# GENDER, MODERN BIOMASS-ENERGY TECHNOLOGY AND POVERTY: CASE STUDY IN SRI LANKA[1]

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## Abstract

This paper presents three case studies conducted in Sri Lanka, two focused on interventions on modern biomass energy, or 'dendro-energy', development and its impacts. The third case study is on the biomass energy system in a village situation where no such modern biomass energy intervention has taken place.

Of the two dendro-energy case studies; one was designed to generate electricity commercially for the national grid, while the other was designed as a community-level energy generation project for providing electricity for the households in the community organisation. These two cases examine the gender and poverty implications of the clean and modern energy interventions on men and women. The third study is intended to broaden our understanding of the gender, energy and poverty nexus in a non-interventional situation.

The findings of this study reveal that the dendro-energy interventions were somewhat novel and created an enterprise opportunity linked to village and farm biomass. Therefore this intervention has the potential to reduce poverty through income-generation. The situation in the field showed that the commercial supply of biomass feedstock for the plant producing electricity for the national grid was handled by landowners and capital investors, rather than by women who are the traditional woodfuel suppliers for domestic use. The community-level intervention provided greater opportunities for women through the community organisation due to its focus on organising the household supply of feedstock for generating electricity for the same households. The situation in the village with no such intervention represents the patterns in traditional biomass resource use and the features stemming from gender and poverty. The comparison between the village without modern intervention and those with suggests that dendro-energy interventions have the potential to provide strategic means for reducing poverty while addressing the needs of women who bear the triple burdens of poverty: the lack of land, of income and of power.

**Keywords:** dendro-energy, biomass, energy, poverty, gender

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## Executive Summary

This is the first study on gender and modern biomass energy – technically referred to as dendro-energy – so it breaks important new grounds. It looks at the recent technological moves to promote dendro-energy as a means of rural electrification in Sri Lanka and examines two cases, one in which feedstock is provided for a national grid-connected plant, and another in which a community-level energy generation plant provides electricity to the participating households. A third case, in which there is no energy generation plant and the people depend on the traditional biomass system, is also included as a control. A gender analysis framework underpinned the study, and a household survey was carried out as well as other RRA field methods and focus groups. The study has highlighted linkages between the feedstock provision, agriculture, and the biomass energy cycle in the villages, as well as gendered roles.

The second section of the paper describes the energy sector in Sri Lanka, its trends and context. Biomass is the primary source of energy in rural areas, and the sole source of energy for cooking. It is an important element in the agricultural livelihood system. Due to the high cost of fossil fuels and the limited hydropower potential, renewable energies including biomass are being explored as a way to expand beyond the 65% of the population currently connected to the national grid. Decentralisation is also a priority. Two modes of biomass-based electricity generation are supported by state policy: generation for the national grid through private-sector partnerships, and community level off-grid generation for village electrification.

The study addresses two research questions, about the effects of gender relationships on the goals of such interventions, and the effects of the dendro-energy interventions on empowering women and how to do this most effectively. It uses gender analysis as a framework as well as a cross-cutting variable in the biomass energy system. A wide range of criteria and indicators on gender relations, energy interventions, wellbeing, and resource stewardship are assessed through a variety of gender-disaggregated data collection methods, ranging from field surveys, including questionnaires, to various RRA methods and focus groups.

The third section of the paper presents the case studies, describing modern biomass energy technology through the dendro-energy initiatives and the Bio Energy Association of Sri Lanka which is promoting the bio-energy industry using the country's past experience, feedstock potential and interest in renewable energy. It gives an overview of the gender impacts of the dendro-energy initiatives. This section also describes the ecological conditions and the livelihoods in the three areas covered. It provides a typology of the three situations covered in the study and the methodology developed and introduced in this research.

The fourth section examines the findings from the case studies. The first case study is in Kumbalgamuwa, producing electricity from dendro-energy for the national grid. In this project, large farm holdings have benefited but the poor, with small farmlands, have not been involved in providing feedstock and neither have the landless benefited. Protests have been launched on environmental grounds, and 68% of the households were against the project. Men have reaped most of the benefits of planting, preparing and selling feedstock to the plant, while women have little interest in the project since it does not contribute to the local energy needs or to food production - their leading roles in a farming family. In fact, it detracts from these by shifting control over woodfuel to the cash economy.

The second case study concerns a community level, off-grid dendro-energy development project in Wadagahakiwla. It was established in 2004 as a pilot project by an NGO, in support of the state policy of decentralisation and promotion of grassroots partnerships in energy development as indicated by the Energy Service Delivery Project of the World Bank. This is the first community-

level project to provide 100 households with 250W of electricity per household per day that is run as a private-public-civil society partnership. The project successfully involves the community in assessing their energy needs and their potential to provide feedstock, in forming a community level organisation, and in selecting the plant site. Women are involved as family members and members of community organisations. Despite this, there is no special provision for meeting cooking needs.

The third case study investigates the traditional biomass energy system and any associated poverty in Hapuwala. There seems to have been no serious shortage of cooking fuel in this village, as it could depend on multiple sources and its forest location. Perhaps as a consequence, little adoption of improved stoves is noted but fuel shortages are beginning to appear. Women do not control the sources that they depend upon for biomass fuels, or make the decisions on how biomass sources are used. Women from poor families spend the greatest time on fuel collection and have to depend on riskier resources. Women's roles in the woodfuel system are undervalued, and their linkages with livelihoods are ignored.

This section is followed by the conclusions which provide a summary comparing the findings of the three sites in relation to gender and poverty. The final section, on policy recommendations, gives a series of recommendations for energy policies, capacity and partnership building, social mobilisation, employment and so on that could enrich the national strategy in addressing crucial issues and so become a meaningful way to achieve the development goals.

# 1 Introduction

The linkages between gender, energy and poverty have resulted in a progressive change in the paradigm development, but more in relation to conceptualisation than in practically realising the developmental goals through strategic means. In real situations, the difficulties of working with this triangular relationship for justice, equity and social inclusion have long been realised by many nations and in many regions. It is also difficult to find demonstration cases where all these concerns are accommodated in a holistic manner.

The gender, energy and poverty view can accommodate different perspectives in relation to the issues of immediate concern. For instance, the eradication of poverty and gender inequity have been included in sustainable development goals. The linkage between gender and poverty is supported by the fact that 70% of the nearly 1.3 billion people living on less than a dollar a day are women. Their lack of access to energy services is a serious impediment to assuring livelihood security, and therefore contributes to poverty. This absence of sufficient choices in accessing reliable, affordable, adequate, high-quality, safe and environmentally benign energy services to support economic and human development is defined as energy poverty (see Reddy, 2000). Referring to the available literature (such as Cecelski, 1999; Clancy et al., 2003) on the 'energy-gender-poverty nexus', Karlsson and Oparaocha (2003) show that it is evident that providing increased access to cleaner fuels for cooking and heating, more efficient and less polluting stoves, and decentralised and renewable energy technologies that provide energy for lighting and other household and productive purposes is essential for improving women's lives, helping them raise their families out of poverty and hence contributes to sustainable development.

While entertaining the arguments raised by various experts, it is important that we do not overlook the directions that are formulated globally and the initiatives taken through projects to realise the goals. Havets' effort on 'Linking women and energy at the local level to global goals and targets' (2003) in this respect allows one to examine the Millennium Development Goals (MDGs) (UN, 2002) from the perspectives of energy and gender, although there is no MGD on energy as such. The argument presented to development practitioners is that 'expanded access to energy services for the third of humanity that does not have electricity or modern fuels is an essential prerequisite for meeting all of the MDGs'. This implies that access to energy services and modern fuels is essential for eradicating poverty and hunger, achieving universal primary education, promoting gender equality and empowerment of women, reducing child mortality, improving maternal health and ensuring environmental sustainability.

These linkages were recognised at the World Summit on Sustainable Development in 2002 in Johannesburg where countries agreed to improve access to reliable and affordable energy services for sustainable development in order to facilitate the achievement of the Millennium Development Goals. The acceptance of energy as a mode, means, instrument and a facilitator for sustainable development is expected to make some transitional move from the level of policies to the level of projects and programmes.

However, in real situations, why is that these perspectives and linkages have not been integrated into recent interventions? Cecelski (2004) argues that while enormous quantities of empirical evidence on gender and sustainable energy have been generated in recent years, much is undigested, and frameworks for analysis are weak. As Cecelski has pointed out, perhaps it is time to review and examine – and ask whether we are asking the right questions?

This study looks at the recent move to promote modern biomass energy, technically known as dendro-energy, which has potential in terms of rural electrification. This is the first study on gender and modern biomass energy so it exposes important new ground. It examines two applications of modern biomass energy, one in which feedstock is provided for a national grid-connected plant, and

another in which a community-operated plant provides electricity to the village. A third, comparative case study was undertaken in an area which has no such plant for generating electricity from biomass and uses biomass in the traditional way. Gender analysis was used as a framework for the study and a household survey was carried out as well as RRA field methods and focus groups being applied.

The analysis of the case studies reveals linkages between the feedstock provision, the livelihood source (agriculture) and the biomass energy cycle in these villages as well as the gender roles. The final section, on policy recommendations, provides a series of recommendations, including for energy policies, capacity and partnership building, social mobilisation and employment. It is important to note that since the two dendro-energy projects are recent interventions and the first initiatives of their type it is too early to make definitive conclusions. Nevertheless, the project design, the expected goals and the returns to communities do allow us to examine whether gender relations constitute a key variable and whether the intervention contributes to empowering women. This study as a whole should be seen as an initial effort to broaden the perspectives for effective interventions.

# 2 Background

## 2.1 Biomass and the energy sector

In Sri Lanka, biomass dominates primary energy provision, and it met about half of all primary energy requirements in 2002. The country has favourable conditions that enable consumers to get 'woodfuel' from natural forests as well as from manipulated forest production systems. Of the total of 6.5 million hectares of land, around 1.5 million hectares are natural forest, around 0.8 million hectares are home gardens, while tree plantations and other integrated land uses retain further tree cover. Although the country's forest cover has been reduced, from about 86% to 23% over the last century, the woodfuel users have had various options for satisfying their 'wood-energy' needs. The mosaic patterns of home gardens comprising individual plots, living hedges demarcating boundaries of individual plots of land including farms, the riparian agroforests and reserves, and also 'ribbon' belts of planted trees etc. are all important sources of woodfuel.

