detailed survey from each district. Fuelwood supply and issuing records for consistent three years from different private suppliers as well as the Sri Lanka state timber cooperation (STC) for the Matara and Badulla districts were investigated.

3.5 Stakeholders Perception analysis.

To get better understanding of stakeholders perception, in this study there were twenty six statements were used (Annexed) for the analysis with the participation of small tea farmers as well as TSHDA officers in the area. We interviewed 15 farmers and 10 officers in each district to observe their selection of pre decided statements which were identified after preliminary discussion with the stake holders and literature review. By using given scoring scale, advice farmers and officers to arrange these statements according to their views using with their experience. Before arrange the statements researcher advise them to consider past, present and future conditions (for the farmers: their land condition and for the officers: their responsible TSHDA area) which is applicable. Thereafter advised them to place each twenty six statements according to their best of knowledge in the given table negatively agreed or positively agreed (scale -5 to +5).

3.6. Secondary data collection methods

In this study we used annual reports, manuals, official statistics collected from the officers at local, regional, zonal and national level as secondary sources of information.

3.7 Data Analysis

The collected data were coded, tabulated, compiled and organized into shorter forms for easy handling and then categorized into different sub and main themes. Statistical Package for the Social

Science (SPSS) ver.17 was used for the data analysis. Descriptive statistical analysis, perception analysis was carried out through cross tabulations described by the percentage values, range, means and standard deviations. For some explanations, frequency analysis and cross tabulations have been done to compare the qualitative data correlation were performed to understand and show the difference and the relationship with the proposed objectives

Chapter 4 Assessing current conditions of MSTH, their livelihood capitals and land use conversion special reference to farmer property rights

Summary

With the aim of filling the knowledge gap about the overall livelihood capitals of Marginal Small Tea Farm Holders (MSTH) and to guide future policies and other interventions based on existing realities, this chapter analyses the livelihood capitals of MSTH in Badulla and Matara districts using the Sustainable Livelihood Capital (SLC) Framework. Since land is the most limiting factor for their livelihood, the MSTH were first divided into four land categories ranging from very small to large land holders. Then, their livelihood capital was measured using the five livelihood capitals, i.e., natural, human, social, physical and financial. The result showed inconsistent relationships between the land size of the MSTH and other capitals such as the number of trees planted and the income from tea production. The district with the smaller average land size (Matara) and the very small and small land holders within the district were found to generate more income from tea production. Improving human capital through education for younger generation was also found to contribute negatively toward labour contribution for tea production. Between districts, weather and elevation, two forms of natural capital that are mostly neglected in rural studies using the SL approach, were found to play important roles in determining the outcome from tea-based livelihoods. The study also found that only large land holders have the most strong property right, i.e. land deeds that give some strong bundles of property right on the land. The other categories have Government temporary permits, Divisional Secretory permits and Letter from Government Agent which are weak in terms of their property right provisions.

4.1 Introduction

Strengthening or supporting of activities that improves livelihood capitals gain from a given livelihoods strategy is a primary approach for improving rural people's livelihoods. The poor farmers who live in marginalized remote areas commonly require a range of capitals to improve their living standards. The main concepts for understanding of local decision-making to follow a given livelihood strategy, therefore, is the notion of asset substitution and trade-offs. Such understandings enable the framing of strategic questions for development planning such as: Could

an increase in one capital such as social capital substitute for a lack of physical capital in a particular livelihood strategy, Or, do people need to change their whole livelihood strategies in order to efficiently utilise the available capitals? Or capitalizing one of the readily available capital and change or moderate it into a new feasible way for the benefit of the local marginalized people (Baumann 2002).

In this chapter, we observe farmers present livelihood conditions by using the five sustainable livelihood capitals (DFID 1999). These five livelihood capitals are natural, financial, human, social and physical capital. Natural capital is the natural resource stocks including forest, soil, water etc while financial capital refers to monetary capital bases such as incomes, credits, savings and other (Sherbinin et al. 2008) and non-monetary savings like livestock that household keeps for the purpose of selling when needed. The skills, knowledge, ability to labor etc are the human capital. Physical capital includes productive assets held by the household like land, tools, oxen etc (Scoones 1998 and Sherbinin et al. 2008). The social capital include networks, social claim, social relations, affiliations, association upon which people draw when pursing different livelihood strategies requiring individual or coordinated action (Scoones 1998).These capitals are commonly used by scholars in the past decade for the national and international poverty reduction programs. Hence, they are vital role to understand the livelihood condition of farmers living in degraded areas where focusing with low income generating house holders. Most of these house holders live in rural areas with sloppy and marginal tea growing areas with high environmental and ecological vulnerability and limited resources compare to other tea growing areas in Sri Lanka.

Data was collected from two districts in two stages and after collection of the data with the participation of TSHDA officers and the research team, marginal tea farmers were divided in to categories based on their land extent. The similar type of categorization is used by the TSHDA for grouping the tea small holder farmers for their identification and implication of small scale subsidy programs for example distribution of fruit trees among small to medium sized land holders. The farmer categorization is explained in the table 4.1 below. The selected farmers were categorized into four land classes, i.e., very small land holders (VSLH) (<1 ha), small land holders (SLH) (1-2 ha), middle land holders (MLH) (2-3 ha), and large land holders (LLH) (3< ha) (Table 4.1). Direct observation of the land conditions ,the slope was measured and after that calculated as a percentage, maturation of the tea bushes and weather they are seedling or vegitatively propagated

plants, and type of management were conducted on the MSTHs' plantations. The visit was also used around the village boundaries as an opportunity to get familiarized with the village and the farmers with an aim of getting more reliable data.

Table 4.1: Description of the farmer categorization according to their land size

Category	Land extent	Number of farmers	
		Matara	Badulla
Very Small Land Holders (VSLH)	Less than 1hectare	32	8
Small Land Holders (SLH)	Between 1 and 2 hectare	8	8
Middle Land Holders (MLH)	Between 2 and 3 hectare	5	5
Large Land Holders (LLH)	More than 3 hectare	5	10

4.2. Result and Discussion

4.2.1 Natural capital

Among the two districts Matara, has large proportion of the randomly sampled households belong to the VSLH category had an average land area of 0.7 ha. In Badulla, on the other hand, most of the farmers are from the LLH category with an average land holding of 15.9 ha. In addition, the average land size of farmers in the first category is smaller in Matara compared to Badulla (Table 4.2). This may imply that the Badulla district is relatively well endowed in terms of the most important natural capital, i.e. farmland. The reason for this disparity can be traced back to the origin of the current land tenure system of the two regions. In the Badulla district, tea plantations were established during the British colonial era with large scale tea plantations (Wenzlhuemer 2008 and De Silva 1981). After independence, the government of Sri Lanka introduced a new land reform act in 1972 declaring that individual farmer could hold up to 20 ha (50 ac) land, and the remaining land was acquired and managed as government property. Over time, these 20 ha plantations were further divided into smaller portions among the family members (Samaraweera 1982). In the case of the Matara District, however, small holder tea plantations were popularised after the independence. (De Silva 1981).

When considering to the selecting sloped lands for cultivate tea, moderately suitable farmland recommended by the TRI for Matara is the slope between 25% to 70%, and is between 25% to 55% for Badulla, the actual average slope ranges from 48%-53% in Matara and 49%-61% in Badulla. Farmers belong to the MLH category with an average land area of 2.4 and 2.1 ha have the highest slope percentages at 53% and 61% in Matara and Badulla, respectively (Table 4.2).

Table 4.2: Natural and bio- physical capital of small holders in the two districts

Natural &bio-physical capital	Matara District				Badulla District			
	VSLH	SLH	MLH	LLH	VSLH	SLH	MLH	LLH
Farm size (ha)	0.7	1.3	2.4	13.7	0.8	1.3	2.1	15.9
% uncultivated	11	22	13	22	15	6	7	30
% Slope	48	48	53	49	49	54	61	52
Number of tree (high shade, medium shade)	1806 (178, 1628)	202 (42, 160)	861 (141, 720)	476 (26, 450)	459 (119, 340)	309 (104, 205)	848 (193, 655)	1484 (384, 1100)
Location	Low elevation				High and mid elevation zone			
Weather	Higher temperature				Low temperature			

All of the slope categories of both districts are in the upper levels of moderately suitable land according to the TRI land suitability classification for tea. In general, however, the slope

percentages were not significantly different ($p<0.1$) between the districts and among the four land categories in both study areas except the MLH in Badulla District.

We observed the farmers response for having uncultivated land in their plantations. And was categorized into four categories (Table 4.3). Results reviled 50% of Matara and 16% of Badulla farmers in VSLH category were not cultivated any crop was the particular area is unproductive and already eroded. Nevertheless 25.8% and 8% of the farmers belongs to LLH was agreed with the same response. None of the farmers belongs to SLH category in both districts followed by MLH in Badulla, highlighted low profit from their plantation is not the main reason for abandoning of these plantations. According to the results 26 % of farmers in VSLH category and 25.8 % from LLH category in Badulla District responded is due to the slope.

According to the results 42% of the Matara and 12.9% Badulla farmers belongs to VSLH highlighted reasons for having uncultivated areas is due to dying of the tea plants which they already planted or infilled (Table 4.3). Compare to Matara all land categories except VSLH of Badulla says dying of tea plants were higher. There are number of reasons causes for tea plant dying (Hand book on tea, TRI Sri Lanka 2006). Farmers strongly pointed out tea plant dying is highly influenced by shallow soil depth in their plantations and the pattern of weather. The other key natural capital sources and the most determinant in terms of affecting the productivity as well as the income of the tea producers are elevation and weather. Matara is in a low elevation wet zone of Sri Lanka with higher temperatures. On the other hand, Badulla is located in the high to mid elevation zone of Sri Lanka with relatively low temperatures. Due to the higher temperature, the Matara tea yield/unit area is higher with a higher number of harvesting rounds per year compared to Badulla (Wijerathna, et al. 2007). In addition, the low elevation of Matara has a higher green leaf price compared to mid and higher elevation tea leaves from Badulla (Sri Lanka tea board 2010, Ministry of plantation 2013).

Table 4.3. Farmers reasons for having uncultivated land in two districts

Category	Matara District % Response				Badulla District % Response			
According to farm size (ha)	Un-productive & eroded	Too sloped	A banded due to low profit	Dying of tea plants	Un-productive & eroded	Too sloped	A banded due to low profit	Dying of tea plants
VSLH	50	26	14	42	16.1	9.6	3.2	12.9
SLH	8	8	0	16	9.6	9.6	0	22.5
MLH	8	10	8	8	12.9	6.4	0	9.6
LLH	8	10	6	10	25.8	25.8	19.3	29

Trees inside the plantation is a good assets for the farmers and is identified as important capital for the tea growers. Some of the trees were identified as multipurpose trees in the tea plantations where maintaining trees in a proper scientific way will increase the overall performance of tea plant, tea is identified as shade loving plant. Maintaining shade trees will provide multiple servicers to tea plants as well as to the growers such as, provides shade for tea, nitrogen fixation (leguminous trees), nutrient recycle (absorption of nutrients from the deeper layers of the soil through the well-developed root system of shade trees compare to tea plants and releases nutrients for the surface layers through decomposition of the dropping leaves from shade trees), a cheap source of firewood to meet energy requirements as well as an income source, provide timber and nutrients for the soil in which tea bushes grow and to reduce soil erosion. Energy is one of the most important commodity for any country. This is since Sri Lanka has no oil or natural gas reserves, biomass from shade trees and other sources is of central importance to the overall energy supply of the country as identified by the Forestry Sector Master Plan-Sri Lanka (FSMP 1995).

Interestingly, the results showed that the VSLH farmers in Matara have the highest average number of trees, 1806 trees, of which 178 are high shade trees. In the Badulla district, however, the LLH have a higher average number of trees (Table 4.4). In addition to providing shade, these trees are of vital importance to the farmers. Usually, pollarding and periodic lopping of high and medium shade are practiced to ascertain the optimal shade level of 10-40%. In addition, when the

tree life span is over, it is removed from the plantation and replanted. For example, the average life spans of *Gravillea* and *Albizia* are 30 and 12 years, respectively.

The pollarded and lopped materials, as well as the entire trees that have been removed after finishing their life spans, are used for fuelwood. Such wood/fuelwood production from non-forest tree resources is highly significant in the Sri Lankan context. It is vital, especially for tea growers, to minimize the fuelwood shortage they commonly face. Due to the fuelwood shortage, for example, the price of *Gliricidia* increased to Rs 1500 per cubic meter from Rs 1000 per cubic meter two years ago (TRI Sri Lanka 2012). In addition to fuelwood, these trees also provide diverse goods for the farmers from providing shade and mulch for the tea plantation, to providing edible food, medicine, fuelwood and timber for the local people. *Gliricidia sepium* is the dominant species in both districts, followed by *Milia azedarach, Albizzia moluccanain* in Matara and *Calliandra calothrysus*, *Erythrina lithosperma* in Badulla.

Table 4.4: Tree species and their population in the study site

Tree	Matara District (farmers)				Badulla District (farmers)			
	VSLH	SLH	MLH	LLH	VSLH	SLH	MLH	LLH
Number of high shade trees	178	42	141	26	119	104	193	384
Number of medium shade trees	1628	160	720	450	340	205	655	1100
Total number of shade trees	1806	202	861	476	459	309	848	1484
Type of species found in the tea farmland								
Species name	Total No trees	No. of farmers (%)	Land area	Tree/ha	Total No trees	No. of farmers (%)	Land area	Tree/ha
*Gliricidia sepium**	2958	34(68)	97.8	30.2	1370	15 (48)	73.76	18.6
*Erythrina lithosperma**	0	0	0	0	580	9 (29)	64.4	9
*Grevillea robusta**	0	0	0	0	437	21 (68)	142.31	3.1
*Calliandra calothrysus**	0	0	0	0	350	5 (10)	19.4	18
Swietenia mahogany	93	8 (16)	35.4	2.6	118	7 (23)	71.9	1.6
Michelia champaca	0	0	0	0	100	19 (61)	135.4	0.7
Eucalyptus spp.	0	0	0	0	87	15 (48)	136.3	0.6
Toona sinensis	0	0	0	0	58	11 (35)	123.5	0.5
*Albizia moluccana**	138	17(34)	30.3	4.6	0	0	0	0
Chloroxylon swietenia	6	1(2)	0.94	6.3	0	0	0	0
Artocarpus hetorophyllus	59	7(14)	12.61	4.7	0	0	0	0
Milia azadirach	184	23(46)	57.68	3.2	0	0	0	0

While conducting our investigations, farmers in Matara District pointed out the benefits of planting and maintaining Sri Lanka Agarwood plants inside their marginal tea plantations, which is identified as important income generating tree. Agarwood *Gyrinops walla* (Sri Lanka native) is medium sized tree grown in natural conditions as well as in home gardens and grown as a sub canopy tree in intermediate to wet climatic zone of the country (photo 4.1). The tree produced a resinous substance named "Agarwood" and is used as a base for producing world's most prestigious and expensive perfumes (Subasinghe et al. 2013). The plant was not found in Badulla District. Interestingly during the field investigating period collection and transportation of the product is illegal and highly punishable offence. However, except for VSLH, all the farmers in the other three groups were unanimously willing to plant and maintain the trees inside their tea plantations (Table 4.5). This is because of the value of the tree and its ability to grow naturally in the area. In addition to that farmers pointed out plants potential to withstand heavy pruning and even after cutting whole tree its copping ability.

Photo 4.1 Two year old Sri Lankan agarwood tree in MSTH plantation in Matara District
Source: Author

Table 4.5. Farmer's response on planting high valued Lanka agarwood inside their plantation

Farmer's response	Matara District			
	VSLH (32)	SLH (8)	MLH (5)	LLH (5)
Willing to plant (Lanka Agarwood)	3 (9.3%)	8 (100 %)	5 (100 %)	5 (100%)
Plant by themselves	1(3.1%)	3(37.5 %)	0 (0 %)	3 (60 %)
Plant with the government support (1: planting; 2: technical; 3: buying)	2 (6.2%)	6(75 %)	5 (100%)	5 (100%)

4.2.2 Financial capital

The financial capital of the farmers was measured through interviews and was referred to their written documents such as receipts and salary slips. Four major income sources were identified: tea, other agriculture products (other than tea such as pepper, clove, fruits, and vegetables), salary/pension/rental of the property other than the tea plantation and income from non-regular labour work. The income was measures in Sri Lankan Rupees and presented in Table 4.6. Compared to Badulla, tea farming was found to contribute to a major portion of the income in Matara. Eventhough Badulla has relatively large tea farms than Matara.

Tea produce in Matara fetches higher price from the international market and farmers gets the benefit out of that. The percentage of farmers having tea as the only income source was high in Matara with 43%, 50%, 80%, and 40% from the VSLH to the LLH, respectively. Tea income was found to be relatively less important in Badulla where salary/pension/ renting were the major sources of income.