Climatic diversity with rainfall varying between 900mm and 4000mm per annum plus geomorphological diversity between the coastal lowlands and the central highlands rising to 2000m mountain peaks provides a promising diversity of options. Woodfuel deriving from various systems such as a by-product of other tree uses, agro-residues and purpose-grown biomass are all potential resources of feedstock for the energy industry. The country has been rather slow in utilising this promising resource for generating clean energy.

Biomass is the primary source of cooking energy and the sole source in rural households. It has gained enormous attention since the early 1980s with the FAO initiatives on Community Forestry and the Regional Wood Energy Development Programme. Interventions in forestry development have undergone a paradigm shift by integrating two elements, the 'communities' and 'woodfuel production', in the process of forestry development in Sri Lanka. Biomass plays a vital role in catering for the energy needs and ensuring the livelihood security of over 15 million rural people and contributing to the cooking energy needs of the urban poor. Nearly 10 million tonnes of biomass are consumed annually, and the total value of this is about US$ 440 million. It is primarily used for subsistence and household wellbeing, and also in rural industries. It is often procured as a 'free commodity' without involving direct payment for the sources and materials and also for the labour involved in procuring, transporting and combustion. In this paradigm, in the present circumstances, gender is a key variable, and the system is sustained by women's contributions. It is the household sector that consumes the lion's share: nearly 81% of total biomass energy through direct combustion with some pretty insignificant technological interventions. Petroleum is the second most significant source of primary energy and provided about 42.6% of the primary energy in 2002. Hydropower is another significant source of energy and contributed around 8% of primary energy and is the dominant source for electricity generation. The potentials for expanding hydropower generation are limited due to resource constraints, rainfall fluctuations and increasing costs. The unreliability of fossil fuel supply and the high costs has encouraged the power sector to search for renewable solutions. The Power Sector Guidelines (MOPE, 2002) produced in 2002 indicate that the objectives of the power sector is to meet the demand for energy services at all times, with the minimum economic, social and environmental costs, and thereby promote economic development and social wellbeing.

## 2.2 Energy policy

The energy sector of Sri Lanka has not been guided by a unified National Energy Policy. The Ministry of Irrigation, Power and Energy, in 1997, recommended that the following elements should be in an energy policy:

- Providing basic human energy needs;

- Reducing dependence on imported energy and diversifying energy sources;
- Having an optimum mix of energy sources;
- Optimising the operation of available energy sources;
- Conserving energy sources and eliminating wasteful consumption;
- Developing and managing forest and non-forest woodfuel resources;
- Adopting an appropriate pricing policy and ensuring price stability;
- Ensuring continuity of energy supply;
- Increasing local manufacture, fabrication, construction and value addition in energy supply and utilisation; and
- Establishing capabilities to develop and manage the energy sector.

In support of these elements it was also recommended to introduce reforms to the electricity sector, the oil and gas sector, the biomass/woodfuel sector, and to consider environmental concerns, regional cooperation and integrated energy planning and guidance.

In Sri Lanka, the Ministry of Power and Energy exercises the sole authority over the electricity sector. The Ceylon Electricity Board (CEB) operates under the Ministry and vertically integrates the power utility. The CEB generates around 80% of the power supplied through hydropower generation and thermal power plants. Independent power producers supply the other 20%. The present situation suggests that the total technical potential for hydropower generation is around 8000 GWh per annum, and that nearly 50% of this is already achieved. Over 42 MW of mini-hydro plants have been connected to the national grid. One of the crucial features to take into account is that, of the total population of over 19 million in 2002, 72% live in rural areas. Nearly 65% of the population is connected to the national grid, but this varies spatially. The highest percentage found is 80% in the Western province - the area with the highest urban population - and an extremely low penetration is found in the rural Uva province, with only 30% of the population having access to electricity. Thus, a substantial proportion of the population live in non-electrified households, especially in the rural areas where only about 47% have access.

Electricity is the major source of power for lighting, commercial uses and industry. Petroleum is the major source of power for transportation and has been under state authority control for decades. The biomass sector provides the bulk of the energy needs of the population with an annual consumption of about 10 million tonnes of woodfuel satisfying the cooking energy needs of about 92% of the population. This sector as a whole has been a “no body business” and has been managed informally by the users for generations. As a result, biomass energy has remained outside the dominant energy policy frameworks of Sri Lanka. The non-commercial nature of this traditional source has made no significant advancements in terms of technology or gained any recognition for its contribution. Electricity, LPG and kerosene, which are possible alternative cleaner sources of energy, are extremely costly. Not only do these sources remain outside the public energy domain, they are also only available within a commercial system. Under the Energy Sector Development Project, about 28 village mini-grids, producing 4-45 kW have been established to serve 1400 households. Hydropower is the primary commercial electrical energy source with the potential to produce around 2000 MW, but marked with serious uncertainties due to severe affects of droughts and competing water demand for irrigation and agriculture, and for drinking water. A serious problem for the power sector is the increasing cost of fossil fuels needed to meet the electricity demand. According to the Ceylon Electricity Board (2003), in 2003, about 49% of the energy demand was met by thermal plants at a cost of about US$ 113 million and this is expected to increase to 76% by 2017 at a likely cost of some US$ 282 million. Such an increase in foreign exchange expenditure for generating electricity using imported fuel is becoming impracticable for the country.

Therefore, the Rural Electrification Policy in Sri Lanka is facing a threat from the increasing need and pressure to provide electricity services to rural areas on the one hand, and the non-affordability

of thermal power generation on the other. It has also been realised that 20-40% of the average rural household income is spent on kerosene for lighting, and on batteries and battery charging to provide domestic energy for non-cooking purposes. With rural electrification being rather limited, with the highest connection rates of 47-50% found in the estate sector, the interest in off-grid systems and the promotion of renewable energy using local resources including biomass through motivating sectors beyond the state agency have become policy priorities. Provisions have been made to promote wind power plants, solar home systems, village/community level microhydro, and dendro-energy plants to meet national, local and industrial demands.

The existing situation reflects how the state agency has concentrated heavily on rural electrification and energy needs, but has narrowed down energy needs to lighting requirements. Further improvements are needed in the process of democratisation of the energy sector to enable others including energy users, particularly women, to become involved in the system as key stakeholders. Woodfuel, which dominates the biomass energy scene, is not included in the energy sector and remains under the forestry sector and in the hands of women – the informal service providers.

## 2.3 Trends in the energy sector

The development of renewable energy sources has become a national priority for energy security. This is facilitated by focusing on the decentralisation of power generation and promoting hydro/biomass/hybrid systems rather than concentrating on costly mechanisms for grid extension. The rationale for this is quite clear because 1.8 million rural households and another 150 000 households in the estate sector do not have access to grid electricity. The national policy on rural electrification, decentralisation, and renewable resource-based energy generation has led to some changes in this sector.
The major trends in the energy sector include:

- Since 1996, the private sector has been allowed to generate power due to hydropower shortages and the inability of the CEB to meet the need. As a result, in 2002, private sector stations provided nearly 32.6% of the electricity delivered;
- Promoting off-grid electricity generation for rural electrification. It is expected that 80% of electrification will be achieved by grid extension and the remaining 20% by off-grid generation;
- Promotion of locally available renewable sources such as hydro, biomass and wind for electricity generation, and securing external support as a way to enhance rural electrification. For instance, grid-connected and off-grid microhydro and dendro-energy projects are promoted to cater for national and local electricity needs; and
- Facilitation of dendro-thermal energy generation using biomass for sustainability and decentralisation. As a result, a number of modern biomass energy interventions have been established. A 35 kW model dendro plant in Sapugaskanda, and a 1 MW dendro plant in Walapane – Kumbalgamuwa have been commissioned by the private sector. A community-based dendro plant has been established in Badalkumbura – Wadagahakiwla to for generate electricity for the community. On the basis of currently available biomass resources and possible future expansion of "energy plantations" it is estimated that nearly 1800 MW of electricity could be generated from biomass.

## 2.4 Dendro-energy initiatives

Two types of initiative have been used to promote biomass energy technologies; one generates electricity for the national grid, and the other is a community level off-grid energy supply to meet the electricity demand in rural areas. These two models for biomass electricity are supported by the State under its policy on renewable energy development and decentralisation. The community level dendro-energy development policy is supplementary to that covering grid extension which aims to

enable 60% of households to access the grid. The state agency - the Ministry of Power and Energy - intends to reach 75% of Sri Lankan households by 2020. According to the policy, only 80% of households can realistically expect electrification through the national grid. This means that off-grid systems will be the only way to provide electricity to the remaining 20% of consumeRs. In this regard, many initiatives have already been introduced. An off-grid electrification programme, supported by the World Bank's Energy Services Delivery Project (ESDP) and Renewable Energy for Rural Economic Development Project (RERED), has already begun to promote solar home systems and village hydro schemes. The potential for biomass-based electricity generation through off-grid technology to provide a community-level service in rural areas is less exploited, but has wider potential.

The potential for generating electricity from biomass - dendro power - in Sri Lanka has been investigated from three main aspects. The first is the previous practical experience in the country with dendro power generation as initiated by individuals and the private sector for their own use. The second is the potential to obtain the biomass feedstock on a sustainable basis as a raw material for electricity generation. There are already more than thirteen fast growing species, including the *Gliricidia* and *Acacia* of the farmlands, that are potential source materials. The third aspect is the possibility of converting underutilised, unutilised and degraded state lands into dendro plantations. The possibility of motivating private landowners to invest in dendro plantations is also considered promising.

The generation-long practice of tree farming as a component of land-based livelihoods in Sri Lanka is a capital asset when promoting dendro energy. There are potentials to use fast growing species, targeting woodfuel production, as well as using coppicing techniques to provide feedstock. Dendro energy development is seen as a strategy for "re-greening Sri Lanka" and for addressing the energy crisis that the country is experiencing. It is considered economically beneficial to make use of species grown in living fences, and also to inter-crop coconut plantations for diversification purposes. In this regard, pre-feasibility studies have been carried out by the Ministry of Science and Technology, the Ministry of Environment and Natural Resources, and by non-governmental organisations such as ITDG and the Energy Forum.

The Bio Energy Association of Sri Lanka (BEASL) has been formed by several scientists to promote the bio-energy industry. It has had a significant impact, particularly in promoting favourable policy initiatives, research, regulations, tax incentives and motivating and mobilising resources. Its aim of "re-greening" Sri Lanka by producing biomass for the energy industry recognises that growing and harvesting trees for woodfuel is both sustainable and profitable. BEASL acts as a catalyst, and has built partnerships and interactions involving the state agency, NGOs, technical and research institutions, farmer organisations and the private sector. Dendro energy initiatives, as reflected in the BEASL strategy, include:

- Establishing a network involving industries and farmer organisations for the successful generation of bio-energy;
- Serving as a forum for the exchange of information and interactions on bio-energy development;
- Encouraging and promoting bio-energy development activities in Sri Lanka;
- Establishing bio-energy as a major development goal in addressing poverty;
- Serving as a vehicle through which the government, bilateral and multilateral donors and private assistance may be equitably and effectively extended to members;
- Providing information to all members and relevant state agencies and similar bodies;
- Encouraging the provision of all types of services for bio-energy development, dissemination, ownership and management;
- Providing information, lobbying with, and acting as an industry promoter with GoSL, the CEB and with the public in the furtherance of the industry;

- Providing the necessary services for the purpose of, or acting as regulatory body for, biomass pricing, approval of standards for the installation and operation of plants; and
- Liasing with banks and funding agencies to promote bio-energy development.

The Bio Energy Association of Sri Lanka plays a leading role in promoting dendro-energy and its focus on social, economic and environmental implications is essential for long-term sustainability.

## 2.5 Research questions

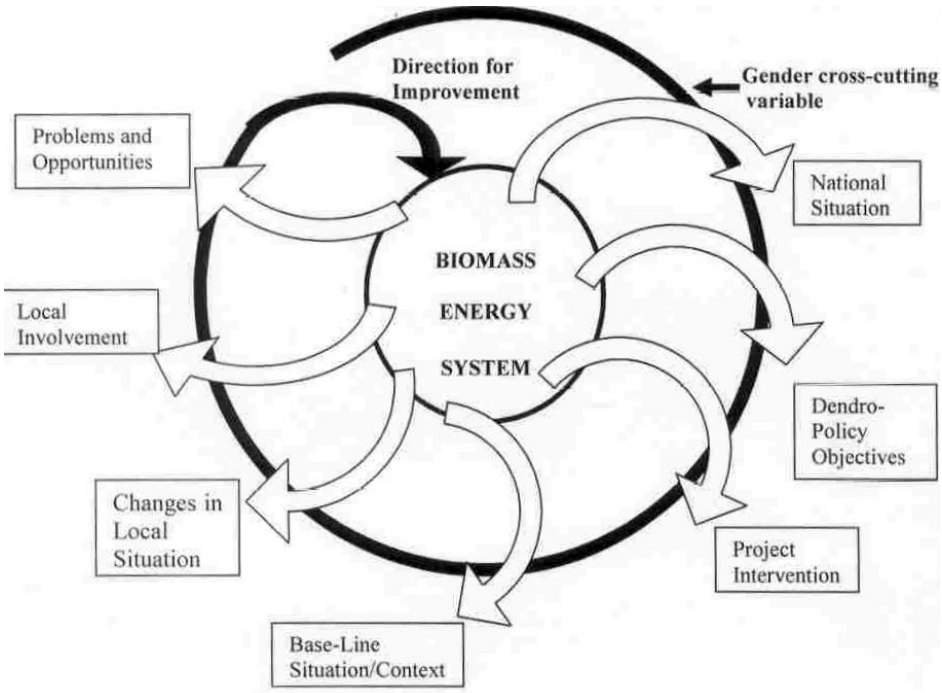
This study was designed to provide an in-depth analysis that would determine the linkages between gender, poverty and energy in three villages. The study focused on two key research questions:

1. Should gender relationships constitute a key variable in designing dendro-energy interventions and do they contribute to achieving the goals of the intervention?
2. Is a dendro-energy intervention effective in contributing to the process of improving the wellbeing of women and empowering them, and how can it best do this?

## 2.6 Analytical framework

Gender analysis was adapted as a framework, for investigating gendered aspects of the rural energy situation, and the impacts of two modern biomass dendro-energy development projects on gender and poverty. The two main questions indicated above were elaborated upon and expanded concentrating on four sets of criteria: gender relations, energy interventions, wellbeing and resource sustainability. Gender is used as a variable cutting across the biomass fuel system. In gathering information, and also in analysing the policy objectives of the modern biomass-energy interventions in rural situations, gender is used as a key variable at several levels in the study (see Figure 1).

**Figure 1. Analytical Framework using gender as a key variable**



# 3 The study

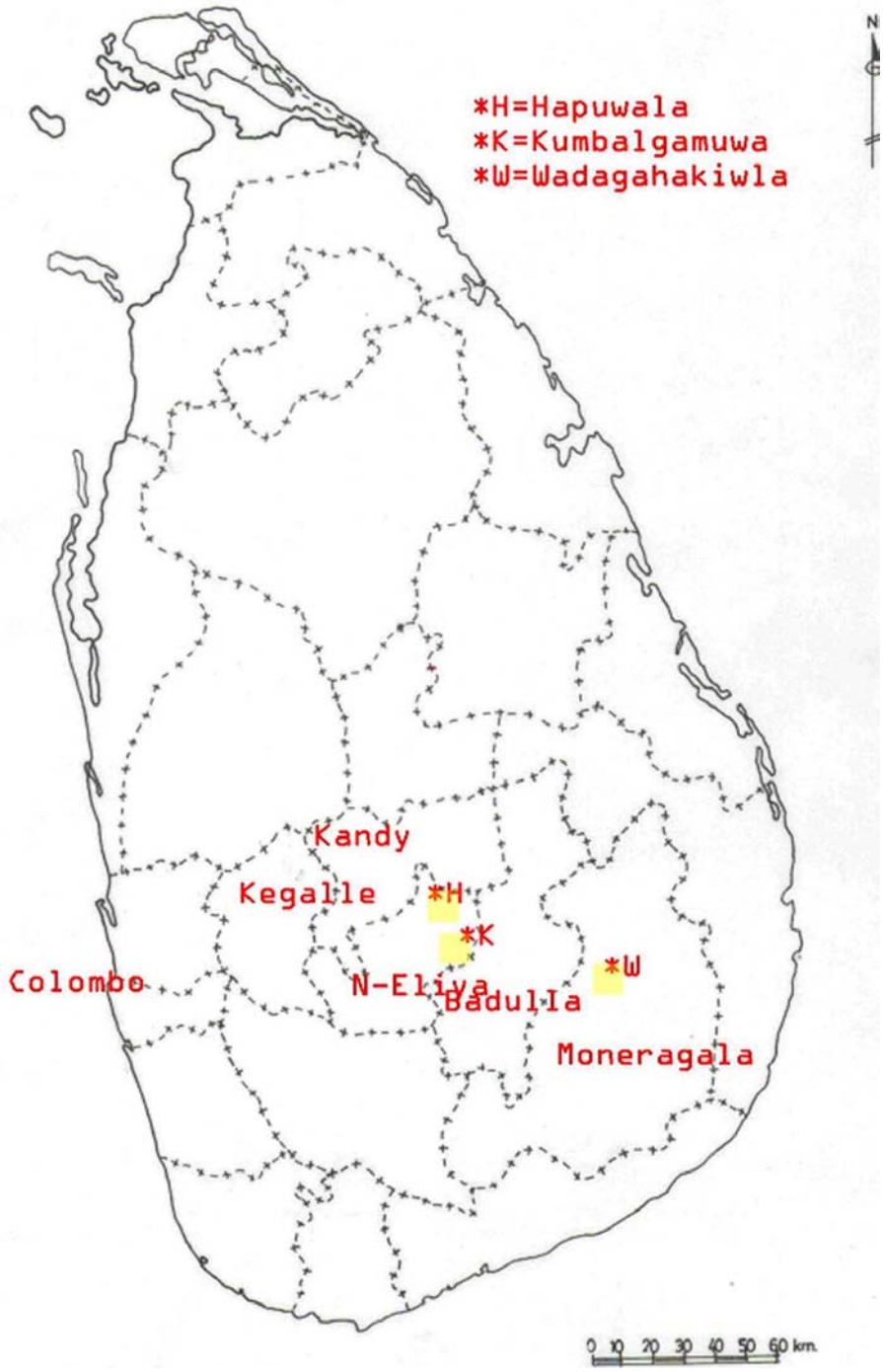
## 3.1 Typology of the case study situation

For this study, three geographically dispersed villages located in hilly terrain were selected. Two villages had 'benefited' from dendro-energy interventions which had been completely new concepts for the villages. These had been established through different promoters with specific management regimes (see Table 1). The Kumbalgamuwa dendro-energy project aimed to generate electricity for feeding into the national grid. It is located in the Nuwara-Eliya district of Sri Lanka and the project is implemented by the private sector. Wadagakiwla, with an off-grid dendro-energy project for providing electricity for the involved households, is located in the Moneragala district and the project was implemented through community mobilisation by an NGO. The third village, Hapuwala, is located in the Nuwara-Eliya district and acts as a control case in which modern technology has not been introduced (see Figure 2 for locations).

**Table 1. Typology of situations covered in this study**

| Aspect | **Kumbalgamuwa** | **Wadakahakiwla** | **Hapuwala** |
|---|---|---|---|
| **Energy intervention** | Project on dendro-energy for national grid | Project on dendro-energy for off-grid electricity | No project – biomass only used in traditional way |
| **Mode** | Private sector energy entrepreneur | Community-level organisation | Traditional (household-based) |
| **Partnership** | State agency, private sector, local suppliers, local feedstock producers | NGOs, community organisation, local producers supplying feedstock | Individual household responsibility |
| **Decisions** | Energy entrepreneur and supplier | Community organisation 'Dendro-power', Electricity consumer society and NGOs | Household - women in particular |
| **Biomass Technology involved** | Externally introduced, raw biomass for modern-clean (electricity) power generation<br>Combustion in cooking | Externally introduced, raw biomass for modern clean (electricity) power generation<br>Combustion in cooking | Locally-evolved raw biomass combustion in cooking |
| **Operation** | Private management | Community management | Household/women |
| **Output** | Electricity for the national grid<br>Biomass combustion for cooking | Electricity for lighting, community-use<br>Biomass combustion for cooking | Biomass combustion for cooking |

**Figure 2. Location of study areas and boundaries of districts of Sri Lanka**



## 3.2 Geographical features

The geographical settings of these areas are rather similar both physically and socioeconomically. All three villages are located in the climatically-defined intermediate zone of Sri Lanka. The annual average rainfall is in the range of 1400-2000 mm. The high seasonality of the rainfall is marked by a rainy season during the north-eastern monsoon, primarily between October and February, with the rest of the year being largely dry. In terms of terrain, Hapuwala and Kumbalgamuwa are similar with mountainous terrain and intermediate valleys with steep slopes prone to erosion. These areas are of central importance in the sustainable management of the Upper Mahaweli watershed. Wadagahakiwla is located more to the south and has undulating terrain with less steep slopes.