Especially among the LLH farmers, despite of the expectation of the land size, only 14% of their income was contributed from tea and the rest 78% is from their salaries and pensions. Significant number of farmers from VSLH category getting higher portion of their income from working as a hired labor in the outside plantations (Table 4.6). Overall, the total income from the tea land was not directly correlated with the land size, but with the productivity of the land or number of tea bushes in a unit area. For example, farmers with SLH or MLH has generated more income than the farmers with large land extent (LLH) land holdings. With the observations of farmers monthly profit from tea farming is higher in the Matara district compare to Badulla (table 4.6.1 and 4.6.2).

Table 4.6: Financial capital of small holders in the two districts (Rs/Ye)

Category		Matara District				Badulla District			
		Tea crop	Agriculture	Salary/ Pension/ Rent	Labor	Tea crop	Agriculture	Salary/ Pension/ Rent	Labor
VSLH	Amount	57471 (45)	17800 (14)	46908 (37)	4333 (3)	54462 (27)	16133 (8)	126000 (64)	2000 (1)
	%	43 *	43	34	9	38*	38	38	12.5
SLH	Amount	54336 (52)	21000 (20)	30000 (28)	0 (0)	59276 (32)	26766 (14)	100800 (54)	0 (0)
	%	50 *	37	13	0	50 *	38	25	0
MLH	Amount	73419 (31)	8000 (3)	156000 (66)	0 (0)	36572 (23)	14400 (9)	111000 (68)	0 (0)
	%	80 *	20	20	0	0 *	20	80	0
LLH	Amount	28023 (8)	75000 (21)	259992 (71)	0 (0)	26681 (14)	14800 (8)	144000 (78)	0 (0)
	%	40 *	20	60	0	30 *	30	50	0

*Indicates %farmers getting income only from tea

Table 4.6.1

Category	Matara District							
	Tea crop(income Rs)	Green leaf in Kg Rs65	Total labour units	Labour cost	Other cost (estimated)	Total cost	Profit /year	Profit /month (Rs)
VSLH	57471	884	44	22000	13200	35200	22271	1856
SLH	54336	835	42	21000	12600	33600	41736	3478
MLH	73419	1129	56	28000	16800	44800	28619	2385
LLH	28023	431	22	11000	6600	17600	10423	869

- Rs = Sri Lankan Rupees (1 USD $ = 130 Rs in year 2014)

Table 4.6.2

Category	Badulla District							
	Tea crop(income Rs)	Green leaf in Kg Rs53	Total labour units	Labour cost	Other cost (estimated)	Total cost	Profit /year	Profit /month (Rs)
VSLH	54462	1027	57	28544	17126	45670	8792	732
SLH	59276	1118	62	31067	18640	49707	9569	797
MLH	36572	690	38	19167	11500	30667	5905	492
LLH	26681	503	28	13983	8390	22373	4308	359

- Rs = Sri Lankan Rupees (1 USD $ = 130 Rs)

4.2.3 Human capital

For the effective management of MSTH farmland and to get desirable income levels, farmers' individual performances, as well as their group work, are vital. Tea farming is a labor intensive activity. In Sri Lanka, labor involvement is much higher than the other tea growing countries (Ganewatta et al. 2000). Hence, the number of family members and their labor contributions to tea planting, experience tea farming, formal training and their level of education play important roles (TSHDA Sri Lanka 2010). As shown in Table 4.6, the average number of family members ranged from 2.8 ha for the MLH of Matara to 4.4 ha for the VSLH in Badulla. The average number of family members is above 4, for all categories in the Badulla district. This is larger than the 2011 average household size of Sri Lanka, which is 3.9 people.

Family member contributions decreased with the increase in land size, the lowest being for the MLH and LLH of Matara. The reason for this, according to the respondents, is that household members in the MLH and LLH categories have higher social recognition and education levels, which made them reluctant to assist their parents in the tea farm work. Their argument was also supported by the education level data (Table 4.7 and Table 4.8). The presence of leaches (blood sucking small and tinny creature's lives in humid tropics) in the tea farm is said to be responsible for creating black scars on the skin for a longer period and was another justification for the unwillingness of the educated youth to help their families. Even though these scars are not painful but are signify to their peers that they are working in tea plantations. Sometimes unexpected bleeding will observe from these scars which, for them, are socially degrading.

Farmer experience in tea production for the two districts varied from 26 years for the SLH of Matara to 57 years for the LLH of Badulla. Overall, the Badulla district farmers have more experience than the Matara farmers in all 4 categories (Table 4.7 and Table 4.8). The main reason for this is that Badulla farmers either inherited or purchased the plantations under the Land Reform Act introduced in 1972, and most of them have working experience with tea either on their own plantations or plantations managed by British companies which provide training for the plantation workers as well as given training for the youth in the area with a aim of recruiting them for the plantation work.

Furthermore, the majority of small holder farmers in the Matara District were established in the late 1970s and the early 1980s after the establishment of the TSHDA and the introduction of the open economy system to Sri Lanka in 1977 (TSHDA 2012). For these farmers , before entering to tea farming are neither experience nor training in tea farming and most of them are involving in paddy farming or worked as hired unskilled labor.

The education level of family members is high for both districts. Although there is not a significant inter-district difference in education levels, the intra-district distribution was found to be quite different. Unlike Badulla District, farmers' education levels in Matara are higher for the MLH and the LLH with 13.8 and 13.6, respectively (Table 4.8 and Table 4.8), and was significantly higher than the VSLH and the SLH (6.5 and 7.6, respectively). The possible reason for this is the number of schools functioning in the Badulla district near the large scale tea plantations that were established in the colonial period. The number of farmers who had received formal training is significantly higher for Matara than Badulla, as well as for large land holders compared to small land holders, except for the VSLH of Badulla.

Table 4.7 Human capital of small holder farmers in Badulla District

	No of Farmers	Farm size	No of family members	Score/FM contribution	Tea farming experience (Number of Years)*	No of formal training (Total trainings)	Farmer education (No of years in formal education)
VSLH	08	0.809	4.375a	6.38a	49a	2.0a	8.38a
SLH	08	1.296	4.00a	5.38a	51.8ab	1.125a	10.88a
MLH	05	2.1	4.2a	3.2a b	52.6ab	1.6a	9.6a
LLH	10	15.9	4.00a	0.10b	57.4b *	3.7b	12.9a

Table 4.8. Human capital of small holder farmers in Matara District

Farm size (ha)	No of Farmers	Farm size	No of family members	Score/FM contribution	Tea farming experience (Number of Years)*	No of formal training (Total trainings)	Farmer education (No of years in formal education)
VSLH	32	0.717	4.34a	7.06a	30.0a	1.44a	6.47a
SLH	08	1.284	4.38a	7.55a	25.8a	2.25a	7.63a
MLH	05	2.42	2.80b	1.25b	40.2b	6.80a *	13.80b
LLH	05	13.66	3.00ab	0.50b	43.4ab	9.20a *	13.60b

(Note): To calculate the FM contribution score, the rational scoring weight method was used.

* Indicates the level of significant ($p<0.1$), letters with similar letters indicate no significant deference and different letters indicates

4.2.4 Social capital

Property right institutions

Secured property right has been identified as one of the most important factor for local people investment on natural resource management such as tea planation and fuelwood. In the study site, six different types of property right permits under government land allocation programs were identified. These are:

1) L.D.O permission

2) Government temporary permits

3) GA (Government Agent) and D.S (Divisional Secretory) permits

4) Letter from Government Agent (G.A)

5) Any other category government permission

These land allocation documents are granted to the farmers/small tea farmers under the following government policy decisions.

1. Land Development Ordinance – No. 19 of 1935: An Ordinance to provide for the systematic development and alienation of state land in Sri Lanka

2. Land Grants (Special Provisions) Act – No. 43 of 1979: An Act to provide for the vesting in the state of agricultural or Estate Land which is vested in the land reform commission under the land reform law; to enable the transfer, free of charge, to the landless farmers.

3. Title Registration Act – No. 21 of 1998: An Act to make provision for the investigation and registration of title to a land parcel; including government encroached lands (Ministry of land and land development (2014)

Land Development Ordinance (LDO) is one of most important legal document related to land administration in Sri Lanka. According to section 3 (1) (b) of the LDO, the Land Commissioner has power of general supervision and control of all GAs and LOs in the administration of state land and in the exercise and discharge of the powers and duties conferred and imposed upon them by the LDO, where Swranabumi/jayabumi deeds were issued to the land

settlers / farmers and issuing letters with the decision making powers and responsibilities of Government Agent (GA) to map out and distribute the state land for the various purposes such as village expansion, village forest, pasture, human resettlement, prevention of the erosion of the soil, forest reserves, preservation of objects of archaeological or historical interest and the requirements of local authorities etc.

Farmer with land deeds have full legal authority to utilize the land in terms of planting crops, trees, sell or transfer the whole land or part of the land to a another person (only to a Sri Lankan not for a foreigner). However he or she has to follow the prevailing rules and regulations of felling and transporting of the timber trees listed by the government. L.D.O permission holders also can utilize the land for planting crops, trees, construction of their houses but cannot sell it. LDO permit holders have also to follow the prevailing rules and regulations of felling and transporting of the timber trees listed by the government. The difference with deed holders is that for L.D.O permits, holders follow longer procedure to get cutting and transporting permits.

Government temporary permits issued by the District Land commissioner is a permit issued prior to issue original L.D.O permission and these land holders enjoy the land property rights as mentioned under the LDO permits except that they cannot get Property Loans through banks. Government Agent (GA) and Divisional Secretory (D.S) permits holders can utilize the land only for agricultural activity (planting crops and trees) and construct a house (permanent). They cannot cut the listed trees by the government inside their land and difficult to get transporting permits. If really need to remove or cut the trees, has to get special permit from the GA or DS. Like Government temporary permits, they cannot get Property Loans through banks. Letter from Government Agent holders too can only utilize the land for agricultural activities, and construct temporally houses but cannot cut or transport timber trees listed by the government or get Property Loans through banks. Moreover, any time the government can decide to cancel the letter issued by the GA. Finally, there are also other category of less important government permission. People with these permissions also have similar bundles of property right as Government temporary permits. Deeds provide strongest property right followed by L.D.O permission, government agent and divisional secretory permits, letter from government agent, other category government permission, and government temporary permits.

Except for the LLH, majority of the farmers have property right other than deeds. Only 12.5%, 25% and 40% of the VSLH, SLH and MLH respectively in Matara and 12.5%, 37.5% and 20% of the VSLH, SLH and MLH respectively in Badulla have deeds. For the LLHs, it is 80% in Matara and 60% in Badulla. About 9%, 12.5% and 20% of the VSLH, SLH and MLH respectively in Matara and 12.5%, 20% and 25% of the VSLH, SLH and MLH respectively in Badulla cultivated their tea land without having any legal document with them by using encroached government lands (Table 4.9).

Breakdown of farmers with other forms of property right showed that most farmers have L.D.O permission, followed by Government temporary permits, GA and D.S permits and Letter from GA in Matara district (Table 4.10). In Badulla too, most farmers have L.D.O permission, followed by Government temporary permits, GA and D.S permits and Letter. However, the proportion of farmers with Government temporary permits, GA and D.S permits and Letter is much better than Matara district (Table 4.11)

Table 4.9. Land ownership according to four different land categories of the MSTH in Matara and Badulla district

Category	Matara District			Badulla District		
	With a deed (%) inherited private land	Any other legal document (%) under category 1-5	Without any legal document (%)	With a deed inherited private land	Any other legal document	Without legal document
(VSLH)	4(12.5)	25(78)	3(9)	1(12.5)	6(75)	1(12.5)
(SLH)	2(25)	5(62.5)	1(12.5)	3(37.5)	3(37.5)	2(25)
(MLH)	2(40)	2(40)	1(20)	1(20)	3 (60)	1 (20)
(LLH)	4(80)	1 (20)	0	6 (60)	4(40)	0

* Very small land holders (VSLH), Small land holders (SLH), Middle land holders (MLH), Large land holders (LLH)

Table 4.10. Breakdown of farmers with any other legal land ownership document in Matara District (% of farmers)

Category	L.D.O permission (%)	Government temporary permits	GA and D.S permits	Letter from GA	Any other letter from government
(VSLH)	11(44)	6 (24)	4 (16)	3(12)	1 (4)
(SLH)	2(40)	1 (20)	1 (20)	1 (20)	0
(MLH)	2 (100)	0	0	0	0
(LLH)	1 (100)	0	0	0	0

Table 4.11. Breakdown of farmers with any other legal land ownership document in Matara District (% of farmers)

Category	L.D.O permission	Government temporary permits	GA and D.S permits	Letter from GA	Any other letter from government	Any other legal document
(VSLH)	2(33%)	2 (33%)	1(17%)	1(17%)	0	6
(SLH)	1(33%)	1(33%)	1(33%)	0	0	3
(MLH)	1(33%)	1(33%)	0	1(33%)	0	3
(LLH)	2 (50%)	1(25%)	1(25%)	0	0	4

Social organizations

Owing to the labour intensive nature of tea farming, MSTH can acquire greater benefits by working collectively and forming groups or networks that can be recalled when labour is demanded. This is quite advantageous despite opportunity costs such as time allocated to participate in meetings and payments needed for membership (Barrett et al. 2001 and Barrett et al. 2002). In this study site, four types of societies were identified: the TSHDA, organisations with government support and involvement, autonomous local organisations formed and maintained by the local people, and NGO-supported organisations. The MSTH from all land categories in both districts were found to belong to the TSHDA (Table 4.12). Next to the TSHDA, farmers were found to be more frequently affiliated with government supported organisations than autonomous and NGO-supported organisations. The greater interest in the local autonomous organisation over the NGO-supported organisation is due to the diverse goods and services provided by the former. The roles of these local organisations include providing temporary construction materials, cooking utensils, financial loans and labour during special social occasions such as funerals and weddings. In Matara, a few farmers are attached to a type 3 organisation that mainly focuses on a pipe born water project for household consumption, and in Badulla, farmers were not involved in any NGO activity in the study area.

Table 4.12. Social capital of small holder farmers (Average. Number of members attached to social organizations)

Social Organizations	Matara District				Badulla District			
	VSLH	SLH	MLH	LLH	VSLH	SLH	MLH	LLH
Average No of members	1.8	1.6	2.2	2.4	1.25	1.75	1.8	1.8
TSHDA	1	1	1	1	1	1	1	0.8
Government supported	0.5	0.3	1	0.7	0.25	0.25	0.4	0.5
Local autonomous	0.2	0.1	0.2	0.6	0	0.4	0.4	0.4
NGO supported	0.2	0.1	0	0.2	0	0	0	0

4.2.5 Physical capital

Availability and mode of transportation in the rural farming areas plays a key role in the rural economy (Holden 1998). Hence, analysis of the physical capital involved an assessment of the possession of different transportation means. Different types of vehicles, including bicycles, motor bicycles, three wheelers, tractors, trucks and cars were possessed by the MSTH, but no farmers used animal drafted vehicles. Bicycles and motor bicycles were common among all four categories in the two districts, and were used for transportation and carrying goods, and bicycle usage was significantly lower among LLH in both districts (Table 7). The usage of tractors was extremely low compared to the use of trucks, and it was higher among the LLH in both districts, where they were used for dual purpose such as human and material transportation.

Car usage is extremely luxurious and used by the LLH in two districts, Matara has a larger percent of car users (0.6% compares to Badulla (0.2%), these results are due to the comparatively better road network in the district (Table 4.13).

Table4.13: Physical capital of small holder

Physical capital	Matara District				Badulla District			
	VSLH	SLH	MLH	LLH	VSLH	SLH	MLH	LLH
Bicycle	0.5	0.5	0.4	0.2	0.5	0.5	0.6	0.2
Motor bicycle	0.4	0.8	0.6	0.6	0.5	0.8	0.6	0.6
Three wheelers	0.06	0.2	0.2	0	0.1	0.1	0.2	0.1
Tractors	0	0	0	0.2	0	0.1	0	0.1
Trucks	0.1	0.1	0.4	0.8	0	0.1	0.2	0.9
Cars	0.03	0	0	0.6	0	0	0	0.2

4.3 Concluding remarks

Observing with the analyzed results we found MSTH farmers are themselves decided to abandon portions of their tea land, exacerbating the existing social (poverty) and environmental (soil erosion and land degradation) problems. Overall, the prominent reasons for farmers leaving a portion of their land uncultivated are due to poor natural capital (the unproductivity and the slope of the land), the low financial return (low profit from the land), the lack of human capital (difficulty in finding labour to manage the land) and the problem of plants not surviving.

Among these challenges, unproductive and eroded lands, as well as the dying of plants, were very important factors to the VSLH of Matara district, while the latter was vital for all categories of Badulla farmers as well as the SLH and the LLH of the Matara district.