All these areas are marked by outstanding cultural landscapes, consisting of mountain forest patches, traditional village hamlets, homegardens and farmlands. All three areas have a land-based livelihood system where agriculture remains the mainstay of the rural economy. Household/family-based farming is a feature with specific crop rotations in accordance with rainfall patterns. One season is full of farming potential, and the other less so due to the dry conditions which influences income, food production, farming activities, employment opportunities etc. For both men and women, the rainy season holds out much more promise in their daily lives.

The farm production system is associated with a family's units of land. Often a family has three pieces of land: a homegarden, a farm plot relying on rain and, in some cases, a plot of paddy land in low-lying valleys. Cultivation of paddy during the rainy season in narrow tracts, known as *yayas*, located in the valleys; plus vegetables and cash crops in highland fields; and the perennial mix in homegardens adjoining the dwellings is a common pattern. Traditional settlement patterns have inculcated homegarden-based forest mosaics, paddy tracts and farmlands reflecting a village architecture evolved over generations. The same architectural features influence the division of labour between men and women in the distinct seasons. Women tend to work the homegardens and the highland farms more regularly than their counterparts, while men generally work the paddy fields. Energy production for domestic use is reflected in the spatial distribution of crops and trees. Every production system includes several varieties of trees producing a range of outputs including woodfuel.

In these villages, energy is used for cooking, lighting, communication, transportation, shared services such as in health and education and in industry. Of these, cooking and lighting are the most regularly derived services and are therefore closely integrated into village life. Cooking energy is locally derived and the responsibility is borne by women for their individual households. Energy for lighting comes from either the national electricity grid or kerosene. The two villages located in the highlands, Kumbalgamuwa and Hapuwala, have grid electricity, and those with the necessary capital can gain access. Wadagahakiwla has no electricity links. Energy use of for transportation, services, communications etc. is on an occasional basis because services are not widely available.

Land is the source of living, and it is managed for both subsistence and income. During the past twenty-forty years, these areas have seen commercial agricultural interventions: Wadagahakiwla for the cultivation of sugar cane, and Hapuwala and Kumbalgamuwa for tobacco. For the private sector and entrepreneurs, the rural nature, and the relatively poor quality of energy services, make it clear that 'remoteness', although there are roads fit for motorised transport, is an impediment to economic and social advancement.

From the perspectives of dendro-energy development, the two villages in which the projects are being implemented have the wood potential to promote such projects. In both areas suitable biomass is available as feedstock for the dendro-plants. It is produced from existing farmlands, hedges with trees, shrubs and bushes, fences with linearly grown trees and woody species, and

homegardens. The traditional land management systems are also involved with trees grown in homegardens, fences and hedges, and also through managing trees on common lands. In both village areas, the species *Gliricidia sepium* which provides the type of wood required for dendro-energy electricity generation is widely available. It is locally known as Ginisiriya, Sevano, Nanchi, Kola-pohora, Wetahiriya and Ladappa. It has nitrogen fixing qualities, can be coppiced, its new growth readily forms cuttings for plants and further it provides fodder for livestock. Its ability to produce straight branches and its narrow canopy are qualities that attract rural farmers. The project interventionists' matter in hand was to organise the supply of feedstock using the preferences established by the project mode.

## 3.3 Criteria and indicators

In examining the field situation and analysing the information, attention was given to the following broad criteria and related indicators (see Table 2).

**Table 2. Criteria and indicators used in this study**

| Criteria | Indicators |
|---|---|
| Gender relations | • Position in household unit;<br>• Political representation;<br>• Involvement in decisions on development projects/programmes, asset ownership and decisions;<br>• Freedom of mobility;<br>• Access to market;<br>• Violence;<br>• Women's and men's contributions to production, reproduction, local resource management. |
| Energy interventions | • Access to end use of energy services;<br>• Focus of energy policies;<br>• Gender sensitivity of energy policies;<br>• Availability of energy tools for empowering;<br>• Partnership and gender inclusiveness in energy projects and programmes;<br>• Equity and equal opportunities in energy intervention. |
| Well-being | • Housing;<br>• Health and sanitary condition;<br>• Education;<br>• Patterns in human-energy use;<br>• Access to leisure and information. |
| Resource sustainability | • Biomass in village land use;<br>• Decision-making opportunities;<br>• Tenure and trends;<br>• Power of control;<br>• Technology/extraction;<br>• Market trends;<br>• Biomass demand and per capita energy use;<br>• Management and local authority;<br>• Nature and level of contacts;<br>• Policies. |

## 3.4 Methods used in this study

In conducting the field study in all three villages a combination of methods were used: Rapid Appraisal, field reconnaissance, questionnaires, analysis of secondary information (spatial maps), participatory methods and some mapping techniques. At the preparatory stage, and in implementing this study, the state agencies, primarily the Energy Conservation Fund of the Ministry of Power and Energy, NGOs, CBOs, and the private sector (Ceylon Tobacco Company) involved in facilitating/implementing both projects were consulted. With the objective of understanding the linkages between gender, modern biomass energy technology and poverty, an in-depth analysis was undertaken in all three areas using a household survey. Sixty households were randomly selected from Kumbalgamuwa where the dendro-plant feeding the national grid is established. An additional 150 households were selected from the peripheral areas with the potential to provide feedstock. In Wadagahakiwla, all 98 households covered by the project were interviewed. Sixty households were randomly selected in Hapuwala where no modern biomass-energy interventions had taken place, and the traditional system of biomass usage prevails. A detailed breakdown of the activities undertaken and the methodology adopted for securing the relevant information is given in Table 3.

**Table 3. Draft outline of methodologies for the proposed study**

| Goals | Activities | Methodologies |
|---|---|---|
| 1. Construction of profiles on livelihood and habitats. | Field reconnaissance and orientation of proposed study. | Rapid Rural Appraisal (RRA); Participatory Rural Appraisal (PRA). |
| 2. Information on energy access, use and services. | Field survey. | Discussions with line agencies, household/village survey. |
| 3. Information on activities related to biomass fuel and patterns of engagement. | Collection of gender - disaggregated data. | Activity profiles; Time allocation related to various activities; Questionnaire survey; Discussions; Interviews. |
| 4. Information on value of biomass and cost of technology. | Survey of market price of woodfuel in the area; Communication with project/private interventionists. | Measurement of biomass used by the households; Nature of technology. |
| 5. Information on long-term consequences perceived by the providers and end-users of biomass. | Collection of gender-disaggregated data. | Ethnographic records; Recording of life histories of women (a selected number). |
| 6. Information on gender-specific linkages, contacts with sources/using resources. | Gathering information to highlight patterns, and intensity of contacts. | Transect walks; Gender mapping; Participatory observation. |
| 7. Information on biomass resource distribution, ownership, tenure and control over biomass sources. | Gathering gender-disaggregated information. | Questionnaire survey; Field mapping; Transect walks; Discussions; Participatory observation. |
| 8. Information on demography, income, poverty, energy linkages. | Gender-disaggregated data on population, wealth, income, investable assets, decisions on energy use and technology. | Questionnaire survey; Discussions; Participatory self- assessments. |

| | | |
|---|---|---|
| 9. Information on interventions and their concerns and capacity to integrate gender. | Collect policy statements;<br>Conduct meetings with interventionists;<br>Examine their capacity to promote gender-integrated interventions. | Gender auditing. |
| 10. Identification of linkages to show linkages in gender, biomass fuel and poverty nexus. | Conduct field workshops. | Discussions;<br>Presenting preliminary findings using a model with linkages. |

One of the most useful methods was small group discussions, where men and women were given opportunities to interact, exchange views and come to a consensus on gender-specific dimensions pertaining to livelihood, local biomass resource management, their involvement in the project and benefit sharing. Data gathered through such group discussions were supplementary to the household survey.

# 4 Summary of findings

## 4.1 Dendro-energy development for the national grid in Kumbalgamuwa

### *4.1.1 Background of the Kumbalgamuwa Project*

The dendro-energy project in Kumbalgamuwa is a commercial enterprise established in 2004 for generating 7 GWh of electricity per annum for the national grid. It is located in the administrative division of Walapane Divisional Secretariat and set within environmentally fragile lands. The energy plant requires about 40 metric tonnes of biomass daily and it is expected to generate around 20 million Rupees annually for the rural economy. The technical investments are provided by the private sector, Lanka Transformers Limited, while the supply system including extension services is provided by the Ceylon Tobacco Company using the network of links that it has established over the last five decades in support of the tobacco business in this area. The dendro-energy project has been justified on a range of benefits including:

- Benefits to the energy sector – intended to generate 7 GWh/year for the national grid (one-thousandth of annual national demand);
- 400 farmer families gaining part-time employment;
- 400 ha. of energy plantations (3.2 million trees – *Gliricidia sepium*);
- Market for woody biomass: 12 000 tonnes of wood will be consumed in the power plant (Rs. 20 Million/year);
- 10 400 tonnes of foliage;
- Tree fodder for 2400 milk cows;
- Income from milk – 2.7 million litres/year (Rs. 48.6 million/year);
- 12 800 tonnes of dung as manure for farmlands;
- 7.8 million cubic metres of biogas (Rs. 20 million/year); and

The project has been justified as a way of catalysing the economy. Energy, according to the project's objectives, is integrated into land management, reforestation, afforestation, enhancing the agricultural economy, employment generation and income; and the sustainable management of soil and the dairy industry; and local livelihoods. From the perspectives of gender and poverty, these goals are of tremendous importance. The energy industry connects the land to local biomass production for improving the quality of life. The potentials to provide equal opportunities, and space for empowering women, through energy services and the land-based agricultural economy are immense.

The linkages between dendro-energy interventions, gender and poverty are emerging out of local socioeconomic conditions including livelihoods, the management of the energy sources including production and supply, and in relation to gender and the local context of poverty. The overall situation in the project area in Kumbalgamuwa and in the adjoining Grama Niladari Divisions (GND), which are the lowest/village level administrative divisions managed by a state officer in the hierarchical system, are favourable to dendro-energy interventions. The area has the potential to provide the wood feedstock, from the *Gliricidia sepium* tree, with the potential to expand production. This study covers the project site – Kumbalgamuwa, where the dendro-plant is located, plus six neighbouring GNDs which are expected to benefit through supplying feedstock. These are based around the neighbouring villages of Naranthalawa, Kumbalgamuwa-East, Mulhalkela, Deliwala-North, Deliwala-South and Tennehenwala. This area started to grow tobacco in the 1960s leading to one major transition: replacing traditional subsistence farming and chenas (slash and burn agriculture) with commercial farming. With the withdrawal of tobacco in 1990s, the degraded lands were often abandoned while some lands have been returned to subsistence farming. The area has earned national recognition through the establishment of the dendro-energy project for producing

electricity for the national grid. It has already established inter-regional linkages through the woodfuel trade to provide biomass for energy generation.