Labour shortage is another important factor forcing farmers to leave their farms uncultivated. It is particularly important for the MLH of Matara and the LLH of Badulla. Labour shortages, however, are found to be less important problems for the VSLH in both districts (Table 4.3 & 5.4). This is because of the smaller farm size that famers can efficiently use with their family labour, as described by other researchers such as Basnayake et al. (2002). Overall, for the MSTH, tea farming seemed to be a compatible livelihood strategy only for the VSLH, farmers with land area less than 1 ha, as compared to the other land categories. All categories would seem to prefer shifting to other livelihood strategies if they have the opportunity to do so.

Chapter 5 Perception analysis of the stake holders on tea farming and fuelwood / tree planting

Chapter 5 Perception analysis

Chapter 6 Supply and demand of fuelwood and the possibility of converting degraded small holder tea plantations to fuelwood plantations for land sustainability

Summary

Fuelwood plays a pivotal role as a renewable energy source all over the world, especially in developing countries. In Sri Lanka, it is one of the main sources of energy used by tea factories and small- to medium-scale cottage industries; the main supply sources were identified as home gardens (HG), large-scale tea plantations (LTP), small-holder tea plantations (SHTP) and the State Timber Corporation (STC). Rubber is the fuelwood most in demand in both districts, but it is difficult to find. Multipurpose tree species, such as *Albizia* and *Gliricidia*, which are grown inside tea plantations, are popular as fuelwood and are moderately priced. HG supply a mixed-type of fuelwood and dominate the fuelwood supply, followed by LTP and STC. The STC contribution is minimal in both districts because of poor road accessibility, the lack of coordination among farmer organizations and the strict existing policies on fuelwood harvesting and transportation.

6.1 Introduction

Sustainable land management is an integral part of the process of harmonizing agriculture and production, often with conflicting interests of economics and the environment. Agriculture is expected to continue to be the engine of economic development (Timmer 2002) in most developing countries, but for this to be realistic, agriculture in the future will have to be increasingly more productive, more economically efficient and more environmentally friendly towards long-term sustainability (Gamett et al. 2013). Although sustainability will continue to be elusive, learning to evaluate sustainability must begin now for the betterment of future generations (Tschamtke et al. 2012), especially in the field of agriculture. The task is critically important when considering sustainable agricultural activities conducted in marginal lands (Gelfand et al. 2013), where economically beneficial crops, such as bioenergy producing crops and pasture are suitable for planting and productive lands can be reserved for planting high-value food crops (Plieninger et al. 2011).

Biomass is the most common source of energy supply in Sri Lanka, as well as in the world (Bhattacharya et al. 2005 and SLSEA 2011). Biomass comes in different forms, and the most commonly available forms in Sri Lanka are fuelwood, municipal waste, industrial waste and agricultural waste from different types of agricultural lands. Of the country's primary energy requirement, 47.4% is supplied by fuelwood, followed by petroleum (43%) (SLEA, 2007 and SLEA, 2001). The majority of the biomass in the domestic sector is fuelwood, which is widely used for cooking and heating purposes (De Wijesinghe 1984 and Koopmans 2005); however, the major portion of household fuelwood usage is not properly recorded. On the supply side, fuelwood production requires a number of steps (growing, harvesting, chopping, transporting and feeding) and creates job opportunities for local people (Withanaarachchi et al.2014).

Furthermore, many industries, such as the agro-industry (tea, rubber, coconut, processing), manufacturing industry (brick, tile, lime etc.) and certain establishments in the commercial sector (bakery, hotel, eating houses, etc.) use biomass, mainly fuelwood, for process heating and drying. In addition, there are a number of small-scale industries that use bio-energy; these include pottery, ceramics, chemicals, metals, textile, distilleries, and crop & fish drying, laundries and paddy parboiling (Perera et al. 2005). Home gardens, crop plantations (mainly rubber, tea and coconut) and man-made forests supply the major portion of the biomass requirement of the country, which is mostly used 'as-is' rather than being converted into other forms, such as charcoal (Sri Lanka Energy Balance 2007).

Utilizing or converting good agricultural lands into biomass production units (mainly for fuelwood and biogas /liquid fuels) will create ethical and controversial problems for world food production and will contribute to increasing food prices and food-insecurity (Tatsuji et al. 2007). One of the possible options for fuelwood and biofuel production would be the utilization of agriculturally less-important lands, such as degraded, marginal and abandoned lands or underutilized areas inside plantations. Most of the abandoned and marginal lands are either due to wrong selection for commercial-scale crop production or to poorly manage intensive farming (Hurtt et al. 2011). Moreover, scientific studies conducted all over the world using satellite images estimate that there are 430 to 580 million ha of abandoned or marginalized agricultural lands (Campbell et al. 2008).

If these lands were properly utilized all over the world for bioenergy production (above-ground biomass), they would provide 2 to 23% of the world's primary energy demand (Campbell et al. 2008). While estimating fuelwood usage and future projected demand from 1970 to 2020 for South Asia, the FAO projected an increased demand from 234 to 361 million cubic meters (Michael et al. 2006). Therefore, focusing on the current under productivity and the future usage/role of fuelwood as an energy source for industries (especially tea and small- to medium-scale cottage industries) in Sri Lanka, we conducted this study in two marginal tea-growing areas in two districts.

6.1.1 Tea industry and cottage industries

The Sri Lanka tea industry uses two main tea-processing methods, which are commonly called orthodox black tea and cut tare and curved (CTC) tea (Sri Lanka Tea Board 2013). For drying the tea, fuelwood is typically used to obtain the desired heat in a drying unit in which hot air at 100 to 130 C° is blown through the fermented tea particles at a rate of 40–120 m^3 kg^{-1} of tea (Palaniappan & Subramanian 1998).

In the process of tea drying, in Sri Lanka, more than 95% of the energy requirement is thermal energy, and most of this energy (85%) is obtained from fuelwood (Jayah et al. 1999 and Jayah. 2001). Furthermore, the tea industry consumes the largest quantity of fuelwood; additionally, other industries that use fuelwood, including bakeries, hotels, brick and tile industries, rubber, coconut and tobacco processing industries (Energy balance 2007, Perera et al. 2003). In terms of fuelwood consumption, the small- to medium-scale cottage industries in Sri Lanka, (mainly hotels and bakeries) are highly dependent on fuelwood as the main energy source (Kumaradasa et al. 1999).

This study especially refers to the situation of the sloped tea lands situated in different tea growing areas; these farms, commonly called Marginal Small Tea Farm Holders (MSTH**),** face common problems all over the country, as well as unique problems related to their location. Most MSTH earn lower income from these plantations, and it may not be sufficient to support their present livelihood conditions. Furthermore, the uncultivated areas inside these plantations, which result from the lack of interest of the farmers to develop the plantations, will create further problems for the continuation of tea farming, as well as for the surrounding environment.

At the same time, fuelwood plays a key role for the tea industry, as well as for the small- to medium-scale industries in the surrounding area.

However, the majority of the small tea farmers were unable to supply fuelwood for the present market for various reasons, as explained by the fuelwood end users in the area. Therefore, to determine the possibility to utilize these marginal tea plantations as fuelwood suppliers would be a timely solution for the farmers, as well as the fuelwood users in the area. However, the MSTH areas already face environmental problems, such as soil erosion and landslides. Thus, the purpose of this chapter is to determine the possible mutual benefits for the farmers, the fuelwood suppliers, the end-users and, finally, for the betterment of the surrounding environment, as well as the country. This information will show the role and importance of fuelwood for the tea factories and the small- to medium-scale cottage industries in Sri Lanka. Therefore, in our study, we collected data focusing on different fuelwood suppliers (including middle men), fuelwood sources and the main fuelwood end users in the research area, with special reference to the possibility of supplying fuelwood from marginal tea plantations at the commercial scale in the future.

6.2 Results

We observed the advantages (+) and disadvantages (-) faced by the MSTH (Marginal Small Tea Farm Holders) to supply fuelwood from their plantations to the end users in the studied area, with special consideration to the tea factories and the small- to medium-scale cottage industries in the research area.

6.2.1 Type of fuelwood producing trees in the MSTH and end user's preferred fuelwood species

We found a number of multipurpose tree species being maintained inside the MSTH, and these are discussed in detail in chapter four. In this chapter, we investigate end-user preferences for fuelwood species in the two study areas. There were two primary groups of fuelwood end users, the tea factories and the small- to medium-scale cottage industries. The results are summarized in Table 6.1.

Table 6.1: End user's preferred fuelwood species in the two districts

Fuelwood users' preference (1 to 6)	Tea factory		Small to Medium scale users (Bakeries and hotel)	
District	Matara	Badulla	Matara	Badulla
1st Preference	Rubber	Rubber	Rubber	Rubber
2nd Preference	Jungle	*Eucalyptus*	Jungle	*Eucalyptus*
3rd Preference	*Gliricidia*	*Gliricidia*	Mixed/*Millia*/Jack	Jungle
4th Preference	Mixed (*Millia,* Jack, *Albizia*)	Jungle	*Gliricidia*	*Gliricidia*
5th Preference	*Albizia*	*Acacia*	-	*Acacia*
6th Preference	Mango	Mango/ cashew	-	-

According to our discussions with the fuelwood end users, rubber is the first-preferred species in the two districts. This is mainly because of the relative advantages of rubber wood: it has a relatively high caloric value and is easy to burn, and suppliers do not need to apply for transportation permits (TSHDA 2013, De Silva 1994). Because of these benefits, the unit price is comparatively higher than for other fuelwood types (Table 6.2). The fuelwood suppliers, as well as the end users, commonly used the term "jungle fuelwood" for the species that grow naturally inside their home gardens, farm lands or along the boundaries of their tea plantations, widely using the local names for these tree species. Although these local tree species have a slow growth rate, their high caloric value makes them more popular among the end users. *Eucalyptus* spp. was the most popular timber species in the higher elevational regions of the country, including the Badulla district (Reed at al. 2009, Ruwanpatirana 2012). The pruned branches and the parts remaining after the extraction of timber are used as fuelwood. This is one of the most common practices in the two study areas, for its high performance, as well as its suitability for use as fuelwood (Reed at al. 2009). *Gliricidia* is very common in the two districts and has a moderate market price (Table 6.2). Although acacia, mango and cashew are also used as fuelwood in other tropical countries throughout the world (Egeru 2014), the majority of the end users in the study area did not much prefer these species, highlighting their personal reasons, beliefs and practical experience.

The main reasons they highlighted are the low caloric values of these species and the belief that their use negatively affects the quality of the end product, especially tea. For example, they believe cashew and mango fuelwood will negatively affect the maintenance and long-term durability of tea dryers, mainly because of the high resin content of these woods (Discussions with the tea factory manager, Badulla and Matara Districts 2013 and 2014).

Regarding the energy utilization of the industrial sectors, the tea industry is the largest fuelwood user in the country and uses approximately 33% of the total; in addition, the tea industry is the country's largest electricity and fossil fuel consumer (Haskoning 1989, Sri Lanka Energy Balance 2011). It is estimated that the demand for fuelwood will steadily increase in the future (forestry sector master plan 1995, Sri Lanka Energy Balance 2012). Moreover, the government of Sri Lanka has a long-term plan to expand the tea industry with the support of the TSHDA and other organizations, such as TRI; thus, this industry is identified as one of the main income sources of the country (TSHDA 2012).

Table 6.2: Average price of fuelwood in the study area from 2012 to 2014

Fuelwood species	Matara (Year and price in Sri Lankas Rupee/m^3				Badulla (Year and price in Sri Lankas Rupee/m^3			
	2012	2013	2014	% Increment	2012	2013	2014	% Increment
Rubber	1000	Na	1200	20	2000	Na	2300	15
Jungle	825	875	900	9	1316	1700	1800	37
Gliricidia	775	800	900	16	1200	1650	1700	42
Other/mixed	675	800	800	18	1250	1733	1750	40
Albizia	625	700	750	12	Na	Na	Na	
Eucalyptus spp	Na	Na	Na		1600	1850	1900	19
Acacia spp	Na	Na	Na		1150	1533	1600	39
Mango/cashew	Na	Na	Na		1250	1500	1600	28

- 1 $ USD = 131 Sri Lanka Rupee
- Na = Not available

6.2.2 Fuelwood supply from different sources

Table 6.3: Monthly average fuelwood supply to tea factories from different suppliers in m^3/ha
Monthly Fuelwood supply to tea factories from different suppliers in m^3/ha and (land extent in ha)

Study sites	**Matara**			**Badulla**		
	Volume m^3	**m^3/ha**	**% supply**	**Volume m^3**	**m^3/ha**	**% supply**
Monthly Av. from tea plantations < 20 km	**14.7**	**2.34 (6.3)**	**3.85**	**45.76**	**0.378 (121)**	**10.96**
Monthly Av. from marginal small tea plantations < 20 km	**2.76**	**0.0243 (113.6)**	**0.72**	**52.7**	**0.28 (188.3)**	**12.62**
Home gardens/other agric. lands <20 km	**1.25**	**0.1 (12.5)**	**0.33**	**7.29**	**0.45 (16.2)**	**1.75**
Home gardens/other agric. lands >20 km	**321.7**	**7.5 (42.52)**	**84.35**	**296.5**	**2.2 (134.2)**	**70.99**
From STC <20 km	**0**	**0**	**0.0**	**0**	**0**	**0**
From STC >20 km	**41.3**	**-**	**10.85**	**15.4**	**-**	**3.69**
Total	**381.4**			**417.67**		

Table 6.4: Monthly fuelwood supply to (bakeries/hotels/ end users) from different producers in m3/ ha and (land extent in ha) in the two study sites. (Used 10 end-user units)

Monthly fuelwood supply to ten (bakeries/hotels/ end users) from different producers in m^3/ ha and (land extent in ha) in the two study sites. (Used 10 end-user units)

Study sites	Matara			Badulla		
	Volume m^3	m^3/ha	% supply	Volume m^3	m^3/ha	% supply
Monthly Av. from tea plantations < 20 km	7	0.14 (50)	2.6%	20	0.29 (69)	9%
Monthly Av. from marginal small tea plantations < 20 km	2	0.018 (113.6)	0.7%	5	0.043 (188.3)	2.2%
Home gardens/other agric. lands <20 km	1.12	0.09 (12.5)	0.4%	3.2	0.20 (16.2)	1.4%
Home gardens/other agric. lands >20 km	241.3	1.25 (193)	90%	183	1.36 (134.15)	81%
From STC <20 km	0	0	0.0	0	0	0
From STC >20 km	17.2	0.1 (165)	6.4%	14	0.12 (117)	6.2%
Total		268.6		225.2		

We observed the different fuelwood supply sources (Table 6.2), and the fuelwood consumption pattern is more or less equal for the supply pattern. All of the tea factories in the field had additional stock (buffer stock stored in a shade house), and according to the fuelwood usage, the buffer stock is refilled on a monthly basis through various fuelwood suppliers. One advantage for maintaining a buffer fuelwood stock is that the fuelwood is sufficiently dry at the time of use. In some months of the year, the supply is slightly greater than the demand, and sometimes, it will be vice versa. One of the main reasons for these types of variations is the weather, especially the

effect of the rainy and dry seasons. Our study was conducted in the dry months of the year and shows that the supply is a little higher than the demand (Table 6.4).

Ten medium- to small-scale end users in the area were investigated, mainly because some of the end users are purchasing fuelwood from one or two of the main sources categorized in Table 6.3 above. Therefore, to monitor the overall supply, we selected 10 small-to medium-scale fuelwood end users in the study area. The average monthly usage for the medium-scale cottage industries are 27 m^3 and 22.5 m^3, of which 90% and 81% of the supply was fulfilled from home gardens and agricultural lands, respectively, other than tea plantations situated > 20 km distance. The lowest supply account was from the same land category at < 20 km distance, supplying 0.4% and 1.4% of the monthly requirement for the Matara and Badulla Districts, respectively. Concerning the different fuelwood supply sources, compared to home gardens, the contribution of the STC is the smallest (Table 6.3 and 6.5).

Photo 6.1: Fuelwood store in a tea factory; the fuelwood was collected from a tea plantation (a medium shade tree species grown in tea plantations *Gliricidia)*
Source: Researcher

Photo 6.2 Fuelwood stock maintained inside the shelter house (as a buffer stock)
Source: Researcher

Table 6.5: Average monthly supply and usage of fuelwood for tea factories in cubic meters

Average monthly fuelwood supply and usage for tea factories	Matara (m^3)	Badulla(m^3)
Supply	320.2	405.1
Usage	306.4	400.9

Average usage and supply in the study area for the years 2012 & 2013

Source: Field survey 2014

For tea factories, the main source of fuelwood supply is the home gardens and other agricultural lands situated more than 20 km in both study sites, followed by the STC (10.8% for Matara and (12.6%) for Badulla (Table 6.3). Concerning the fuelwood supply from MSTH, compared to Matara, the Badulla farmer contribution is much higher because the farmers have the highest percentage of uncultivated areas inside their plantation (30% in the LLH, discussed in chapter 4). On the other hand, the fuelwood supply from the MSTH in Matara was found to be the minimum, even though they have the potential to supply fuelwood.

One possible reason is that home gardens and other agricultural lands at a distance < 20 km in the study area were occupied by other crops, such as pepper, clove, nutmeg, coconut, beetle nut, jackfruit and other fruit crops. In contrast, home gardens located at >20 km distance and situated in the adjoining district mostly cultivate seasonal vegetables, cereals, pulses and cash crops, such as chili. Before the onset of the rain, these famers sell pruned branches and other suitable stem parts for fuelwood (Arnold 2003). Furthermore, during the dry season, when it is difficult to cultivate crops, they harvest some of the trees inside the home garden and other places, which are either planted or naturally grown along the boundary of their land. This type of timber and fuelwood harvesting is a common practice, especially as a way for the marginally poor tea farmers in the area to obtain extra income.

The tea yield in Sri Lanka ranged from 304 million kg in 2007 to 338 million kg in 2014, with values of 318, 291, 331, 327, 328 and 340 million kg in 2008, 2009, 2010, 2011, 2012 and 2013, respectively (Annual reports of the Sri Lanka Tea Board and Tea Market Review 2014). This means that over the years, the tea factories need more fuelwood for the processing of tea unless the tea factories shift to other sources of energy for tea drying; however, to date, the country's tea factories are highly dependent on fuelwood (Sri Lanka Energy Balance 2011). At the same time, the state-controlled fuelwood supply from the STC remained consistent with some fluctuations in certain years (Table 6.6).

From 2001 to 2014, the cost of production (COP) for 1 kg of tea shows a pattern of continuous increase (Department of Census and Statistics- Sri Lanka 2014), and the cost of manufacturing (COP) for tea showed a continuously increasing trend, as well (Department of Census and Statistics, Sri Lanka 2014). In addition to a number of other costly components in the COP, such as labor, energy and machinery, fuelwood plays a key role as the energy supplier for

tea manufacturing in Sri Lanka, and the variability in its price fluctuation influences the regulation of guaranteed income from tea factories (SLSEA 2011).

Table 6.6: Supply of fuelwood from the STC from 2007- 2011

Year	Supply (m^3)
2007	85 412
2008	84 661
2009	75 985
2010	11 544
2011	97 838

Source: Annual Report of the State Timber Corporation

Photo 6.3. Fuelwood collection from MSTH
Source: Researcher

Photo 6.4. Fuelwood collected (mixed species) for selling (home garden in the Matara District)
Source: Researcher

Photo 6.5. Fuelwood collected (remains after extracting flanks) for selling (home garden in the Matara District)
Source: Researcher

6.2.3 Major disadvantages faced by MSTH for supplying fuelwood

6.2.3.1 Location of the plantation in relation to accessible roads

The location of agricultural land or plantations in sloped terrains plays an important role in selling or sending the products to the market, and access to the markets via a well-connected extensive road network would contribute substantial benefits for the farmers (Jacoby 2000). However, most of the rural farmers will have to suffer with a poor and difficult to travel road network; especially for those who want to transport bulky heavy products such as fuelwood (photo 6.3, 6.4 and 6.5), motorized transportation is much needed (Sieber 1999). Furthermore, if the accessible road is located far from the production site, the producers have to carry the products up to the last point where the vehicle may reach, and local farmers have to use either human or animal power for the local transportation inside their plantation (Danso –Wiredu, 2011). On the other hand, farm land that is situated far away from the motorable road, will simultaneously reduce the value of these bulky products, such as timber/ fuelwood because of the relatively high cost for local handling or heaping inside the plantation (Wiggins et al. 2001).

This study in both districts, describes accessible roads that are located towards the upper side of the plantation, which makes it difficult for lifting heavy products, such as fuelwood to the upper side of the plantation, irrespective of the land size (Table- 6.7). Farmers with an accessible road towards the lower side of the plantation have a comparative advantage over other farmers. The results reveal that a larger number of farmers have an upper side road network in their plantations in all of the land categories of both districts (minimum 52% to maximum 65% MLH in Badulla and LLH in Matara).

Table 6.7: Location of the plantation towards an accessible road (% farmers)

Plantation situation	Matara District				Badulla District			
	VSLH	SLH	MLH	LLH	VSLH	SLH	MLH	LLH
The accessible road is towards the upper side of the plantation	62	58	55	65	56	58	52	59
The accessible road is towards the lower side of the plantation	35	38	42	30	32	29	37	26
The accessible road is in the middle of the plantation	03	4	03	05	22	13	11	15

Table 6.8: Problems mentioned by fuelwood collectors and end users (Using Likert scale 1-5. Responses are represented as % by pooling numbers 4 and 5)

Response	**Collectors**		**End users**	
	Matara	**Badulla**	**Matara**	**Badulla**
Price increment	100%	100%	100%	100%
Scarcity of collection sites	66%	75%	88%	88%
Fragmentation of collection site	74%	80%	93%	89%
Inaccessibility	78%	80%	88%	75%
Lack of local organizations support	75%	75%	75%	75%
Lack of government support	80%	92%	100%	100%
Lack of support from tea factories	65%	50%	-	-
Legal barriers	90%	92%	90%	88%
Problems with the existing policy	80%	90%	75%	90%

*Note: Likert scale ranging from 1 = strongly disagree to 5 = strongly agree

6.2.3.2 Problems faced by the fuelwood collectors (farmers, transporters and middlemen) and end users in the two districts

The scarcity of fuelwood collecting sites was higher for the Badulla collectors, where the area is intensively covered with large-scale tea plantations (TRI 2012) followed by the road inaccessibility compared with the Matara District. Some of the farmer organizations (autonomous and formed by the TSHDA) receive support to sell the fuelwood of the MSTH, but the majority of the collectors (farmer- and government-supported organizations) expected to receive support is not satisfactory (Table 6.8). Moreover, end users and fuelwood collectors face legal problems because of regulations implemented by the government for the transportation of the fuelwood (Table 6.9) categorized as "mixed fuelwood"; this type of fuelwood contains different types of species, such as branches and remaining main stem parts after extracting timber from the trees, which are categorized as "trees required felling and transporting permits" (Gazette Sri Lanka 2009). Overall, more than 75% of both the collectors and the end users believe that the existing policies for fuelwood collecting and transportation are not satisfactory, and they face a variety of legal problems while collecting, transporting and storing the fuelwood.

Table 6.9: Timber and fuelwood tree species inside MSTH tea farming land and its multiple usages

Tree Species (Badulla)	High Shade	Medium Shade	Timber	Fuelwood	Fodder	Food for people	Medicine	Insecticide	Apiculture
Gliricidia s. *		X		x	x			x	x
Grevillea r. *	x		x	x					
Eucalyptus spp	x		x	x				x	x
Toona spp.	x		x	x			x	x	x
Erythrina l. *		X			x	x	x		
Michelia c.	x		x	x				x	x
Swietenia m.	x		x	x					
*Calliandra c.**		x		x	x				X

* **Recommended by TRI Sri Lanka**

6.3 Possibilities for MSTH to supply fuelwood from their plantations

All of the MSTH maintain a number of multipurpose trees inside their plantations and also have uncultivated areas inside their tea plantations; most of these uncultivated areas were difficult to cultivate with tea. Most of the available trees inside these plantations (trees recommended by TRI as well as those not-recommended) are already utilized as fuelwood by the local people and the tea factories, as well as by the small- to medium-scale cottage industries in the area (Table 6.9). Therefore, we observed that fuelwood has the potential to be a source of income for the MSTH, but the harvesting of fuelwood was not functioning in a practical manner in the field level (Table 6.10 and 6.11).

Table 6.10 Timber and fuelwood tree species inside MSTH and their growth performance and the states of timber /fuelwood transportation

Tree species	Fast growing (< 10 years)	Moderate growing (15~ 20 years)	Slow growing (> 20 years)	Require transportation permits
Gliricidia s. *	yes			No
Grevillea r. *		yes		No
Eucalyptus spp.			yes	Yes
Toona spp.		yes	yes	Yes
Erythrina l. *	yes			No
Michelia c.			yes	No
Swietenia m.		yes	yes	Yes
*Calliandra c.**	yes			No
Artocarpus heterophyllus			yes	Yes

* Trees recommended by the TRI Sri Lanka

Table 6.11 Multipurpose usage of timber and fuelwood tree species inside MSTH

Tree Species (Badulla)	High Shade	Medium Shade	Timber	Fuelwood	Fodder	Food for people	Medicine	Insecticide	Apiculture
*Gliricidia s.**		x		x	x			x	x
*Grevillea r. **	x		x	x					
Eucalyptus spp	x		x	x				x	x
Toona spp.	x		x	x			x	x	x
*Erythrina l.**		x			x	x	x		
Michelia c.	x		x	x				x	x
Swietenia m.	x		x	x					
*Calliandra c**		x		x	x				x
Tree Species (Matara)									
*Gliricidia s.**		x		x	x			x	x
*Albizia m. **	x		x	x	x				x
Chloroxylon .	x		x	x					x
Artocarpus h.	x		x	x	x	x	x		x
Milia azedarach	x		x	x			x	x	x
Swietenia m.	x		x	x					

6.4 Conclusions and policy implications

The MSTH in the both districts have a comparatively higher percentage of uncultivated areas inside their plantation, which is a little higher than the upper slope limits as recommended by the TRI Sri Lanka. In addition to the higher slope and the presence of rocks above and below the shallow layers of the top soil, the heavy soil erosion that coincides with infertile soil for tea and the shortage of labor are the key reasons for the presence of uncultivated areas inside the plantation. At the same time, the MSTH face other problems, such as uncultivated areas, sloped areas inside their plantation and land erosion problems coinciding with landslides during the rainy season. Most of the MSTH farmers maintain trees inside their plantations, including recommended and non-recommended trees by TRI, which can be used as fuelwood with higher demand by the end users.

Tea factories, as well as the small- to medium-scale cottage industries that involve processing, require a source of heat, and fuelwood plays a key role for supplying the required energy. Home gardens and agricultural lands other than tea plantations are identified as the key fuelwood supplier for both the end users and the MSTH contribution to date has been minimal.

Furthermore, the fuelwood end users face a number of problems; the key problems that were identified include, the constant price increase, the scarcity of the fuelwood sites and the fragmentation of collecting sites, as well as the increase of the transportation costs due to longer distances. Apart from *Erythrina*, all of the other species were utilized as either timber or fuelwood. The majority of the farmers preferred to maintain medium shade trees as fuelwood producing trees, mainly because of their coppicing ability.

Planting fuelwood trees inside these uncultivated areas would be vital for the marginal farmers for the future sustainability of the marginal tea plantations. The main limitations faced by the marginal tea farmers to convert their tea plantations into fuelwood plantations are the lack of government involvement and support for promoting fuelwood planting among MSTH.

Chapter 7 Discussion, Conclusions and Policy Recommendations

Summary

This chapter explores our overall findings and presents this study's implications by investigating Sustainable Livelihood Approach (SLA) using five livelihood capitals of the MSTH and the potential for the partial conversion of the current land use to fuelwood planting in the Matara and Badulla districts of Sri Lanka. Marginal tea farmers can minimize the problems of natural capital, such as soil erosion and landslides, with this approach, particularly addressing uncultivated areas in the plantations by effectively utilizing other capital to increase their standard of living. Compared to the present and past conditions of their tea farms, the stakeholders clearly perceive that farmers will face higher natural and economic constraints in the future. However, observation of the fuelwood supply and demand pattern, coupled with the possibility of a future demand increase, indicated that MSTH were the ideal candidates to supply fuelwood to meet the future demand while sustainably managing their plantations and safeguarding the surrounding environment. Finally, our conclusions will address the current supply and demand for fuelwood, which this study recommends as an alternative to planting tea on marginal tea farms with the goal of improving the livelihood of marginal tea farmers in Sri Lanka.

7.1 The role of the tea industry in Sri Lanka and its economy

After the introduction of tea as a plantation crop to Sri Lanka during the British colonial period, it became a key income generator for the country. The tea industry itself has been the primary generator of income with respect to the Gross Domestic Product (GDP) for decades but has been replaced by the garment industry, as well as with earnings from foreign employment (Ministry of Plantations 2013, Central Bank of Sri Lanka 2013). Although the tea industry has been replaced,

it still creates a large number of direct and indirect job opportunities (Department of Census and Statistics Sri Lanka 2012). The tea industry requires a comparatively large labor force to perform routine tasks, such as weekly harvests, (or, in certain instances, a five day harvest cycle) or the management of tea bashers, which requires periodic pruning over a three- to five-year period (Handbook on Tea 2006).

Two principal types of tea plantation management have been identified in Sri Lanka; large plantations managed either by the government or private companies and small-scale plantations managed by individual householders (TSHDA 2010). Compared to large scale plantations, the contribution of small tea plantations is considerably higher, and they account for approximately 59% of the total tea production in the country.

7.1.1 Small Tea Farm Holders

With the introduction of a new land reform act during the 1970s, the maximum size of privately owned tea plantations was restricted to 20 ha. As a result, small plantations increased in number. In addition, the introduction of new economic reforms by the newly appointed government further boosted the rate of expansion in terms of both the land area devoted to tea and the number of farmers. During the 1970s the government reallocated tea land above the maximum approved limit and handed it over to landless people for tea planting (TSHDA 2013, Perera et al. 2014). Previously uncultivated government land, as well as private land, was also allocated to the landless to establish new tea plantations with the support of TSHDA and other governmental institutions to allow a smooth transition to profit-making from tea planting (TSHDA Act No.35 of 1975). With land allocation facilities provided by the government plus technical and extension services from TSHDA, TRI tea farming became more popular, providing secure high income generation compared to most other traditional farming in Sri Lanka. For these reasons, the number of small tea farmers grew, especially in the low elevation tea growing regions of the country (Mendis 1992 and Perera et al. 2014).

Recent statistics indicate more than 390,346 small tea farm holders reside in the country, according to latest detailed TSHDA census of all registered small farmers (TSHDA 2012). The number of registered and non-registered small tea farmers greatly increased during the period of 2010 to 2012 (TSHDA 2012).

7.1.2 Marginal Small tea farm Holders

Tea plantations can be categorized as high performing, marginal or poor performing in terms of returns. For tea plantations, the term high performing can be defined as a high yield generated in a unit area of land, or the profit margin of the farmer. Many factors affect yield, most importantly the biophysical conditions, the location, and plantation management practices (TRI 2010). Small holder tea plantations may be deficient in these areas, which is not good for the farmer nor for the country. Most marginalized tea plantations are located in sloped mountainous areas adjacent to areas that are not suitable for cultivating tea (for example, on the boundary of wet to intermediate zones, or intermediate to dry zones).

7.1.3 The importance and proper utilization of marginal small tea plantations

Maintaining marginal tea plantations no longer provides attractive benefits for farmers or the nation either environmentally or economically. Therefore, a portion of marginal tea plantations have been poorly maintained and managed by the land owner solely to obtain a government subsidy, such as a fertilizer subsidy (field survey 2013; researcher), or for the prestige of owning one's own land.

7.2 Problems faced by MSTH

The slope of a tea plantation highly affects its productivity and long-term sustainability. A survey of the topography of Sri Lanka's tea growing areas indicated that most plantations contained sloped terrain (TRI 2006 and Department Agriculture 2012). An upper limit of the slope based on

elevation has been recommended by the Tea Research Institute, and the results indicated that the MSTH were in the upper recommended limit in both districts. The slope of a plantation is one of the main reasons for uncultivated areas inside a plantation, as well as the natural, physical, and management conditions of the plantation.

7.3 Problems faced by Fuelwood suppliers and end users

Fuelwood has been identified as one of the most important energy sources in the country (Forestry Sector Master Plan FSMP 1995and Sri Lanka Sustainable Energy Authority SLSEA 2011). Since felling trees and fuelwood collection from natural forests has been banded in Sri Lanka, three main types of fuelwood supplies have been identified; home gardens, government-controlled suppliers (the State Timber Cooperation and the Forest Department own man-made plantations) and the third is agricultural plantations (primarily rubber, tea, other plantation types and private forest plantations). Our observations and the results of discussions with stakeholders highlighted the difficulties and suggested a way to overcome these problems by converting marginal tea lands to fuelwood plantations.

7.4 Conclusions

7.4.1 Summary of the livelihood capital of marginal tea lands owned by small holders

In order to describe the present condition, as well as the future prospects, for marginal tea plantations owned by small holders, five principal types of livelihood capital were investigated, as delineated by a sustainable livelihood approach (SLA). The average size of the land holdings ranged from 0.7 ha for VSLH in Matara to 16 ha for LLH in Badulla, and the percentage of uncultivated land from 7% for MLH in Badulla to 30% in LLH. The reasons that the farmers had un-cultivated areas inside their plantations were:

1) Unproductive areas or areas in which tea cultivation was difficult due to soil erosion, steepness or an uneven soil surface, areas highly vulnerable to soil erosion or with a significant percentage of top soil already washed away and, particularly, areas containing hard rocks and boulders on the

soil surface or in the active root zone of the tea plants. These hard materials make active functioning of the root system difficult, and the tea plants may ultimately die even in a moderate drought that only lasts for several weeks.