### *4.1.2 The socioeconomic profile of the area*

The seven GNDs include a total of 23 hamlets with 1292 family units and 5445 people. 14% of the households are women-headed units (see Table 4 for details). Only 541 of the 1165 households (46%) in the whole area have water-sealed toilets, and only 126 have pipe-borne water services (see Table 5). The key features in the overall picture indicate: 1) the exclusively rural nature of the area; 2) the dependence on land and agriculture; 3) the lack of permanent and regular sources of income; 4) the heavy dependence on seasonal employment; 5) grid electricity in every village; 6) a heavy dependence on woodfuel for cooking; and 7) inequalities in housing, accessing to safe drinking water and sanitary facilities. Thirty-six percent of the available labour is agricultural, when seasonal agricultural occupations are included this rises to about 70% (see Table 6).

**Table 4. Demographic characteristics of the study area**

| GN Division | Vill-ages | House-holds | Ext'ded units | Pop. | Fe-male | Male | Population by age group | | | | Women-headed HH. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 0-5 | 6-14 | 15-60 | >60 | |
| Kumbalgamuwa | 6 | 397 | 15 | 1978 | 1021 | 957 | 198 | 343 | 1264 | 173 | 52 |
| Naranthalawa | 4 | 86 | 18 | 453 | 232 | 221 | 52 | 97 | 281 | 23 | 7 |
| Kumb'wa-East | 2 | 169 | 28 | 763 | 389 | 374 | 51 | 137 | 517 | 62 | 45 |
| Mulhalkele | 4 | 132 | 41 | 698 | 365 | 333 | 209 | 111 | 302 | 76 | 23 |
| Tennehenwela | 4 | 140 | 0 | 525 | 271 | 254 | 62 | 60 | 380 | 23 | 12 |
| Deliwala-North | 1 | 122 | 25 | 525 | 250 | 275 | 45 | 83 | 345 | 52 | 26 |
| Deliwala-South | 2 | 119 | 0 | 503 | 252 | 251 | 60 | 85 | 282 | 72 | 3 |
| Total | **23** | **1165** | **127** | **5445** | **2780** | **2665** | **677** | **916** | **3371** | **481** | **168** |

**Table 5. Housing and basic facilities**

| GN Division | **Housing** | | | | **Water** | | | | | **Toilet** | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Own | Rent | Temp. | Family units | HH | Own pipe | Comn pipe | Own well | Comn. well | Other | Water shield | Pit | None |
| Kumbalgamuwa | 377 | 1 | 34 | 412 | 397 | 10 | 130 | 12 | 153 | 92 | 96 | 286 | 15 |
| Naranthalawa | 89 | 0 | 15 | 104 | 86 | 22 | 63 | 1 | 0 | 0 | 10 | 50 | 26 |
| Kumb'wa-East | 169 | 2 | 26 | 197 | 169 | 38 | 105 | 5 | 3 | 18 | 151 | 7 | 11 |
| Mulhalkele | 132 | 0 | 41 | 173 | 132 | 26 | 75 | 2 | 0 | 29 | 85 | 47 | 00 |
| Tennehenwela | 140 | 0 | 0 | 140 | 140 | 17 | 9 | 2 | 1 | 111 | 90 | 38 | 12 |
| Deliwala-North | 117 | 2 | 28 | 147 | 122 | 13 | 52 | 3 | 21 | 33 | 69 | 34 | 19 |
| Deliwala-South | 119 | 0 | 0 | 11 | 119 | 0 | 5 | 0 | 0 | 114 | 40 | 45 | 34 |
| Total | | | | **1292** | **1165** | **126** | **439** | **25** | **178** | **397** | **541** | **507** | **117** |

In the villages, multiple energy sources are used. The most widely used is fuelwood, almost universally used for at least cooking. 51% of the households have grid electricity and the other 49% use kerosene for household lighting. Variations among these villages regarding electricity use are quite marked (see Table 7). Out of the total of 569 non-electrified households, 38% do not have access to grid supply, and 62% do not have the capital needed to get a connection. More than 80% of the houses in the most remote hamlets such as Nranthalawa, Deliwala North and South are non-electrified. When it comes to cooking energy, 96% use only biomass while 4% use LPG. Electricity is mainly used to provide lighting, and in addition households use electricity for electrical appliances such as televisions, radios and irons.

**Table 6. Key features related to employment**

| GN Division | Labour force | | | | | Total | Unempl-oyment | No of HH selected for in-depth study |
|---|---|---|---|---|---|---|---|---|
| | Permanent | Self | Foreign | Sea-sonal | Total in Agricul. | | | |
| Kumbalgamuwa | 49 | 9 | 5 | 239 | 246 | 302 | 57 | 60 |
| Naranthalawa | 6 | 4 | 1 | 220 | 221 | 231 | 25 | 20 |
| Kumbalgamuwa-East | 38 | 69 | 12 | 196 | 252 | 315 | 198 | 15 |
| Mulhalkele | 26 | 16 | 4 | 170 | 181 | 216 | 86 | 40 |
| Tennehenwela | 39 | 9 | 6 | 226 | 231 | 280 | 18 | 25 |
| Deliwala-North | 24 | 34 | 6 | 13 | 28 | 77 | 126 | 30 |
| Deliwala-South | 12 | 20 | 0 | 60 | 72 | 92 | 27 | 25 |
| Total | 194 | 161 | 34 | 1124 | 1231 | 1513 | 537 | 215 |

**Table 7. Household energy use in the GN Division**

| GN Division | Electricity | | | Cooking | | | | Σ family |
|---|---|---|---|---|---|---|---|---|
| | With | Without | HH | Wood | Elec. | LPG | Biogas | |
| Kumbalgamuwa | 272 | 125 (31%) | 397 | 412 | 0 | 0 | 0 | 412 |
| Naranthalawa | 8 | 78 (91%) | 86 | 102 | 0 | 2 | 0 | 104 |
| Kumbalgamuwa-East | 164 | 5 (3%) | 169 | 195 | 0 | 2 | 0 | 197 |
| Mulhalkele | 52 | 80 (61%) | 132 | 149 | 10 | 14 | 0 | 173 |
| Tennehenwela | 67 | 73 (51%) | 140 | 120 | 8 | 12 | 0 | 140 |
| Deliwala-North | 22 | 100 (82%) | 122 | 145 | 0 | 2 | 0 | 147 |
| Deliwala-South | 11 | 108 (91%) | 119 | 119 | 0 | 0 | 0 | 119 |
| Total | 596 | 569 (49%) | 1165 | 1242 | 18 | 32 | 0 | 1292 |

### *4.1.3 The features of the surveyed households*

The field research investigation covered a sample of 215 households with a total population of 989. The study revealed that every household has a plot of land adjoining the house used for perennial mixed vegetable cultivation. In around 94% of cases, men legally own the land; while in about 6% cases women legally own the land. In terms of educational enrolment the gap between men and women is narrow, and in fact more women have had secondary level education (see Table 8). Women are less engaged in permanent employment and are concentrated within agriculture (Table 9). Agriculture is the source of living for 70% of women and 50% of men, and 53% of overall income comes from agriculture. From the perspectives of the dendro-energy project, two aspects are important. The first is women's strong contact with the land through the farming upon which their family livelihood is based. The second is their involvement in farming from which more than half of household income is derived. Farming is a family-based affair, and the investments made for the returns are fully recorded.

**Table 8. Educational achievements by gender**

| Description | Female (%) | Male (%) |
|---|---|---|
| Population (total 989) | 51.4 | 48.6 |
| Illiteracy (above 10 years) | 8.0 | 7.0 |
| Education – only primary | 22.8 | 28.3 |
| Education – secondary | 27.6 | 21.5 |
| Education – secondary with GCEs (O or A levels) | 41.6 | 40.7 |
| Higher education | 0 | 2.5 |

Source: Household survey.

Nearly 65% of the households had less than half an acre of land; 27% between one-half and two acres of land, and 8% more than two acres of land. Farming tends to be carried out on two units of land. All 215 households have seasonal crops integrated in their perennial mixed homegardens.

Sixty-eight percent of households cultivate paddy during the rainy season in waterlogged terraced fields located in the lower valleys, with vegetables as a second crop during the dry season. Further space is allocated for cultivating vegetable and cash crops in sparse tree stands. *Gliricidia* occupies a prominent place, dominating the fences and hedges which demarcate the individual family plots. In the interior, it is also grown as a support for the pepper vine. The homegardens are labour-intensive cultivation units, managed mostly by women, and are rich in diversity. They provide space for producing food for the family pot, wood for domestic energy and also some excess vegetables and tree produce for the market. Women's links with the paddy plots are less regular and more distant.

**Table 9. Source of employment by gender**

| Description | Female (%) | Male (%) |
|---|---|---|
| Farming/agriculture (own, rent-in) | 70 | 50 |
| Non-agricultural labour | 2 | 8 |
| Permanent employment | 4 | 12 |
| Self-employed (trade etc.) | 3 | 13 |
| Unemployed | 21 | 17 |

Source: Field survey

Women are involved in specific labour-intensive tasks such as transplanting, weeding and harvesting. Demand for women's labour for producing the second crop of vegetables is extremely high since this mainly takes place during the relatively dry season – the 'Yala' – when watering is also needed. Rotational cultivation of vegetables (carrot, beans, beetroot, cabbages etc.) requires regular manual work and demands more of women's labour. Producing several varieties of crops from the high fields and marketable goods for cash from lowland farms is seen as crucial. Managing homegardens while allocating time for paddy work and vegetable cultivation comes on top of women's daily domestic chores.

The income profiles of the surveyed households shows that the typical monthly income is in the range of 3000-7000 Rupees (30-70 US$) per month (see Table 10). Divided by the average family size of 4.5 people, it can be seen that the per capita monthly income is generally in the range of 660– 1550 Rupees (6.6 – 15.5 US$ per person per month). These low incomes have resulted in many families receiving state subsidies. Nearly 38.7% of the households receive subsidies; 46% of them between 151 and 250 Rupees, and 54% between 251 and 500 Rupees, per month. These subsidies are a supplementary source of income for purchasing essential food items.