2) Labor shortages, especially for medium to large land holders, who were not interested in planting tea in these uncultivated areas because of this. Another interesting finding was that workers disliked harvesting green leaves from poorly managed areas or demanded higher wages for such work because harvesting was difficult due to poor management practices in these areas. For example, selective harvesting was difficult, as well as the achievement of expected harvest targets, mainly because daily wages were calculated for tea harvesters based on norms - some plantations set a harvest target of 20 kg /green tea leaves per person per day, and certain tea land owners paid individual harvesters on the basis on number of kilograms that they harvested.

Most farmers primarily depend solely on tea income, but a portion have additional income-generating sources, such as seasonal fruits, spices, multipurpose trees on their plantations, monthly or daily wages from other work, a pension, or small-scale businesses and property rental income. Income generation from the tea crop was determined to have reciprocal relationship with the land area. Matara is a district that has relatively small tea farmlands, but it generates a large proportion of its income from tea production. Within that district, VSLH and SLH were found to generate large proportion of their income from the tea crop compared to MLH and LLH.

This study also identified approximately twelve species already growing in this marginal area. A portion of the species are recommended by Tea Research Institute (TRI) of Sri Lanka, and a portion are not. Selection of these tree species was based on the individual farmer's preference, or they were species already adapted to local conditions and easy to maintain. Conversely, the basis of the TRI recommendation of certain trees is based on their potential to increase the tea yield, but the farmer's basis is primarily that these trees provide multiple benefits, for example, a possible use as timber, fuelwood, or shade trees for tea.

Farmers in both study sites have good human capital considering their level of education, and the amount of formal training for tea farming and management. In some instances, formal education of young household members was found to contribute negatively to that member's contribution to tea production. Fear of recognition by peers at school as a tea farmer caused some

educated members to be reluctant to help the family with tea farm activities. Elevation and weather were found importantly to affect the standard of living obtained from tea production.

7.4.2 A stakeholder's perspective of marginal tea plantations

The perspective of the farmers in the two districts (Matara and Badulla) in this study are similar. As physical constraints, farmers agreed that soil erosion and heavy wind are critical but they disagreed on significance of the rockiness of an area with respect to farming. The farmers agreed that landslides were an important factor only for farmers in Badulla. In both districts, the farmers mentioned that the government can play a vital role in alleviating their problems, more so than NGOs and the private sector. All the interviewees from both districts except Badulla farmers, who disagreed about the high cost of labor for tea farming, agreed regarding the problems associated with continuing tea farming, such as labor shortages, high management costs and high labor costs. Additionally, the farmers agreed on the prevailing biophysical conditions in the areas, lower labor costs, and a high market demand as conducive for fuelwood. The farmers also ascertained a need for the provision of environmental services to tea plantations. The only worry that the farmers expressed concerned the profitability of this venture. Finally, interviewees from both districts mentioned their dissatisfaction with the existing property rights system, which is vital for the implementation of a long term investment such as a fuelwood planation. Hence, the farmers thought that future government policies should target the improvement of the property rights system.

7.4.3 Summary of fuelwood supply and demand

Fuelwood is the principal energy source for various end users in the study area. Compared to small to medium scale cottage industries, tea factories consume considerable fuelwood. Rubber demands the most fuelwood in both districts. The price of fuelwood was found to be continuously increasing for all species utilized. Four types of fuelwood suppliers were identified: 1). land owners, 2) the end users themselves, 3) professional fuelwood suppliers or middle-men, and 4) the State Timber Cooperative (STC). Professional fuelwood suppliers or middle-men predominate as fuelwood

suppliers. Three main collection sites were also identified: 1) home gardens situated more than 20 km distance from the study sites were key suppliers, 2) tea plantations, and 3) STC (harvested on forest department plantations and from government or private land by request).

Fuelwood supplies from all land categories of MSTH were found to be very low in both study districts, even though farmers maintained some multipurpose trees on their plantations. Various factors directly and indirectly affected the farmers' willingness to supply fuelwood, such as the difficulty of supplying larger amounts of fuelwood required by individual farmers, a lack of sufficient support from other farmers, a lack of networking among individual farmers or fewer active farmer groups, a lack of government support in terms of subsidies to promote fuelwood planting inside the MSTH or to support its purchase, and active government support via grassroots level officers at the time the fuelwood is transported to the market.

7. 5 Policy implications

From a policy perspective of tea plantation maintenance, (i.e., planting, harvesting, or the transport of multipurpose trees as timber or fuelwood) the farmers were unsatisfied with existing services and support, especially from the government, tea factories and green leaf collectors. Furthermore, the effective utilization of uncultivated areas of the plantations would reduce soil erosion and the landslide problems faced by MSTH in both study areas. Therefore, a new policy for the proper utilization of uncultivated marginal tea land is timely and important, especially if it encompasses the previously mentioned problems facing these farmers.

An alternative for farmers is the conversion of a tea plantation to a fuelwood plantation to minimize the cost of production that discourages farmers from continuing tea farming. In addition, fuelwood is in high demand in the current market because of existing shortages in the tea production industry. Once the farmers convert their uncultivated areas to fuelwood plantings and overcome problems faced by the MSTH, Sri Lanka's tea industry will move toward environmental friendly ventures, leading to a price increase for tea products in the world market.

The policy implications of our study indicate that the government should promote or provide incentives for farmers based on their potential or the amount of uncultivated land in their plantations to convert such degraded and abandoned land into a fuelwood plantation to improve their livelihood while also safeguarding the environment. For example, compared to VSLH, LLH have a higher potential (a larger extent of uncultivated areas in their plantations, and good social, physical and financial capital for land use conversion) to sell their product. Finally, we must change the stakeholder's perception regarding the generation of a higher income for them to improve their livelihood.

Our observations generally highlighted following key issues faced by the MSTH farmers that must be addressed by new policies:

7.5.1 From land selection to tea farm management

Different subsidy programs introduced by the government as well as by commercial banks to increase the productivity of these plantations have been identified. Subsidies, as well as most land improvement activities, were highly focused on re-planting, new planting, and land improvement programs highly geared to the promotion of tea but not to the promotion of fuelwood/tree planting. For examples of subsidy programs for tea planting (new planting, re-planting, and filling vacancies), see TSHDA 2013. In addition, the TSHDA has introduced a number of social empowerment programs for tea farmers, such as

1. Encouraging farmers to replant and rehabilitate tea plantations (an incentive program).

2. Coordination of training programs on tea planting and extension.

3. Implementation of welfare programs and the provision of credit.

4. Facilitating the maximum price for the green leaf produced (acting as a mediator) between the farmers, the green leaf transporter, the tea factory, and sometimes with the finished tea broker.

5. Active involvement in preparing/buying/selling planting materials to tea farmers and the supply of other agricultural materials such as agrochemicals and fertilizers to farmers at a concessionary price.

In addition, TSHDA has arranged credit for farmers for tea planting from one of the leading government banks with a payback period of 13 years, including a three-year grace period.

Even though these incentives, as well as subsidy schemes, help the tea industry, we argue that the ultimate return for farmers as well as for the country will not achieve its expected targets unless the tea land is properly identified and these land development activities are applied. For example, we observed that some farmers planted tea on unsuitable land (such as land with rocks and boulders, very sloped areas vulnerable to soil erosion), thereafter, more than 80% of the tea died due to prolonged drought. On the other hand, some of the farmers tried to maximize the utilization of their land with tea, especially the LLH farmers, and decided to cultivate tea in very steep areas, utilizing subsidized planting materials. Such improper land selection and utilization has both direct and indirect effects on landslides and soil erosion. There are no such incentive schemes for planting timber or fuelwood trees in these plantations. Therefore, a firm new policy is currently important to popularize fuelwood/tree planting in areas unsuitable for tea planting.

7.5.2. Recommended tree species

Our observations have identified recommended and non-recommended trees popular among growers. The benefits of these trees was varied; for tea plantations, they are shade trees but for the farmers, they are a source of extra income. Farmers have the freedom to cut or remove TRI recommended shade trees without a transportation permit (Hand book on tea 2006 and district secretory reports of Matara & Badulla). From the farmers' point of view, planting of multipurpose trees inside the plantation is highly dependent on government recommendations, as well as its overall benefits. Our observations indicated that the number of trees on marginal tea plantations can be easily increased with government involvement. Conversely, research to investigate the suitability of non-recommended tree species, including the Sri Lankan native agarwood, and

enable them to grow on the plantations is necessary. For example, MLH and LLH have a high potential to plant and maintain native agarwood trees to produce a quality final product. A new policy dictate is important for harvesting these trees and transporting them to the market.

7.5.3 Land property rights & utilization of trees grown by farmers.

Tea farmers have various property rights, conferred by deeds and different land ownership permits issued by government authorities. Except for deeds, each type of permit confers different legal authority to fell and transport timber and fuelwood. It is important to propose the implementation of a policy decision giving authority to the farmers to utilize the trees that they grow with the recommendation of TSHDA.

7.5.4 Incentives for fuelwood suppliers

Fuelwood has been identified as an important energy source in Sri Lanka (SLSEA 2011), but there is still no systematic support for suppliers and growers. For example, in the tea industry, the government supports the tea growers through taxes collected through the export of tea (i.e., a "cess tax" collected on the basis of export of one kilogram of tea) (Sri Lanka tea board 2014). Stakeholders have suggested that a portion of the "cess tax" be allocated to increase fuelwood planting in tea plantations to promote the self-sufficiency of the fuelwood required by the tea industry for itself. This type of incentive will certainly especially benefit fuelwood suppliers and will automatically go to farmers, such as VSLH, SLH and MLH, to encourage them to plant fuelwood trees in their marginal tea plantations.

7.6 Methodological implications

In this study, socio-economic data were combined with agronomic practices and biophysical attributes of the land to yield a comprehensive understanding of the MSTH farming system. These data are particularly important in the study of sustainability because such studies cross discipline boundaries.

Promoting MSTH in the country and their long-term sustainability, utilization of available resources is currently important. Meaningful investment in uncultivated areas as a win–win situation for both the land user and the environment is the primary focus of our research.

Reference

Abeywicrama B.A., (1959). A provisional checklist of the flowering plants of Ceylon. Ceylon J.Sci. Biol.Sci pp 119-240.

Alexander.E.Farrell, Richard J.Plevin, Brian T.Turner, Andrew D.Jones, Michael O,Hare, Daniel M.Kammen., (2006) Ethanol Can Contribute to Energy and Environmental Goals Vol 311 , number 5760 pp 506-508.

Alonso,W., (2005) The Theory of the urban land market Papers in Regional Science Vol 6 (1) pp 149-157.

Amerasinghe,Y.R., (1993) Recent Trends in Employment and Productivity in the Plantation Sector of Sri Lanka with Special Reference to the Tea Sector, ILO, Geneva, Switzerland : 3–25

Amerasinghe,Y.R., (1993) Recent Trends in Employment and Productivity in the Plantation Sector of Sri Lanka: with special reference to the Tea Sector. ILO, Geneva, Switzerland: 3–25.

Andorson, J.R., Hardy, E.E., Roach, J.T., Witmer, R.E., (1976) A land use and land cover classification system for use with remote sensor data Geological Survey professional paper 964 pp 1-28.

Arnold, M., Persson, R., (2003) Reassessing the fuelwood situation in developing countries, International forestry review Vol 5 (4) pp 379-383.

Badulla District Secretary (2014) *www.badulla.dist.gov.lk/index.php?option=com_content.*.

Bahrami, A., Emadodin,I., Ranjbar,M., Bork,H.R., (2010) Land-use change and soil degradation: A case study, North of Iran Agriculture and Biology Journal of North America Vol 1 (4) PP 600-605.

Bai, Z.G., Dent, D.L., Olsson,L., Schaepman, M.E., (2008) Review article Proxy global assessment of land degradation, Soil use and management Vol 24 pp 223-234.

Bakker,M.M., Govers,G., Doorn,A., Quetier,F.,Chouvardas,D., Rounsevell,M.,(2008) The response of soil erosion and sediment export to land-use change in four areas of Europe: The importance of landscape pattern Geomorphology Vol 98 (3-4) pp 213-226.

Balassuriya, T., Silva, B., and Maude, M., (1991) Land and Land Use in Sri Lanka: Introduction. In: LOGOS, Volume 29 Nos. 3 & 4, Centre for Society and Religion, Colombo.

Barret, H.R., Browne, A.W., Harris, P.J.C. and Cadoret, K., (2002) Organic certification and the UK market: organic imports from developing countries. Food Policy 27 (4): 301-318.

Barret,C.B., Bachke, M.E., Bellemare,M.F., Michelson,H.C., Narayanan, S., (2012) Smallholder participation in Contract Farming : Comparative evidence from five countries Volume 40 (4) pp 715-730.

Barrett, H.R., Browne, A.W., Harris, P.J.C. and Cadoret, K., (2001) Smallholder farmers and organic certification: Accessing the EU Market from the developing world. Biological Agriculture & Horticulture: An International Journal for Sustainable Production Systems 19 (2): 183 – 199.

Basnayake, B.M.J.K., Gunarathne, L.H.P. (2002) Estimation of technical efficiency and its determinates in the tea small holding sector in the mid country wet zone Sri Lanka, Sri Lanka Journal of Agricultural Economics, Vol 4 pp 137-150.

Baumann, P. (2002) Improving access to natural resources for the rural poor: A critical analysis of central concepts and emerging trends from a sustainable livelihoods perspective. FAO LSP Working Paper No. 1. Rome.

Bebbington, A., (1999) Capitals and capabilities: a framework for analyzing peasant viability, rural livelihoods and poverty. World Development, 27(12), 2012–44.

Bhattacharya, S. C., Abdul Salam, P., Runqing, H., Somashekar, H. I., Racelis, D. A., Rathnasiri, P. G., Yingyuad, R. (2005) An assessment of the potential for non-plantation biomass resources in selected Asian countries for 2010 Biomass and Bioenergy, 29(3), pp 153–166. doi:10.1016/j.biombioe.2005.03.004

Bouma, J., (1997) The land use systems approach to planning sustainable land management at several scales. ITC Journal Enschede, the Netherlands, pp 237-242

Brocklesby, M.A. and Fisher, E., (2003) Community development in sustainable livelihood approaches-an introduction. Community Development Journal 38 (3): 185 – 198.

Bryant, E., (2005) Natural Hazards Second Edition: New York, Cambridge University Press ISBN 9780521537438.

Campbell, J.E., Lobell, D.B., Genova, R.C. (2008) the global potential of bioenergy on abandoned agriculture lands Environmental Science and Technology Vol 42 (15) pp 5791-5794.

Campbell, J.E., Lobell,D.B., Genova,R.C.,Field,C.B., (2008) The Global Potential of Bioenergy on Abandoned Agriculture Lands Environ.Sci. Technol. Vol 42 (15) pp 5791-5794.

Central Bank of Sri Lanka (2014) Socio Economic Data
www.cbsl.gov.lk/pics_n_docs/10.../Socio_Econ_Data_2014_e.pd

Chunsheng, Y., Chongying, C., Ming L., (2012) Analysis of rural residential energy consumption and corresponding carbon emissions in China, Science direct Vol 41 pp 445-450.

Clay. J., (2004) World Agriculture and the Environment: A Commodity-by-Commodity Guide to Impacts and Practiced, Washington DC, Island Press

Cooper, T. & Baldock, D., (2009). The provision of public goods through agriculture in the European Union, report prepared for DG Agricultural and Rural Development, Contract No 30 –CE-0233091/00-28. London.

Crown land Ordinance (2014) Volume II –Lows of Sri Lanka www.srilankalaw.lk/Volume-II/crown-lands-ordinance.htm

Dai, F.C., Lee, C.F.,(2002) Landslide characteristics and slope instability modeling using GIS, Lantau Island, Hong Kong: Geomorphology.42 (3-4), p.213-228.

Dale,V.H., (1997) The relationship between land- use Change and climate change. Ecological application Vol 7 (3) pp 753-769. http://dx.doi.org/10.1890/1051-0761(1997)007[0753:TRBLUC]2.0.CO;2

Daniels,W.L., Amos,D.F., (1985) Generating productive topsoil substitutes from hard rock overburden in the southern appalachians, Environmental Geochemistry and Health Vol 7 (1) pp 8-15.

Danso-Wiredu, E.Y., (2011) Mobility and Access for off-Road Rural Farmers in West-Akim District Ghana Journal of Geography Vol 3 pp 230-249.

Dauber,J., Jones, M.B., Stout, J.C., (2010) The impact of biomass crop cultivation on temperate biodiversity GCB Bioenergy Vol 2 (6) pp 289-309.