**Table 10. Income profile (monthly in rupees)**

| Category | % of families |
|---|---|
| < 3000 | 20.2 |
| 3001 – 7000 | 48.4 |
| 7001 – 11000 | 20.4 |
| > 11001 | 11.0 |

The lifestyle in these villages is complex and rural. Key features are the land-based nature, irregular sources of income, reliance on subsistence work and poor access to services. Ninety percent have their own dwellings of which 71% are owned by the husband. Eighteen percent of the wells are located in land owned by the wife and 11% are on outside land. Twenty-two percent of the houses are of poor construction without permanent walls and without either a permanent roof or a permanent floor. Seventy-three percent of the households covered in the survey use water-sealed toilets and 27% have pit toilets. Two types of drinking water sources are used: 57% have piped water including 37% who use gravity-fed water from springs at high elevations. Forty-three percent use dug-wells. The use of electricity for providing domestic services is insignificant. In 94% of

households, water is lifted from dug wells manually, mostly by women, for cooking, washing and sanitary purposes.

### *4.1.4 Energy profile and associated features*

In this mosaic of villages the energy system is associated with two dominant uses. First and foremost it is used for cooking, and secondly for lighting. Communal or shared services using energy include transportation, health, education and communication. Energy use for household appliances varies from one household to another. Out of the surveyed households, nearly 60% have televisions using grid electricity or batteries, and 86% have a radio. Seventy percent of households have motorcycles so they also have links with the fossil fuel system. Solar power is used by three households for lighting, and 15 households use biogas for cooking.

All non-biomass energy sources are an additional cost for the family budget. Twenty-nine percent of households keep the cost of lighting below Rs. 100 per month by relying on one or two kerosene lamps and using them for less than three hours a day. Thirty-nine percent have fuel costs in the range of Rs. 100-200, 16% in the range of Rs. 210-500, and 17% pay more than Rs. 500 per month. Those in the highest category use motorcycles and electricity, so the cost is primarily for fossil fuel used in transportation and for lighting. The energy consumption profile shows a mix of sources. Table 11 shows that this is dominated by energy used for cooking and lighting, and that there are gender-specific patterns in responsibilities.

**Table 11. Energy use by households and responsibility of men and women**

| Energy type | Cooking | Lighting | Production | Transportation/ travel | Responsibility | |
|---|---|---|---|---|---|---|
| | | | | | Women | Men |
| Woodfuel | 100 | 0 | 0 | 0 | 90 | 10 |
| Biogas | 15 | 0 | 0 | 0 | 16 | 84 |
| Kerosene | 0 | 37 | 0 | 0 | 88 | 12 |
| Electricity | 3 | 60 | 1(welding) | 0 | 36 | 64 |
| Solar | 0 | 2 | 0 | 0 | 0 | 100 |
| Diesel | 0 | 1 | 0 | 17 | 0 | 100 |

Responsibility for household energy is shared out between men and women. Women are primarily responsible for biomass (woodfuel) and kerosene and to a lesser also for electricity. Men are primarily responsible for solar panels, diesel and also for biogas and grid electricity. Cooking energy is generated through the direct combustion of wood plus a significant portion of residues. This is to meet a recurring need for cooking two/three meals a day. The average per capita consumption per day of biomass is about 1.3-1.8 kilograms. Of this, 20% is residues – mainly coconut fronds, shells, stalks and husks. Approximately 72% of the woodfuel comes from fences and hedges and from trees in the homegardens, while the rest comes from various sources including riparian reserves, forests and trees on non-household lands.

The combustion technology used is traditional, and hearths are used for direct heat generation. Hearth types vary: 21% use three-stone hearths and 60% semi-circular hearths prepared by women; further, 42% do use improved stoves. All the households used two types of hearths. One group used three- stone hearths and semi-circular hearths; the rest used improved stoves with either semi-circular or three-stone hearths. The daily choice depended upon cooking needs – the amount to be cooked, the type of food and the preferred preparations of meals. Seventy-nine percent of the households had a kitchen attached to the main house, 8% had kitchens detached from the main house but linked through a corridor, and 14% completely separate kitchens. Sixty-seven percent of the kitchen hearths have chimneys. Most of the hearths (73%) are installed on elevated tables with the rest on the floor. Sixty-four percent of families cook three meals a day, 34% two meals and 2%

only one. The time spent cooking varies remarkably. On average 2-3 hours are spent each day by 45% of the households and 4-5 hours by 55%. The type of food, variety of rice, number of dishes cooked and also the number involved in cooking influences the time spent on preparing a meal.

Biomass consumption/combustion for cooking is very much a gendered activity (see Table 12). Women provide the human energy inputs for cooking and, when others in the families are involved, they assist rather than take the full brunt of the responsibility. The situation with regard to the supply of woodfuel is somewhat similar, with the wife being solely responsible in 74% of households and partially in most of the rest.

**Table 12. Responsibilities for combustion and gathering**

| Human energy sources | Cooking<br>% households | Fuel Collection<br>% households |
|---|---|---|
| Wife alone | 76 | 74 |
| Wife with some help from husband | 14 | 8 |
| Wife with some help from daughter | 8 | 11 |
| Wife with all others in family | 2 | 0 |
| Hired labour | 0 | 7 |

Village schools, health service centres, community function halls and temples have electricity for lighting. Thirty-two percent of the households are between 0.5 and 1.8 kilometres from roads with public transport services. Service delivery to remote areas is a rarity. The supply of electricity to remote areas is seen as difficult due to high capital costs. Although villages are linked to the national grid, poor households cannot afford to pay for services/connections.

### *4.1.5 The project and the villagers' involvement*

The dendro-energy project in the village mosaics that are spatially connected with each other is specific and it is linked up with the villages through the feedstock supply system - the supply of *Gliricidia* for the energy plant, and through the involvement of people as producers, supply agents, collectors, labourers, transporters and processors. Since the energy is generated for the national grid, rather than for community use, it is seen to be at a distance from village life. The benefits of the dendro-energy project are primarily confined to the villagers who are involved in the supply chain, which is organised and managed by the field officers of the Ceylon Tobacco Company (CTC) who are responsible for organising the supply of *Gliricidia* chips. Locals are involved as producers and have limited opportunities in organising supply, and in being involved in processing, collection and delivery. Registered agents/suppliers bear the responsibility for providing chips to the plant through the CTC. Nearly 60 agents or intermediaries are involved covering about 288 villages. Supply comes from a vast area, extending a distance of about 60 kilometres. The CTC is heavily involved in organising production, collection, processing and delivery; and sub-regions are identified and under the supervision of field officers. Given the wide catchment area, the economic benefits are not confined to the villages covered in this study.

The electricity generation system is completely new in terms of technology. The men and women, especially those who were interviewed in this research, perceive it very differently. Villagers are involved in the supply chain, and work as paid workers, and also in organising production, processing and supply. The greatest involvement had been during the collection of baseline information for uncovering the existing potential to supply and the future potentials to grow *Gliricidia*. This collection of basic data has enabled the project planners to prepare a full profile of feedstock supply and note the local concerns, energy needs and gender-related issues. People have organised several protests on environmental grounds, primarily against the noise, water pollution

and air pollution. The women have been involved in the protest. For nearly 68% of the households it is an unwanted intervention, lodged in their area for externally defined reasons.

Only 40 households have agreed to organise production from local sources, and they are mainly stimulated by subsidies. Since local supply is inadequate, the project has been implemented by obtaining feedstock from distant places where either *Gliricidia* is widely available or a supply system has been established with the help of collectors and supply agents.

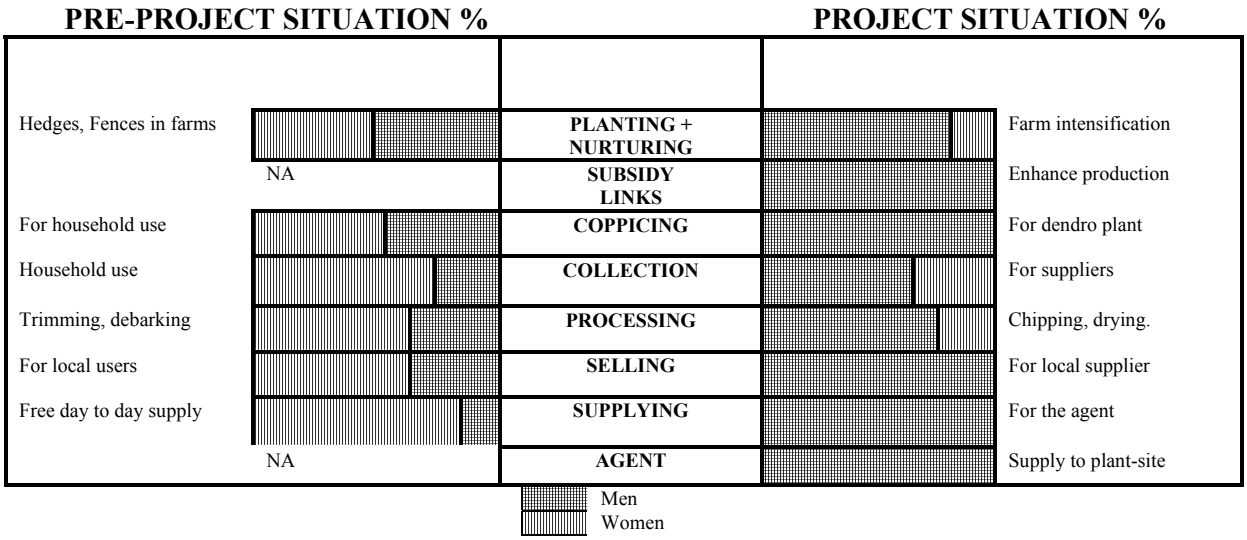
The project uses men as the focal contact points and this has been influenced by the land ownership situation and the desire of the project to involve landowners as legitimate decision-makers. Men thus become eligible to receive technology and subsidies. All the paid employment opportunities are grasped by men. They fill the newly-created roles as suppliers, supply agents and also as technical operators of the chopping machines where *Gliricidia* branches of around 5 cm girth are cut into 10 cm long pieces for the feeder. Women assist by feeding the sticks to the machines. The project consumes around 40 cubic metres of *Gliricidia* per day. Local labour is involved in coppicing, carrying, processing, packing through registered agents who have capital to invest and their own or hired transportation. Local involvement is limited to the supply of feedstock and organising the supply.

In Kumbalgamuwa, the project only involves locals in the supply chain. Women are not employed in the energy plant, and are not involved in organising supply and processing chips (using chipping machines). Technical knowledge on soil conservation, compost preparation and enrichment planting for intensification is given to men. Wood is obtained through selective coppicing. The relatively large farms, usually over an acre, provide around 2000-3000 kg per month foe which they receive Rs. 2800-4200 per month. The poor with small farmlands have no production capacity to offer. To the project, opportunities are open to anyone, and so there is no gender bias. The policy is to allow anyone who can provide feedstock within the recommended specifications to link up with local suppliers. The local supplier gets around one rupee per delivered kilogram. Women being landless farm workers are effectively excluded, and where families do provide *Gliricidia* chips to the supply agents they work as free labour helping men to process/prepare the chips to meet the specifications. Men, as the household heads and landowners, decide when and what is to be harvested, and to whom the stocks should go. New tasks added to women's work schedules are the collection of the leftovers – the pieces that do not meet the specifications - and collecting the discarded foliage for manure or compost preparation.

### *4.1.6 The impacts of the project*

The direct impacts of the dendro-energy project are associated with the operational system, production and supply in particular. Changes have occurred with farmed biomass entering the market and in the producers' involvement. The resource mapping and the discussions held with 26 groups show its impact on men's and women's activities and tasks in biomass supply (see Figure 3). Women's involvement has been reduced. Their involvement could be reinstated as a potential opportunity to enhance production in the area and for their economic advancement. The second feature is that, in a project situation, supply and commercial use is sustained using subsidies, cash remunerations and also intermediaries. The women – the end users or the tradition energy service providers - are not visible. The men, who irregularly attended to about 20% of the biomass-related tasks in the pre-project situation, have gained 94% of the new opportunities in the project. The first reason for this is that *Gliricidia,* produced on their lands, has been diverted to the dendro-plant through a formally organised chain. The second is that the project approach allows landowners and capital investors to be part of the supply chain. Only the small twigs and leftovers of *Gliricidia* are now available for household use by women, and the better quality sticks are diverted to the dendro plant.

**Figure 3. Changes in men's and women's responsibility by task in producing and supplying G*liricidia***




Women are not stimulated to be involved in the project. Nineteen reasons were noted regarding their low involvement and concerns (see Table 13).

**Table 13. Women's reasons for their insignificant involvement in dendro-energy development**

| Reason | No. reported as a reason | Rank |
|---|---|---|
| It does not provide benefits/solution to family and community energy needs | 198 | 1 |
| Project does not offer answers to poverty or reducing poverty | 196 | 2 |
| Preference for having farm woodfuel for household use | 194 | 3 |
| Neglect of women's concerns by men – landowners | 192 | 4 |
| It is designed to provide profit for companies and the rich | 191 | 5 |
| Reluctance to divert their resources | 190 | 6 |
| Reluctant to grow woodfuel as a cash crop | 190 | 6 |
| Lack of economic benefits for women | 190 | 6 |
| Reluctance to lose food producing space | 184 | 9 |
| Income and employment opportunities are insignificant | 182 | 10 |
| Lack of trust in CTC and private company | 176 | 11 |
| Preference of having farm space for food production | 164 | 12 |
| Lack of organisations for women to link-up | 163 | 13 |
| Land scarcity | 162 | 14 |
| Reluctance to lose women's control over land | 158 | 15 |
| Lack of contacts with private sector/agency | 148 | 16 |
| Lack of common/own land for growing *Gliricidia* | 146 | 17 |
| Lack of capital to enter supply chain | 136 | 18 |
| Poor technological knowledge | 120 | 19 |

(Ranking of reasons by number reporting)

The most common reasons that women raised were that the project did not provide solutions to local energy needs and to poverty. Women see the commercial use of *Gliricidia* for the energy plant as taking their resources away from them, and using up space that could be used for food production. The links mediating through the *Gliricidia* supply chain, between farm and energy plant, is not an energy link: it is a commercial link between producer and an intermediary/supply agent. The cash returns that could possibly come back to a farm household are not a guarantee of

better energy options or alternatives. Cash returns are inadequate to increase the capacity of a family to meet the multiple needs met by women in the pre-project situation.

## 4.2 Off-grid dendro-energy development project in Wadagahakiwla

### *4.2.1 Project background and policy imperatives*

The community-level dendro-energy project in Wadagahakiwla was established in 2004. It is a pilot project for off-grid dendro-energy development. The project has been supported by a pre-feasibility study carried out in Wadagahakiwla. The project supports the state policy on decentralisation and the promotion of grassroots partnerships in energy development. The replenishability, renewability, feasibility and environmental friendliness of this indigenous biomass source of energy make it a promising solution to meeting energy needs and helping to solve the energy crisis. Off-grid energy development is acceptable to the local community and a way of meeting rural electricity needs with relatively low capital investments.

The project promotes a private-public-civil society partnership in developing off-grid technology for rural electrification. Energy Forum, an NGO, has completed the installation of the dendro power plant. This is the pilot project introduced at community level and it is expected to provide around 250 W of electricity to each of one hundred households.

### *4.2.2 Geographical setting*

Wadagahakiwla is a traditional village where the lifestyle of the people is associated with generation-long practices and experiences. It is placed under the Karandagama Grama Niladari Division of the Badalkumbura Divisional Secretariat within Moneragala District. Land is the primary source of livelihoods. Rubber is produced as a plantation crop; peppers grow using the *Gliricidia* as a support, primarily in the homegarden mosaics linking individual gardens; paddy is worked in the narrow waterlogged valleys and sugar cane is grown in isolated patches. The most prominent land use is the perennial mixed homegardens with trees, shrubs and seasonal crops. Out of the total land area, around 40% of the land has mixed use, monoculture crops such as rubber and sugarcane cover about 28%, and around 6% is under paddy. The village also has a substantial area under forest, mostly secondary woodlands in abandoned chenas. The legal ownership or the deeds to most of these cultivated lands is still to be obtained from the state. The land under dense forests and chenas add to the spatial diversity indicating the availability of multiple land-based livelihood options which also enrich the biomass energy system. In the area within the Kkarandagama Grama Niladari Division, there are 760 acres of agricultural land, of which 734 acres consist of 223 agricultural holdings over two acres, 20 holdings between one and two acres, and just three less than one acre. This overall pattern is well represented by the 98 households selected for the survey.
The livelihoods of most people have been subjected to several trends affecting the sources of income, resources and energy sources.

Prior to 1970s - Dense forest cover was reduced due to encroachments into the forest for 'chena' cultivation.

During 1980s – Waves of interest and economic pressure motivated people, convincing them of the potential to grow sugar cane in this area. Isolated patches of land were converted to sugar cane and biofuel has been used as a energy source for household-based crystal sugar production. With the opening of a gravel road, sugar cane produced in the village has been transported to the sugar factory in Palawaththa about 45 km away.

During 1990s – The State's land regularisation policy gave farmers ownership authority of the encroached lands. With this regularisation, integration of perennial crops has widely occurred. Growing multipurpose trees and peppers up

*Gliricidia* on a wide scale had a tremendous impact, promoting stable green cover and also cash-crop-based homegardens in the area. The demarcation of individual family held land with hedges and living fences has created more enthusiasm to develop land for the family livelihood. With this, the collective responsibility and reciprocity that evolved in relation to chena cultivation in forests has fragmented.

Recent trends – One recent trend is a move away from sugar cane cultivation to rubber, and further intensification of homegardens with *Gliricidia* supporting pepper.

### *4.2.3 Living conditions of the surveyed households*

The total survey population of the 98 households was 472 people of whom 51.1% were female. The literacy rate was extremely high, with only 6% being illiterate and those all among the elderly. There is a public transport service providing access to the village, although it is reported to be unreliable and irregular. Village access brings several advantages in terms of connecting/accessing better postal, health and educational services located elsewhere. The remoteness of this village is mainly due it being six kilometres from a major road, and public transport to the village is limited to twice a day. This makes it difficult to work outside the village and hinders the transportation of goods and services. The remoteness is also reflected by the lack of electricity: the national grid service has not been extended to this village. Water scarcity is a serious problem from July to October due to the prolonged dry spells.

62% of the houses are permanent structures; 42% have water-sealed toilets and others use toilet pits. Villagers live in harsh conditions, with very few outside labour options and poor linkages with market outlets. This isolation has influenced the villagers to make a living using the resources of their village ecosystem. The growing of food crops for subsistence on family land and in chenas located outside the village; cash crops – primarily non-perishable ones - in homegardens and farms; tree crops and the collection of forest produce including seasonally available non-timber products and wood for fuel are crucial for their living. Their dependence on local resources is thus very strong. The land provides all their sources of living, and 82% of households have more than two acres, with the rest at least one. Forty-eight percent use either natural springs or river water for drinking and other purposes, only 30% have their own dug-wells, and 22% of households had gravity-fed water supplied through a tap. There is no non-farm employment available. The irregularity and fluctuations in family income directly contribute to poverty and therefore the majority of the households benefit from a state subsidy scheme – the "Samurdhi". Subsidies are received by about 68% of the households: 20% receive Rs. 600, 25% receive Rs. 340 and 21% receive Rs. 140 per month. Seventy-two percent of the households reported having a total income of less than Rs. 3000 per month.

### *4.2.4 Energy supply and use*

The energy services used in Wadagahakiwla are for cooking, lighting and transportation. All the 98 households surveyed are members of the Wadagahakiwla Dendro Power Electricity Consumer Society (WDPECS) formed to facilitate the off-grid community-level dendro project. By the time that this household survey was started (5$^{th}$ November, 2004), thirty households had an electricity service linked to the dendro plant. Another 41 were ready for getting electricity connections and had completed the necessary wiring. The remaining were working on establishing service lines to their individual premises. Electricity was reported to be a welcome innovation, and it has made a tremendous impact on the attitudes towards energy technology, as well as on the potential use of woodfuel. The dendro-energy plant, being designed to run on *Gliricidia sepium* - the species known locally as 'Nanchi', is considered to be a means for making a transition in village energy use. Prior to the dendro-energy project, four households had solar panels installed for lighting but they also

had to use kerosene lamps to meet additional requirements. The others all use kerosene for household lighting. Lighting was considered by the villagers as quite expensive, costing about 120-130 Rupees a month depending on the number of lamps used and their duration.

The village households use energy for a range of purposes, but not for productive work. The most widely use fuel is biomass in the form of woodfuel that is used by every household in cooking (see Table 14).