David Hulme., (2007) Integrating quantitative and qualitative research for country case studies of development, Global Poverty Research Group University of Manchester, UK. Website: http://www.gprg.org/ (*economics.ouls.ox.ac.uk/14022/1/gprg-wps-063.pdf)*

De Jong,R et,al., (1999) Performance of dairy farming on abandoned marginal tea lands in the mid country of Sri Lanka. Tropical Agricultural Research and Extension 2 (1) pp55-66

De P.K., and Ratha, D., (2012) Impact of remittances on household income, asset and human capital: Evidence from Sri Lanka. Migration and Development 1 pp 163–179.

De S.Wijesinghe, L.C.A., (1984) A sample study of biomass fuel consumption in Sri Lanka households. Biomass, 5(4) pp 261–282.

De Silva W.C.A., (1994) Status Review of energy utilization by the tea industry in Sri Lanka Sri Lanka Journal of tea science Vol 63 (2), pp 46-58.

De Silva, K M., (1981). A history of Sri Lanka University of California Press.

De, P. K., and Ratha, D., (2012) Impact of remittances on household income, asset and human capital: Evidence from Sri Lanka. Migration and Development, 1, pp 163–179.

Deepananda,H et ,al., (2009) From plantation to smallholder production:The Role of Policy in the Reorganization of the Sri Lankan Tea sector: Agrifood Industry Transformation and Small Farmers in Developing Countries,Vol.37 (11) pp1759-1772.

Delden, H., Stuczynski, T., Ciaian, P., Paracchini, M.L., Hurkens, J., Lopatka, A., Shi, Y., Prieto, O.G., Calvo, S., Vilet,J., (2010) Integrated assessment of agricultural policies with dynamic land use change modelling Ecological Modelling Volume 221 (18) pp 2153-2166.

Department of Agriculture (2012).

Department of Census and Statistics- Sri Lanka (2014).
http://www.statistics.gov.lk/agriculture/COP/COP_Tea.html

Department of labour (2014) wage and statistics *www.labourdept.gov.lk/*

DFID. (1999) Sustainable livelihoods guidance sheets. Department for International Development, London

Dharmasena,P., Bhat,M.S., (2011) Assessment of Replacement Cost of Soil Erosion in Uva High Land tea plantations of Sri Lanka Current World Environment Vol 6 pp 241-246.

Dissanayaka, A.B., (1984) Employment and development problems in the tea and rubber small holdings sector, Plantation agriculture in Sri Lanka, Bangkok: International Labor Organization, ARTEP, pp. 155-181.

Dissanayake, D.R.R.W, Udugama J.M.M. and Jayasinghe-Mudalige, U.K, (2013) Development of an Alternative Microfinance Scheme to finance in the Tea Small Holding sector: A success story. Journal of Food and Agriculture 3(1-2) pp31-40.

District Secretary Report Matara (2013) *www.parliament.lk/.../performance_report_district_secretariat_matara_2*

Doran, John W., (2002) "Soil health and global sustainability: translating science into practice" Publications from USDA-ARS / UNL Faculty. Paper 181. http://digitalcommons.unl.edu/usdaarsfacpub/181

Eastwood R, Lipton M, Newell A., (2010) Hand book on Agricultural Economics vol. 4, Chapter 65, farm size, 3323-3397.

Egeru, A., Kateregga,E., Majaliwa,G.J.M., (2014) Coping with firewood Scarcity in Soroti District of Eastern Uganda, Open journal of Forestry, Vol 4 (1) PP 70-74.

Ellis, E., Goldewijk,K.K., Siebert,S., Lightman,D.,Ramankutty,N., (2010) Anthropogenic transformation of the biomes, 1700 to 2000 Global ecology and biogeography Vol 19 (5) pp 589-606.

FAO (1988) land cover classification system, www.fao.org/docrep/003/x0596e/x0596e02.htm.

FAO (1993) Guidelines for land-use planning FAO Development Series 1 ISSN 1020-0819.

FAO (2012) Report of the Intercessional Session of the IGG on Tea . FAO: Colombo.

FAO (2011) FAO: Scarcity and abundance of land resources: competing uses and shrinking land resource base, SOLAW TR02 pp 8.

Farrell, A.E., Plevin,R.J., Turner, B.T., Jones, A.D., Hare,M.O., Kammen, D.M., (2006) Ethanol Can Contribute to Energy and Environmental Goals. 311: 5760 pp 506-508.

Forestry Sector Master Plan [FSMP] (1995) Sri Lanka Forestry Sector Master Plan. Forestry Planning Unit, Ministry of Agriculture, Lands and Forestry.

Fosu -Mensah, B.Y., Vlek, P.LG, and MacCarthy, S., (2012) Farmers' perception and adaptation to climate change: a case study of Sekyedumase district in Ghana. Environ Development and Sustainability 14 pp495–505.

Gaffar N.M.A, Samaraweera D.S.A., Renewable sources of energy for tea industry., (1981) Tea bulletin, Tea Research Institute of Sri Lanka pp 32-37. http://tri.nsf.ac.lk/handle/1/1463

Ganashan, P., Balendira, S., Dassanayake, M.D., (1996) Sri Lanka: Country report to the FAO, *www.fao.org/pgrfa-gpa-archive/lka/srilanka.pdf*

Ganewatta, G., Edwards, G.W., (2000). The Sri Lanka Tea Industry: Economic Issues and Government Policies. 44th Annual Conference of Australian Agricultural and Resources Economics Society, University of Sydney, Australia pp 23-25.

Garnett, T., Appleby, M.C., Balmford, A., Bateman, I.J., (2013) Sustainable intensification in agriculture: Premises and policies, viewed on September 12, 2014 www.sciencemag.org

Gazette of the Democratic Socialist Republic of Sri Lanka of November 20, 2009.

Gelfand, I., Sahajpal, R., Zhang, X., Izaurralde, R.C., Gross, K.L., Robertson, G.P., (2013) Sustainable bioenergy production from marginal lands in the US Midwest Nature 493 pp 514-517.

Geographical Research Vol 46(1) pp 4-16.

German,L., Keeler,A., (2009) "Hybrid institutions": Applications of common property theory beyond discrete tenure regimes International Journal of Commons Vol 4(1).

Goldewijk,K.K., (2001) Estimating global land use change over the past300 years: the HYDE database Global biogeochemical cycles Vol 15 (2) pp 417-433.

Gomez, A A., Kelly, D E., Syers, J K., and Coughlan, K J., (1996) Measuring sustainability of agricultural systems at the farm level: Methods for assessing soil quality. SSSA Special Publication Vol 49 pp 401–409.

Groom, M.J., Gray, E.M., Townsend, P.A., (2008) Biofuels and biodiversity: Principles for creating better policies for biofuel production Conservation biology Vol 22 (3) pp 602-609.

Hand Book on Tea, 2006 TRI ,Sri Lanka

Hany, E.I.K., Zhang,H., Zhang,P,. Mosandi, R., (2013) Soil erosion and surface runoff on different vegetation covers and slope gradients: A field experiment in Southern Shaanxi Province, China Science direct Vol 105 pp 1-10.

Hartemink, A.E., (2005) Plantation agriculture in the tropics: Environmental issues, Outlook on Agriculture, Vol 34 (1) pp 11-21.

Haskoning., (1989) Royal Dutch Consulting Engineers and Architects. Energy Conservation in the tea industry of Sri Lanka pp 204-206.

Havlik,P., Schneiden, U.A.,Schmid,E., Bottcher,H., Fritz,s., Skalsky,R., Aoki,K., De Cara,S., kindermann,G., Kraxner,F., Leduc,S., Mccallum,I., Mosnier,A., Sauer,T., Obersteiner,M., (2011)Global land-use implications of first and second generation biofuel targets Energy policy Vol 39 (10) pp 5690-5702.

Herath, D., Weersink, A., (2009) from plantations to smallholder production: the role of policy in the reorganization of the Sri Lankan tea sector. World Development 37(11) pp1759–1772.

Hewawasam,T., Effect of land use in the upper Mahaweli catchment area on erosion, landslides and siltation in hydropower reservoirs of Sri Lanka (2010) Journal of the National Science Foundation of Sri Lanka Vol 38 (1) pp 3-14.

Hiemstra-van der Horst, G., Hovorka, A.J., (2009) Fuelwood: The "other" renewable energy for Africa? Biomass and bioenergy Vol 33 (11) pp 1605-1616.

Holloway,G., Nicholson,C., Delgado,C., Staal,S., Ehui,S., (2000) Agro industrialization through institutional innovation Transaction costs, cooperatives and milk-market development in the east-African highlands Agricultural Economics Vol 23 (3) pp 279-288.

Horvath, R.J (1969) VON THÜNEN'S ISOLATED STATE AND THE AREA AROUND ADDIS ABABA, ETHIOPIA, Annals of the Association of American Geographers Vol 59 (2)

Houghton, R.A., Hackler, J.L., (1999) Emissions of carbon from forestry and land-use change in tropical Asia Global change biology Vol 5 (4) pp 481-492.

Humble, R. (1990) Decreasing extent of tea plantations. A Chance for Agricultural diversification or ecological threat, Sri Lanka Journal of tea science (Vol) 59 (2), pp 65-81 URI: http://dl.nsf.ac.lk/handle/1/19503

Hurni, H., (1996) Precious earth: from soil and water conservation to sustainable land management. International Soil Conservation Organization (ISCO) and Center for Development and Environment (CDE), Berne pp 89.

Hurtt, G.C., Chini, L.P., Frolking, S., Betts, R.A., Feddema, J., Fischer, G., Fisk J.P., Hibbard K., Houghton, R.A et al. (2011) Harmonization of land use scenario's for the period 1500-2100 : 600 years of global gridded annual land use transitions, wood harvest, and resulting secondary lands, Climate change Vol 109 (1) pp 117-161.

Illukpitiya,P., Shanmugaratnam,N., Kjosavik,D.J., (2004) Tea Agroecosystems in the Uva Highlands of Sri Lanka Mountain Research and Development 24(1) PP 52-59.

Ilukpitiya, P., Shanmugaratnam,N., (2004) Tea Agroecosystems in the Uva Highlands of Sri Lanka Mountain Research and Development 24(1) pp 52-59.

Jacoby, H. G., (2000) Access to Markets and the Benefits of Rural Roads. The Economic Journal, 110(465), 713–737. doi:10.1111/1468-0297.00562.

Jacoby,H.G., (2000) Access to Markets and Benefits of Rural Roads The Economic Journal Vol 110 (465) pp 713-737.

Jayah ,T.H., Lu Aye, R.J., Stewart, D.F., (1999) Wood Gasifiers for tea drying in Sri Lanka,

Jayah T.H, Lu Aye R.J, Stewart D.F., (1999) Wood Gasifiers for tea drying in Sri Lanka

Jayah, T.H, Lu Aye R.J, Stewart D.F., (1999) Wood Gasifiers for tea drying in Sri Lanka,Department of Civil and Environmental Engineering, the University of Melbourne,

Jayah, T.H., (2001) The potential for wood Gasifiers for tea drying in Sri Lanka, International Energy Journal Vol2 (2) pp 85-93.

Jayah. (n.d.). Retrieved January 23, 2015, fromhttp://www.rericjournal.ait.ac.th/index.php/reric/article/view/256

Jayah.(n.d.)RetrievedJanuary23,2015,from.
http://www.rericjournal.ait.ac.th/index.php/reric/article/view/256

Jayamanne V.S., Wijeratne. M. and Wijayaratna, C.M., (2002) Adoptability of New Technology in the smallholdings Tea Sector. Journal of Agriculture and Rural Development in the Tropics and Subtropics 103(2): 125-131.

Jayasekera,S., Molan,A.L., Garg,M., Moughan., (2011) Variation in antioxidant potential and total polyphenol content of fresh and fully-fermented Sri Lankan tea Food Chemistry Vol 125 (2) pp 536-541.

Jayasuriya,R.T., (2003) Economic assessment of technological change and land degradation in agriculture: application to the Sri Lanka tea sector Agricultural Systems Vol 78 (3) pp 405-423.

Jayaweera,J.M.U.L., De Soysa,M., Kariyawasam,D (2012) UMA-OYA UPPER WATERSHED MANAGEMENT PROJECT (UWMP) IN SRI LANKA: THE IMPACTS AT HOUSEHOLD LEVEL

John, C.V.P., (1997) Sustainability Constraints versus "Optimality" versus Intertemporal Concern, and Axioms versus Data, Land Economics Vol 73 (4) pp 448-466.

Johnson,D.L., Lewis,L.A., (2007) Land degradation: creation and destruction books.google.com

Juliya Brannen., (2005) Mixing Methods: The Entry of Qualitative and Quantitative Approaches into the Research Process International Journal of Social Research Methodology Volume 8, Issue 3, pp 173-184.

Karsently, A., Msangi, S., Souza, C., Shah,M., (2012) Sustainable land use for the 21st century Report - United Nations Department of Economic and Social Affairs Division for Sustainable Development.

Kiome, RM and Stocking, M., (1995) Rationality of farmer perception of soil erosion: The effectiveness of soil conservation in semi-arid Kenya. Global Environmental Change, 5 (4) pp 281-295.

Kleijn, D., Rundlöf, M., Scheper, J., Smith, H.G. & Tscharntke, T., (2011) Does conservation on farmland contribute to halting the biodiversity decline? Trends Ecol. Vol 26 (9) pp 474-481.

Koopmans, A., (2005) Biomass energy demand and supply for South and South-East Asia—assessing the resource base. Biomass and BioenergyVol 28(2) pp 133–150. doi:10.1016/j.biombioe.2004.08.004

Korf, B. and Oughton, E., (2006) Rethinking the European countryside - can we learn from the South? Journal of Rural Studies Vol 22 pp 278–289.

Koulouri, M., Giourga, C., (2007) Land abandonment and slope gradient as key factors of soil erosion in Mediterranean terraced lands CATENA Vol 69 (3) pp 274-281.

Kumaradasa, M.A., Bhattacharya, S.C., Abdul Salam, P., Amur, G.Q., (1999) A study of Biomass as a Source of Energy in Sri Lanka International Energy Journal Vol 21 (1) pp 55-68.

Kuriakose,S.L., (2010) Physically based dynamic modelling of the effects of land use changes on shallow landslide initiation in the Western Ghats, Kerala, India PhD dissertation, Utrecht University.

Laffan, M.D., (2000) A rapid field method for assessing site suitability for plantations in Tasmania's State forest, Forestry Tasmania https://cdn.forestrytasmania.com.au/assets/0000/0183/tasfor_12_08.pd

Lindstrom,S., Mattsson,F., Nissanka,S.P., (2012) Forest cover change in Sri Lanka: The role of small scale farmers Applied Geography Vol 34 pp 680-692.

Lobell,D.B., Burke,M.B., (2010) On the use of statistical models to predict crop yield responses to climate change Agricultural and forest Meteorology Vol 150 (11) pp 1443-1452.

Loumou, A., Giourga,C., (2003) Olive groves: " The life and identity of the Mediterranean" Agriculture and the human values Volume 20 (1) pp 87-95.

Lu,L., Tang,Y., Xie,J., Yuan, Y., (2009) The role of marginal agricultural land –based mulberry planting in biomass energy production, Renewable energy, Vol 34 (7) pp 1789-1794.

Maina,J., Kaluli,W., (2013) Assessment of mechanical harvesting of tea and its viability for use in Kenya Scientific Conference Proceedings elearning.jkuat.ac.ke

Makhura,M.N., Kirsten.,Delgado,C., (2001) Transaction costs and smallholder participation in the maize market in the northern province of South Africa Seventh Eastern and Southern African Maize conference pp 463-467.

Malik,U.S., Ahmed,M., Sombila, M.a., Cueno,S.L., (2009) Biofuels production for smallholder producers in the Greater Mekong Sub-region Applied Energy Vol 86 pp 58-68.

Manikam, P. P., (1995) Tea Plantations in Crisis: An Overview, Colombo, Sri Lanka: Social Scientists Association.

Markelova, H. and Mwangi, E., (2010) Collective action for smallholder market access: evidence and implications for Africa. Review of policy research 27(5): 621-640.

Matara District Secretary report 2014, *www.matara.dist.gov.lk*

Mendis, P., (1992) Human environment and spatial relationship in agricultural production: The case study of Sri Lanka and other tea producing countries. Peter Lang Publishing: New York.

Michael, A.J.E., Kohlin, G., Persson, R., (2006) Wood fuels, livelihoods, and policy interventions: Changing perspectives World Development Vol 34 (3) pp 596-611.

Miller,G., Spoolman., (2011) Change Advantage Books: Sustaining the Earth books.google.com

Ministry of Environment-Haritha Lanka Programe, Sri Lanka (2009) *www.environmentmin.gov.lk/web/pdf/Harita_Lanka_Book_small.pd*

Ministry of plantation industries 2012 Annual Reportwww.parliament.lk/.../performance_report_ministry_of_plantation_indus. Visited on 2015/05/02

Ministry of plantation industries 2013 Annual Report, www.plantationindustries.gov.lk/.../3.%20Annual%20Performance%20-. Visited on 2015/05/03

Ministry of plantation industries. (2012). Tea Small Holdings Development Authority. Annual Report. PP 12-23)

Ministry of plantation industries. (2013). Government of Sri Lanka, Annual Report. (pp 14- 19)

Morgan, R.P.C., (2005) Soil erosion and conservation National soil resources Institute, Cranfield University.

MungaI, D.N., Ong, C.K. Kiteme, B., Elkaduwa, W. and Sakthivadivel, R., (2004) Lessons from two long-term hydrological studies in Kenya and Sri Lanka. Agriculture, Ecosystem and Environment 104 (1)pp 135 – 143.

Nasstrom,R.,Mattsson,E., (2011) Country report Sri Lanka land use change and forestry at the national and sub national level - focali.se.zope.sizeit.se.

National Agricultural Policy (2007)www.agridept.gov.lk/images/stories/site/.../nationalagriculturalpolicy.pd

National Agricultural Policy Sri Lanka (2007).

Newman,S.M., (1985) A survey of intercultural practices and research in Sri Lanka, Journal of Agroforestry Systems Vol 3(1) pp 25-36.

Niroula, G.S., Thapa, G.B., (2005) Impacts and causes of land fragmentation, and lessons learned from land consolidation in south Asia, Land use policy Vol 22 (4) pp 358-372.

Norris, K., (2008) Agriculture and biodiversity conservation: opportunity knocks. *Journal of the society for conservation of biology, (Vol 1) issue 1 pp 2-11.*

Nunes,A.N., De Almeida,A.C., Coelho,C.O.A., (2011) Impacts of land use and cover type on runoff and soil erosion in a marginal area of Portugal. Chapter 4 Soil erosion studies ISBN 978-953-710-9 PP 60-86.

Palaniappan, C., Subramanian, S.V., (1998). Economics of solar air pre-heating in south Indian tea factories: a case study. Solar Energy, 63(1) pp 31–37. doi:10.1016/S0038-092X(98)00028-0

Palihakkara, I.R, Udesh B.G.D, Vithanage P.W.D., (2006) Evaluation of different cover crops on vacant areas (Pottal) in mature tea plantation Proceedings international Forestry and Environmental Symposium.

Pamela, and Susan. (2008) The Qualitative Report Volume 13 Number 4 December 2008 544-559 http://www.nova.edu/ssss/QR/QR13-4/baxter.pdf Qualitative Case Study Methodology: Study Design and Implementation for Novice Researchers Pamela Baxter and Susan Jack.

Parrotta,J.A., Turnbull,J.W.,Jones,N., (1997) Catalyzing native forest regeneration on degraded tropical lands Forest Ecology and Management Vol 99 (1-2) pp 1-7.

Peiris, G.H., (1978) Land Reform and Agrarian Change in Sri Lanka, Journal of Modern Asian Studies Vol 12 (4) pp 611-628.

Perera K.K.C.K., Rathnasiri P.G., Senarath S.A.S., Sugathapala A.G.T., Bhattacharya S.C., Salam P.A., (2005) Assessment of sustainable energy potential of non-plantation biomass resources in Sri Lanka Journal of Biomass and Bioenergy Vol 29 (3) pp199-213.

Perera P., (2014) Tea Smallholders in Sri Lanka: Issues and Challenges in Remote Areas, International Journal of Business and Social Science Vol 5 (12) PP 107-117.

Perera, A.H., Rajapakse, R.M.N., (1991) A baseline study of Kandyan Forest Gardens of Sri Lanka: Structure, composition and utilization, Forest Ecology and Management Vol 45 (4) pp 269-280.

Perera, K. K. C. ., Rathnasiri, P ., & Sugathapala, A. G., (2003) Sustainable biomass production for energy in Sri Lanka. Biomass and Bioenergy, 25(5) PP 541–556. doi:10.1016/S0961-9534(03)00090-4

Perera, K.K.C.K., Rathnasiri, P.G., Senarath, S.A.S., Sugathapala, A.G.T., Bhattacharya S.C., Salam P.A., (2005) Assessment of sustainable energy potential of non-plantation biomass resources in Sri Lanka Journal of Biomass and Bioenergy Vol 29 (3) pp199-213.

Phillips, J.D., (1991) fluvial sediment budgets in the North Carolina Piedmont Vol 4 (3-4) pp 231-241.

Pimentel,D.,Harvey,C.,Resosudarmo,P.,Sinclair,K .,Kurz,D.,Mcnair,M., Crist,s.,Shpritz,L,Fitton,L .,Saffouri,R.,Blair,R., (1995) Environmental and economic costs of soil erosion and conservation benefits Science new series Vol 267 pp 1117-1123.

Plieninger, T., Gaertner, M., (2011) Harnessing degraded lands for biodiversity conservation Journal of Nature Conservation Vol 19 (1) pp 18-23.

Posen, J., Nachtergaele, J., Verstraeten, G., Valentin,C., (2003) Gully erosion and environmental change: importance and research needs CATENA Vol 50 (2-4) pp 91-133.

Qi, Z., Yeh, A.G.O., Li,X., Lin, Z., (2012) A novel algorithm for land use and land cover classification using RADARSAT-2 polarimetric SAR data Remote Sensing of Environment Volume 118 pp 21-39,

Ranasinghe, D.M.H.S.K., (2012) Climate Change Mitigation, Sri Lankas perspective. Proceedings of international Forestry and Environment Symposium, Vol.15, pp. 290-296.

Ranjith,W,.(2006) Annual Symposium on Poverty Research in Sri Lanka Series No. 5.

Ravindranath,N.H., Lakshmi, C.S., Manuvie, R., Balachandra ,P., (2011) Biofuel production and implication for land use, food production and environment in India ,Energy policy Vol 39 (10) pp 5737-5745.

Reardom,T., Timmer,C.P., (2007) Transformation of Markets for Agricultural Output in Developing Countries Since 1950: How Has Thinking Changed? Handbook of Agricultural economics Chapter 55 Vol 3 pp 2807-2855.

Reed,T., Ranawana,,K., Nanayakkara,,A., (2009) Methods tested and their costs to control regrowth of coppiced Eucaliptus camaldulensis in harvested plantations in Naula, Matale District,Sri Lanka, Ceylon Journal of Science Vol 38(2) pp 75-83.

Reubens,B., Poesen,J., Danjon,F.,Geudens,G., Muys,B., (2007) The role of fine and coarse roots in shallow slope stability and soil erosion control with a focus on root system architecture: a review Trees **Review Vol 21 (4) pp 385-402.**

Riccardo, B., Freddy, N., Monica,P., Sally,B.,(2013) LADA Land Degradation Assessment in Dry land FAO report, *www.fao.org/3/a-i3241e.pdf*

Ruwanpathirana, N., (2011) Timber Utilization in Sri Lanka. Proceedings of International Forestry and Environment Symposium. Retrieved from http://journals.sjp.ac.lk/index.php/fesympo/article/view/66

Ruwanpatirana, N.D., (2012) Sustainable utilization of timber resources in Sri Lanka, SOBA, Ministry of Environment, Sri Lanka.

Samaraweera, I., (1982) Land Reform in Sri Lanka. Third Word Legal Studies, Vol.1, Article 7.

Sanchez, P.A., Shepherd., Soule, M.J.,Place,F.M., Buresh, R.J., Izac, A.N., Mokwunye, A.U., Kwesiga, F.R., Ndiritu, C.G., Woomer, P.L., (1997) Soil Fertility Replenishment in Africa: An Investment in Natural Resource Capital Replenishing Soil Fertility in Africa ISBN: 978-0-89118-946-6 PP 1-46.

Sanchez,L.A., Ataroff,M., Lopez,R., (2002) Soil erosion under different vegetation covers in the Venezuelan Andes Environmentalist Vol 22 (2) pp 161-172.

Saracoglu,N., (2010) The biomass potential of Turkey for Energy production: Part 1, Energy sources , part B: Economics, planning, and policy, Vol (5) 3 pp 272-278.

Saroinsong, F., Harashina, K., (2007). Practical application of a land resources information system for agricultural landscape planning. Landscape and Urban .Retrieved from http://www.sciencedirect.com/science/article/pii/S0169204606000661

Schulz, W.H., Kean, J.W., and Wang, G., (2009) Landslide movement in southwest Colorado triggered by atmospheric tides: Nature Geoscience Vol 2 pp 863 - 866.

Scoones, I., (1998) Sustainable rural livelihoods: a framework for analysis (Working Paper 72). Brighton: Institute for Development Studies.

Seeger.M., R., Ries,J.B., (2008) Soil degradation and soil surface process intensities on abandoned fields in Mediterranean Mountain Environments Land degradation & development Vol 19 pp 488-501.

Senanayake, R.L., Sangakkara, U.R., Pushpakumara, D.K.N.G., Stamp,P., (2009) Vegitation composition and ecological benefits of home gardens in the Meegahakiula region of Sri Lanka, Tropical Agricultural Research Vol. 21(1) pp 01 – 09.

Shanker, T.R., (2003) Bridging the gap: Sharing responsibility for ecological restoration and wildlife conservation on private lands in the Western Ghats, Social Change Vol 33 (2-3) pp 129-141.

Sherbinin, A., Vanwey, L. K., McSweeney, K., Aggarawal, R., Barbieri, A., Henry, S., Walker,R., (2008) Rural household demographics, livelihoods and the environment. Global Environment Change Vol 18 pp 38–53.

Sieber, N., (1999) Transporting the yield: Appropriate transport for agricultural production and marketing in Sub-Saharan Africa. Transport Reviews, Vol19(3) pp205–220. doi:10.1080/014416499295493

Silva,P., (2001) Land Use Changes in Sri Lanka. Report number 03. Background information for preparation of National Physical Planning Policy – 2001. Center for National Physical Planning, Urban Development Authority, National Physical Planning Department, Government of Sri Lanka Available at: http://www.nppd.gov.lk/Report_3.pdf

Sivapalan,P., Kulasekara,S., Kathiravetpillap,A., (2006) The way of cultivating tea, Tea hand book,Tea Research Institute,Thalawakele, Sri Lanka

Slawomir.W, and Hermanowicz,, (2005) Entropy and Energy: Toward a definition of physical sustainability, Working paper Water Resources Collections and Archives University of California

SLSEA (Sri Lanka Sustainable Energy Authority) 2011www.energy.gov.lk/pdf/guideline/Grid_Renewable.pdf

SLSEA, (2011), "Sri Lanka Energy Balance", Sri Lanka Sustainable Energy Authority, Colombo

Smith, C S., McDonald, G T., and Thwaites, R N., (2000) TIM: Assessing the sustainability of agricultural land management. Journal of Environmental Management, 60, 267–288.

Soini,E., (2005) Land use change patterns and livelihood dynamics on the slopes of Mt.Kilimanjaro, Tanzania Agricultural Systems Vol 85 (3) pp 306-323.

Spencer, J.E., (1966) Shifting cultivation in southeastern Asia, University of California press

Sri Lanka Energy Balance 2007- Energy Forum –Sri Lanka*efsl.lk/reports/**Sri**%20**Lanka**%20**Energy**%20**Balance**%20**2007**.pdf*

Sri Lanka tea board Annual Report, (2010)

Sri Lanka tea board Annual Report- 2010Annual Report 2010 1x - Sri Lanka Tea Board

Stupak,I., Lattimore,B., Titus, B.D., Smith,C.T., (2011) Criteria and indicaters for sustainable forest fuel production and harvesting: A review of current standards for sustainable forest management, Biomass and bio energy Vol 35 (8) pp 3287-3308.

Subasinghe,S.M.C.U.P., Hettiarachchi,D.S.,(2013) Agarwood resin production and resin quality of Gyrinops walla Gaertn International Journal of Agricultural Sciences Vol. 3 (1), pp. 357-262.

Sunday observer 2003 www.**sundayobserver**.lk/**2003**/08/17/fea08.htm

Survey Department of Sri Lanka (2014)

Tatlıdil, FF., Boz I., and Tatlidil EH., (2009) Farmers' perception of sustainable agriculture and its determinants: a case study in Kahramanmaras province of Turkey. Environ Development and Sustainability Vol 11 pp1091–1106.

Tatsuji, K., Keiji, O., (2007) Biofuels policies in Asian Countries: Impact of the Expanded Biofuels Programs on World Agricultural Markets Agricultural & Food Industrial Organization Vol 5 (2) pp 15-42.

Taylor, D., Mohamed, Z., Shamsudin, M., Mohayidin, M., & Chiew, E. (1993). Creating a farmer sustainability index: A Malaysian case study. American Journal of Alternative Agriculture, *8*, 175–184.

Tea market review, tea Exporters Association (2014) www.teasrilanka.org/market_reports.php

Teja Tscharntke., Jeffrey C.M., Gotz S., Yann C., Fabrice D., Anthony W., Robert R., Jaboury G., (2015) Conserving Biodiversity through Certification of Tropical Agroforestry Crops at Local and Landscape Scales *Journal of the society for conservation of biology Vol 8 (1) pp 14-23.*

Tesfaye,A., Negatu,W.,Brouwer,R., (2014) UNDERSTANDING SOIL CONSERVATION DECISION OF FARMERS IN THE GEDEB WATERSHED, ETHIOPIA Land Degradation & Development Vol 25 pp 71-79.

The U.S. Department of Agriculture (USDA) (2010) the national Resources Inventory (NRI) www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1167354.pdf

Timmer, C.P., (2002) Handbook of agricultural economics Chapter 29. Agriculture and economic development Vol 2 (part A) pp 1487-1546.

Trixie,M., Gunesekara,K (2014) Tea Plant (Camellia sinensis) Breeding in Sri Lanka Global tea breeding pp 125-176.

Tscharntke, T., Clough, Y., Wanger, T.C., Jaxckson, L., Motzke, I., Perfecto, I.,Vandermeer, J., Whitbread, A., (2012) Global food security, biodiversity conservation and the future of agricultural intensification Journal of Biological Conservation Vol 151 (1) pp 53-59.

TSHDA 2012 Annual report Government of Sri Lanka, www.tshda.gov.lk/web/images/pdf/annual_report_2012_english.pdf

UNCCD Report (2012) Zero Net Land Degradation: A New Sustainable Development Goal for Rio+ 20

University of Sri Jayewardenepura. 2007. Fuel wood availability, collection and uses in Sri Lanka, http://forestrystudents.blogspot.com/2007/08/fuelwood- availability-collection-and.html (Retrieved on 3 Aug 2015)

Van De,N., Douglas,I.A.N., Mcorrow,J., Lindley,S., Binh,D.K.N.T., Van,T.T.,Thanh,L.H., Tho,N., (2008) Erosion and Nutrient Loss on Sloping Land under Intense Cultivation in Southern Vietnam

Vesterby, M., Krupa, K.S., (1997) Major users of land in the United States FAO report pp 47.

Wackernagel,M., Rees,W.E., (1997) Perceptual and structural barriers to investigating in natural capital : Economics from an ecological footprint perspective Ecological Economics Vol 20 (1) pp 3-24.

Wakindiki, L.L.C., Hur,M.B., (2002) Soil Mineralogy and Texture Effects on Crust Micromorphology, Infiltration, and Erosion, Soil Science Society of America Vol 66 (3) pp 897-905.

Wenzlhuemer, R., (2008) From Coffee to Tea Cultivation in Ceylon, 1880-1900: An Economic and Social History. Brill Academic Pub. : Boston.

Wiggins,S., Proctor,S., (2001) How special are rural areas? The Economic implications of rural development, Development Policy Review. Vol 19 (4) pp 427-436.

Wijerathne, M.A., (2004) Post-Harvest Losses in Tea production, Tea Bulletin, 19(1&2) pp18-21.

Wijeratne,M.A.,Anandacoomaraswamy,A.,Amaratunga,M.K.S.L.D., Ratnasiri,J.,Basnayake,B.R.S.B., Kalra,N., (2007) Assessment of impact of climate change on productivity of tea (Camellia sinensis L.) plantations in Sri Lank Journal of the National Science Foundation of Sri Lanka 35(2) PP 119-126.

Withanaarachchi, A.S., Nanayakkara, L.D.J.F., Pushpakumara, C. (2014) The Progress of Sri Lankas Renewable Energy Sector Developments in Mitigating the GHG Emission, Energy and Environmental Engineering Vol 2(5) pp 113-119.

www.agridept.gov.lk/images/stories/site/.../nationalagriculturalpolicy.pd

www.pureceylontea.com/index.php/2014.../61-annual-report-2010

*www.pureceylon**tea**.com/index.php/2014.../61-annual-report-**2010***

www.survey.gov.lk/surveyweb/Home%20English/survey_department.php

Yang, C., Shropshire, G. J. and Peterson, C.L., (1997) Measurement of ground slope and aspect using two inclinometers and GPS. Transactions of the ASAE 40 pp 1769–1776.

Ziyad-Mohamed.M.T. and Zoyas, A. K. N., (2006) Current status and future research focus of tea in Sri Lanka. The Journal of Agricultural Sciences 2 (2) pp 32 – 42.

Appendixes

Timber / fuelwood, and other species in different SMTH plantations in two Districts in the sampled (n=81). Nomenclature follows Abeywikrama (1959).

(a) Tree Species

Species	Family	Known users as
Albizia moluccana	**Leguminosae**	**Shade, timber, fuelwood**
Alstonia macrophylla	**Apocynaceae**	**Timber, fuelwood**
Areca catechu	**palmae**	**Cash, pole wood**
Artocarpus hetorophyllus	**Moraceae**	**Food, cash, timber, fuelwood, fodder**
Bambusa vulgaris	**Bambusaceae**	**Timber**
Cinnamomum zeylanicum	**Lauraceae**	**Cash, fuelwood**
Citrus aurantifolia	**Rutaceae**	**Fruit, cash, medicine**
Citrus medica	**Rutaceae**	**Fruit, cash, medicine**
Coffea arabica	**Rubiaceae**	**Cash**
Gliricidia sepium	**Leguminosae**	**Shade, pole wood, fuelwood, fodder, green manure**
Michelia champaca	**Magnoliaceae**	**Timber, fuelwood**
Myristica fragans	**Miristicaceae**	**Cash, medicine**
Switinia macrophylla	**Meliaceae**	**Timber, fuelwood**
Macaranga peltata	**Euphorbiaceae**	**Fuelwood, pole wood**
Wendlandia notoniana	**Rubiaceae**	**Fuelwood, pole wood**

Annex 1: Questionnaire used for first data collection (2013 July)

Questionnaire (1)

Survey on Conversion of Degraded small holder tea lands to energy plantations in Sri Lanka (A Social, Ecological, Economic limitations)

Respondent: Owner manager ☐ Manager ☐

Name and contact information of the respondent:

Address of the Estate: District

Land extent Ha ☐ Acers ☐

A. Personal Information

1. Sex: Male ☐ Female ☐
2. Present Age:
3. Number of family members and their contribution to the tea estate.

   Member Age Way of contribution

   1.

   2.

   3.

4. Your age when you started owning/managing this Estate:

   4.1 Did you establish the estate by your own, or purchase/inherited from others:

5. Education level:

1. Did not go to school	
2. Primary school (< O/L)	
3. Ordinary level pass	
4. Advance level pass	
5. Bachelor's Degree	
6. Postgraduate Degree	

6. Did you receive any formal training and /or relevant technical training before starting up/owning this tea land?

Management ☐ Technical ☐ Both of them ☐ None of them ☐

From where: ☐

7 Before starting up/owning this tea plantation did you have any work experience related to this?

Yes ☐ No ☐

8. Physical condition of the tea land

Type of the land	Observations according to the farmer	Observations according to TSHDA officers
% Flat		
% Sloppy land		
% Very sloppy (beyond TRI recommendations)		

9. Production stage of the plantation

Production stage of the land	**Extent (Ha/Ac)**	**As a %**	**Farmers reason**
VP tea			
Seedling tea			
Immature tea			
Other users (specify)			
Uncultivated land (specify)			

10. What are the reasons if remaining uncultivated land in your tea estate?

1) Un productive and eroded land

2) Too sloppy land for tea

3) Already cultivated tea and abended due to low profit

4) Difficult to find labour

5) Due to other reason (specify)

11. Tea harvesting information

1. Number of resident labour Male ☐ Female ☐
2. Number of hired labour Male ☐ Female ☐
3. Basis of labour allocation (Specify) Fixed ☐ yield basis ☐ other ☐
4. Labour wagers: Government approved rate ☐ any other /specify
5. Average how many hours per day do you /owner usually spend on this business
6. Way of sending tea leaves to the factory
7. Average price of green leaf (per kilo) during last year? Rs

Price of last month:

Category	Year/Month (1-12)	Yield Kg	Labour units/Cost Rs	Other costs	Income	Profit
Tea harvesting						
Tea all other agricultural practices /in puts						
Other crops harvesting						
Other crops all other agricultural practices/inputs						
Total						

12. What are your other income sources except from tea land?

Income sources	Income /monthly
Salary/pension	
Salary/pension from spouse	

Other business (specify)	
Total	

13 According to your experience, what are the other profitable agricultural activities in this area?

Activity	Percentage	Remarks
Annual crops (vegetables, fruits….)		
Perennial crops (fruits, spices, rubber ...)		
Fuel wood trees		
Other		

14. Availability of widely used/highly demand fire wood tree species for tea drying in your area?

Tree species	Very little	Little	Some what extent	Some extent	High extent	Very high extent	Unit prize Rs/m3

15 State the level of support that your factory render to you as a green leaf supplier

Small holder farmer	Very little extent	Little extent	Some Extent	High extent	Very high extent
Financial assistance					
Fertilizer					
Extension services for green leaf quality improvement					
Green leaf transport facility					
Welfare facilities					
Purchase fuel wood					
Other					

16. State the level of support that your leaf transporter renders to you as a green leaf supplier

Small holder farmer	Very little extent	Little extent	Some Extent	High extent	Very high extent
Financial assistance					
Extension services for green leaf handling					
Green leaf transport facility					
Welfare facilities					
Purchase fuel wood					
Other					

17. Relationship with external institutions in order to follow/adopt new knowledge/financial support

Inter-grower relationship	Very little extent	Little extent	Some Extent	High extent	Very high extent
Estate own co- farmers					
Supplier firms / suppliers					
Other tea growing firms					
Relationship with government					
Local government officials					
TSHDA officials					
Sri Lanka tea board officials					
Ministry of plantation					
National institute of plantation Management					
Forest department officials					
Relationship with Research Institutions					
TRI					
Universities					
Others (specify)					

18. Frequency of relationship

Inter-grower relationship	Yearly	Quarterly	Monthly	Weekly	Not at all
Estate own co-farmers					
Supplier firms / suppliers					
Other tea growing firms					
Relationship with government					
Local government officials					
TSHDA officials					
Sri Lanka tea board officials					
Ministry of plantation					
National institute of plantation Management					
Forest department officials					
Relationship with Research Institutions					
TRI					
Universities					
Others (specify)					

19. Tea estate owner's relationship with government and other organizations

Please select that your estate received benefits from following institutions during the past three years.

Government institution/NGOS	TSHDA (ministry of plantation)	Forest department	Local government	TRI	Universities	Others (specify)
Financial supporting (subsidy) RS/unit land 1, soil rehabilitation,2,planting material,						
Access to market						
Education and training /Managerial development						
Consultation service						
Quality improvement support						
Technological development						
Innovation development						
Networking facilities						
Joint research and development						
Other						

20. Tea estate owner's general attitude on his/her estate.

The following statements indicate how you think on your estate. Please circle one number to indicate your agreement on each statement;

1 = strongly disagree 5 = strongly agree

a. Estate owners point of view					
1. In general, my estate generates good income for me, will continue managing my land with tea.	1	2	3	4	5
2. In the past 5 years, my estate has generated low income, creating difficulty to manage the estate totally with tea. (High prices of agricultural in puts)	1	2	3	4	5
3. In last 5 years, my estate has generated low income, creating difficulty to manage the estate totally with tea. (due to high scarcity of labour)	1	2	3	4	5
b. Social/Environmental point of view					
4. I can manage my estate with tea, profitably due to favorable weather condition in this area.	1	2	3	4	5
5. I will have to find other alternative ways to manage my tea estate, while creating job opportunities.	1	2	3	4	5

Field data used for Chapter 4 Sub section:

Farmer property rights and tea farming:

Field data 2015

Field survey March 2015

Deed/ Type of land ownership title and Name

1	2	3	4	5	6	
Deed	Jaya bhoomy (LEAGLE DOCUMENT)	Swarna bhoomy (LEAGLE DOCUMENT)	G.A.PERMIT (GOVERNMENT AGENT PERMITS) TOP LEVEL GOVERNMENT OFFICER	G.S.Permit (Field level government officer)	encroached	

Tenure right (lad use how)						
Cultivation/agriculture	Construct a house					
1	2					

Implication for tea farm management	Implication for planting fuelwood trees	Implication for their livelihood
1. (no problem)	1. (no problem)	1. (no problem)
2. (slightly restricted)	2. (slightly restricted)	2. (slightly restricted)
3.(fully restricted)	3.(fully restricted)	3.(fully restricted)

No of formal discussions with government officers (1 YEAR period 2013-2014) Discussions to get the proper land ownership and demarcate the land extent				
GS (Grameseveka)	TSHDA	Police	DS (Divisional Secretory)	District Land Registrar
a	b	c	d	e

Farmer	Type of land ownership	Tenure right									Implication for tea farm management	Implication for planting fuelwood trees	Implication for their livelihood	No of formal discussions with government officers (1 YEAR)
		access	management	protection	use			Exclude other	Transfer to other	Sale land				
					When (NO OF YEARS)	how	how much (extent)							
Matara District														
1	2	Y	Y		22	1/2	.47		Y	NO	1	1	1	0
2	2/6	Y	Y	Y	19	1/2	0.94		Y	NO	1/3	1	2	6(a,a,b,c,d,e)
3	2	Y	Y		27	1/2	0.47		Y	NO	1	1	2	0
4	2/6	Y	Y	Y	16	1/2	0.5		Y	NO	1/3	1	1/3	5(a,b,c,d,e)
5	1	Y	Y		34	1/2	0.6		Y	Y	1	1	1	0
6	2	Y	Y		19	1/2	0.94		Y	NO	1	1	2	0
7	2	Y	Y		22	1/2	0.94		Y	NO	1	1	2	0
8	1/6	Y	Y	Y	13	1/2	0.47		Y	Y	1/3	1	1/3	6(a,b,b,d,d,e)
9	2	Y	Y		25	1/2	0.94		Y	NO	1	1	2	1(b)
10	1	Y	Y		32	1/2	0.6		Y	Y	1	1	1	0
11	3	Y	Y	Y	17	1/2	0.94		Y	NO	1,2	1	2	2 (a,b)
12	1	Y	Y		20	1/2	0.94		Y	Y	1	1	1	0
13	1/6	Y	Y	Y	12	1/2	1.62		Y	NO	1/3	1	1/3	4 (b,b,d,d)
14	1	Y	Y		14	1/2	20		Y	Y	1	1	1	0

15	2	Y	Y		23	1/2	0.91		Y	NO	1	1	2	0
16	3	Y	Y		21	1/2	1.21		Y	NO	2	1	2	2 (b,b)
17	1/6	Y	Y	Y	15	1/2	1.21		Y	Y	1/3	1	1/3	6(a,b,b,d,d,e)
18	1	Y	Y		11	1/2	0.47		Y	Y	1	1	1	0
19	2	Y	Y		24	1/2	0.47		Y	NO	1	1	2	0
20	1	Y	Y		21	1/2	0.47		Y	Y	1	1	1	0
21	6	Y			16		2.43		NO	NO	3	1	3	6(a,b,b,d,d,e)
22	5	Y			19	1/2	0.94		Y	NO	2/3	1	2	4 (a,b,,d,d)
23	1	Y	Y		11	1/2	0.6		Y	Y	1	1	1	0
24	6	Y			23	1/2	0.47		Y	NO	3	1	3	5(a,b,c,d,d)
25	5/6	Y	Y	Y	29	1/2	1		Y	NO	3	1	2/3	6(a,b,b,d,d,e)
26	5	Y	Y	Y	21	1/2	1.41		Y	NO	2	1	2	4(a,b,,d,d,)
27	5/6	Y	Y	Y	23	1/2	0.6		Y	NO	2/3	1	2/3	0
28	1	Y	Y		14	1/2	1.21		Y	Y	1	1	1	0
29	1	Y	Y		11	1/2	0.94		Y	Y	1	1	1	0
30	2	Y	Y		18	1/2	0.94		Y	NO	1	1	1	0
31	4	Y	Y	Y	21	1/2	1		Y	NO	2	1	2	2(b,b)
32	4	Y	Y	Y	13	1/2	0.66		Y	NO	2	1	2	2 (b,b)
33	4/6	Y	Y	Y	16	1/2	0.6		Y	NO	2,2,3	1	2/3	5(a,b,c,d,d,)

34	4/6	Y	Y	Y	19	1/2	0.6		Y	NO	2,3	1	2/3	5(a,b,c,d,e,)
35	4/6	Y	Y	Y	21	1/2	1.61		Y	NO	2,3	1	2/3	4(a,b,,d,d)
36	1	Y	Y		5	1/2	0.94		Y	Y	1	1	1	0
37	2	Y	Y		17	1/2	0.94		Y	NO	1	1	1	0
38	2	Y	Y		16	1/2	0.47		Y	NO	1	1	2	0
39	2	Y	Y		22	1/2	0.6		Y	NO	1	1	2	1 (b)
40	4/6	Y	Y	Y	23	1/2			Y	NO	2,3	1	2/3	4(a,b,,d,d)
41	1	Y	Y		9	1/2	14.17		Y	Y	1	1	1	0
42	1	Y	Y		8	1/2			Y	Y	1	1	1	1(b)
43	1	Y	Y		12	1/2	0.94		Y	Y	1	1	1	1(b)
44	1	Y	Y		7	1/2	10.12		Y	Y	1	1	1	0
45	1	Y	Y		11	1/2	4		Y	Y	1	1	1	0
46	2	Y	Y		24	1/2	2.83		Y	NO	1	1	1	0
47	3	Y	Y	Y	22	1/2	2.02		Y	NO	1	1	2	2 (b,d)
48	3	Y	Y	Y	35	1/2	2.42		Y	NO	2	1	2	1(b)
49	3	Y	Y	Y	31	1/2	2.42		Y	NO	2	1	2	0
50	2	Y	Y		27	1/2	0.6		Y	NO	2		2	0

Farmer	Type of land ownership	Tenure right									Implication for tea farm management	Implication for planting fuelwood trees	implication for their livelihood	
		access	management	protection	use			Exclude other	Transfer to other	Sale land				
					when(NO OF YEARS	how	how much (extent Ha)							No of discussions with government officers
Badulla District														
1	1	Y	Y		11	1/2	1.82		Y	Y	1	1	1	0
2	1	Y	Y		6	1/2	1.61		Y	Y	1	1	1	0
3	1	Y	Y		11	1/2	0.94		Y	Y	1	1	1	0
4	3	Y	Y	Y	18	1/2	3.23		Y	NO	1,2	1	1	1(b)
5	3	Y	Y	Y	18	1/2	0.6		Y	NO	1,2	1	2	1(b)
6	3	Y	Y	Y	23	1/2	1.21		Y	NO	2	1	1	1(b)
7	1/6	Y	Y	Y	29	1/2	4.65		Y	Y	1,3	1	2,3	0
8	1	Y	Y		8	1/2	1.21		Y	Y	1	1	1	4(a,b,,d,d,)
9	1	Y	Y		10	1/2	1.41		Y	Y	1	1	1,2	0
10	2	Y	Y		24	1/2	12.95		Y	NO	1	1	1	0
11	1/6	Y	Y	Y	18	1/2	6.47		Y	Y	1,3	1	1,2,3	0
12	2	Y	Y	Y	22	1/2	25.1		Y	NO	1	1	1	4(a,b,,d,d,)
13	2	Y	Y	Y	31	1/2	0.8		Y	NO	1	1	1	0
14	1	Y	Y		26	1/2	40.48		Y	Y	1	1	1	0
15	2	Y	Y		26	1/2	0.8		Y	NO	1	1	1,2	0
16	2	Y	Y		41	1/2	3.23		Y	NO	1	1	1	0
17	4/6	Y	Y	Y	30	1/2	20.2		Y	NO	2,3	1	2,3	3(B,B,D)

18	2	Y	Y		21	1/2	1		Y	NO	1	1	1	0
19	1	Y	Y		16	1/2	2.02		Y	Y	1	1	1	0
20	1/6	Y	Y	Y	30	1/2	13.76		Y	Y	1,3	1	2,3	5(a,b,,d,d,e)
21	3	Y	Y	Y	21	1/2	2.02		Y	NO	1,2	1	1,2	0
22	3	Y	Y	Y	41	1/2	2.02		Y	NO	2	1	2	0
23	2	Y	Y		26	1/2	1.11		Y	NO	1	1	0	0
24	2/6	Y	Y	Y	26	1/2	0.81		Y	NO	1,3	1	2,3	6 a,b,c,d,d,e
25	2	Y	Y		19	1/2	0.81		Y	NO	1	1	0	0
26	4/6	Y	Y	Y	27	1/2	0.91		Y	NO	2,3	1	2,3	3(b,b,d)
27	3	Y	Y		32	1/2	2.02		Y	NO	2	1	2	1(b)
28	3/6	Y	Y	Y	28	1/2	1		Y	NO	2,3	1	3	5(a,b,,d,d,e)
29	1	Y	Y		10	1/2	29.14		Y	Y	1	1	0	0
30	1/6	Y	Y	Y	19	1/2	2.42		Y	Y	1,3	1	2,3	4 (a,b,b,d)
31	2	Y	Y		26	1/2	0.8		Y	NO	1	1	0	0