**Table 14. Energy use in the villages (pre-project situation)**

| Energy type | Items | Service | % of households |
|---|---|---|---|
| Kerosene | Lamps | Lighting | 96 |
| Solar panels | Lamps | Lighting | 4 |
| Diesel | Motorcycle | Travelling | 3 |
| Battery | Radio | Leisure/information | 88 |
| Battery | Television | Leisure/information | 76 |
| Biomass | Hearths | Cooking | 100 |
| Charcoal | Iron | Ironing | 64 |

### *4.2.5 Biomass energy system in Wadagahakiwla*

In Wadagahakiwla, wood with a high calorific value from the village forests is widely used in domestic cooking. Women play the key role in every household by collecting the woodfuel, maintaining an outside woodshed for storing woodfuel, converting the wood into cooking energy through combustion, as well as in cleaning the ash and soot etc. This is the traditional system fully controlled by women in their daily lives. Their position in the system has evolved socially and is defined on gender terms. The women themselves felt that it was their responsibility to ensure the supply of woodfuel to generate the most crucial energy service for family wellbeing. Per capita woodfuel consumption is rather high at 1.7 – 2.1 kg per day. Women enjoy the advantages of having forest wood for domestic cooking from the village forest and shrub lands. Forest wood was reported as being efficient in keeping a hearth alight for the whole day. The forest provides 42-63% of the woodfuel consumed by households. The rest is obtained from chenas during clearing, homegardens, farmlands, fences and hedges, and some from riparian vegetation systems. The supply is marked by its multiple sources, with forests and shrub lands providing high quality wood accounting for the largest share.

Forty-eight percent of households have their kitchens separated from the main house, 42% have attached kitchens, and 10% use semi-permanent sheds for daily cooking. Fifty percent use three-stone hearths, 30% semi-circular mud hearths constructed by women, and 20% use both types. Seventy-eight percent of the kitchens have no chimneys and hearths fixed on the floor. Reasons given for using three-stone hearths were that these allow unsplit and long branches to be used. Since woodfuel supply is not a problem, there is no felt need for women to use hearths that would reduce consumption. This also explains why hearths are fixed on the floor, and detached kitchens without chimneys are used.

### *4.2.6 The implementation of the project*

The project has been implemented in partnership with the community, with the Energy Forum retaining technical responsibilities; and with the responsibilities for feedstock and labour supply, and also for service delivery, given to the WDPECS - a 98-member society. The dendro plant and the materials for the service lines were provided by the Energy Forum. All manual labour needs are met by the WDPECS. Each household has paid Rs. 500 to be a member, made up of a Rs. 250 entry fee and a Rs. 250 membership fee. Each household is obliged to contribute family labour on a self-help basis to at least 25 project-related works. This is mostly required for establishing the service

lines and maintaining them on a reciprocal basis. Households have each provided 250 kg of Nanchi wood to initiate energy generation. In emergency situations, the society shares the labour of chipping wood sticks to feed the boiler. Electricity is provided roughly for four hours per day, from 6-10 p.m. The average feedstock requirement is about 40-60 kg per hour, and every household has agreed to supply at least 60 kg of wood per month. The standard payment agreed upon by the transporters for a cubic metre of wood is Rs. 200 and the selling price to the dendro plant is Rs. 375. Transportation is handled by a truck owner identified by the society and the balance of Rs. 175 is the cost of transportation and his profit.

Officers of the society are elected by its membeRs. A 19-member committee has been formed, and each committee member oversees a cluster of five or six houses that receive the dendro-energy service. Any household with land is eligible for membership, and so every household in the village has the opportunity. No special provisions are made on gender terms and so it is gender neutral. The members of the society contribute labour for various self-help 'sharmadana' activities. Usage is not yet metered and the charge for each unit of electricity is yet to be decided but will be related to the operational cost.

### *4.2.7 Project impacts*

This community-level off-grid energy supply project is a challenging experience for the state agency, for Energy Forum and for the village community. It is designed to provide grid-independent electricity for the households in the WDPECS. The associated impacts include:

- Building of social capital through a community level focal point;
- Building a partnership between an NGO – the interventionist - and the community focal point;
- Raising awareness so as to undertake full management responsibilities within two years or so;
- Equal opportunities for the village households – the consumer units get access to electricity through the society;
- Local authority over the supply chain;
- Economic benefits to the families from providing feedstock;
- Improved living standards for the families;
- Increasing local capacity by providing enabling conditions; and
- Improving the environmental conditions by promoting cash-crop integrated woodfuel planting in association with the modern biomass energy enterprise.

The project has involved the local community to a great extent in its design, primarily in assessing their energy needs, their potential to provide feedstock – *Gliricidia* for the plant, in forming a community level organisation and also in selecting a site for the dendro plant. The project, as a community level intervention, has multiple impacts on and implications for the community and individual households. Gender-specific goals have not been incorporated either in relation to energy needs and use or in terms of the need to elevate women's status on the grounds of equity and equal opportunities. This research has examined the gender-specific implications in the villagers' responses (see Table 15).

## Table 15. Perceived gender-specific impacts/implications of the project

| Aspect/category | Nature of benefit | Affirmative responses (%) | |
|---|---|---|---|
| | | Men | Women |
| Energy services | **Lighting** – (from 6-10 in the evening) | | |
| | • Increased efficiency in attending to domestic chores | 21 | 96 |
| | • Reduced risks from using kerosene lamps | 100 | 100 |
| | • Enhanced mobility inside the house | 100 | 100 |
| | • Psychological relaxation | 39 | 88 |
| | • Stimulating children for education | 100 | 100 |
| | • Reading/learning opportunities | 82 | 61 |
| | • Social interactions/work | 86 | 41 |
| | • Attending to production work (mat weaving etc.) | 0 | 2 |
| | • Reduce pressure on domestic chores | 42 | 91 |
| | **Accessing Media** | | |
| | • Receiving information/news | 63 | 63 |
| | • Leisure | 78 | 56 |
| | **Household electrical appliances** | | |
| | • Ironing | 31 | 82 |
| | • Boiling water | 4 | 4 |
| | **Cooking** | | |
| | • Increased pressure on women's resources | 0 | 12 |
| | • Provisions for using electricity in cooking | 0 | 0 |
| | • Enhanced efficiency | 6 | 62 |
| Social | **Building social capital/leadership** | | |
| | • Community level organisation for common goals | 100 | 100 |
| | • Equal opportunities for men and women | 82 | 31 |
| | • Building reciprocity | 100 | 100 |
| | • Building managerial skills | 80 | 60 |
| | • Equal opportunities for the villagers for improving quality of life | 42 | 30 |
| | • Leadership opportunities (officers) | 66 | 33 |
| | • Membership of energy focused organisation | 91 | 09 |
| | • Organising production as suppliers | 100 | 81 |
| | • Organising transportation | 8 | 0 |
| | • Building cohesiveness | 72 | 92 |
| | • Technological know-how | 26 | 0 |
| | **Empowerment** | | |
| | • Cash returns for family | 82 | 82 |
| | • Equal opportunities for the households | 100 | 100 |
| | • Democracy in leadership and decision-taking | 42 | 63 |
| | • Equal opportunities for men and women | 60 | 20 |
| | • Recognising community decisions | 74 | 85 |
| | • Building competence | 64 | 98 |
| | **Economic benefits** | | |
| | • Getting value for farm/household produce (Nanchi) | 100 | 100 |
| | • Employment opportunities | 10 | 0 |
| | • Potential for starting village/home-based industries | 60 | 20 |
| | • Farm intensification by growing more Nanchi | 44 | 30 |
| | • Farm intensification by adding pepper vine | 56 | 60 |
| | • Eliminating expenditure on Kerosene | 53 | 64 |
| | • Getting income from Nanchi to cover energy costs | 100 | 100 |
| | • More diversity in income earning | 86 | 86 |
| Environmental | • Smell-free household | 100 | 100 |
| | • Avoiding kerosene smoke in household environment | 100 | 100 |
| | • Enhanced perennial vegetal cover | 63 | 80 |
| | • Potentials to enrich soil | 90 | 90 |
| | • Potentials to conserve water and reduce water scarcity | 72 | 60 |
| | • Reducing soil erosion | 96 | 93 |

The project's primary objective of providing off-grid electricity for lighting seems to be well accepted by the households. No mention was made regarding the most crucial and widely used energy service, namely cooking. The perceived implications are limited to the non-cooking sphere. This leads to the question as to whether cooking energy is always neglected in rural off-grid technology and modern biomass energy development. The next question that arises is whether women's energy needs and the drudgery of work related to the combustion of wood are completely ignored as 'no body's business'?

Quite clearly, three aspects: cooking energy, women's position in biomass systems, the role of biomass in energy systems have not been taken into consideration in this project. The household, or the family, is accepted as the functional unit in a village community. Decisions over family involvement and family representation in community organisations are often made jointly by men and women.

The Wadagahakiwla situation is unique in regard to women's reduced dependence on woodfuel from family production systems. Women, as key farmers, have the opportunity to divert a farm product – Nanchi – towards the energy industry. Their intention is to use the income received to cover the cost of the electricity that the family is using. Directly, in this village situation, Nanchi has become a source of income to increase the family income, and with its use for generating dendro-electricity, some contribution is made towards poverty eradication.

The Nanchi harvesting and preparation is done with great care to suit the requirements of the dendro plant. The feeling of partnership in the community-level energy enterprise has had two significant effects. The first is through mobilising the households to become involved in modern dendro-energy development, mostly through women's informal and inter-household social links, by securing labour for self-help work on a reciprocity basis. The second is by managing the Nanchi as part of women's everyday farm work and by involving men's labour in the coppicing. Women expressed a committed interest in having clean energy for lighting and to sharing the knowledge and acting as change agents in support of the project. This is a sign of a transitional move that empowers women through confidence building, negotiation, organising and contributing to clean energy development.

## 4.3 Traditional biomass energy system in Hapuwala

### *4.3.1 Geographical context*

Hapuwala consists of clusters of settlements mostly located in the lower valleys where spring water is available. The settlements have expanded into the upper sloping terrain at higher elevations with increasing population pressure and expanding agriculture. As a result, very little area remains under forest. Nearly 44% of the total land area is under paddy and vegetables, 24% is allocated to homegardens, 9% is under forest cover, of which half is eucalyptus, 8% is extremely degraded land and the rest includes stretches of coconut etc. The main source of livelihood is agriculture and 78% of the homegardens have scattered trees and are mostly used for vegetable cultivation during 'Maha', the rainy season, between October and February. During this period, paddy is also cultivated in terraced fields, and during the dry season vegetables are grown. Hapuwala is known as an area that produces vegetables for the market. Forests, riverine areas, fences and hedges, and trees in homegardens are the sources of woodfuel.

The village ecosystem is diverse and clear zoning has evolved related to elevation, drainage and land use. Undulating lower slopes are intensively cultivated with either paddy or vegetables. The higher slopes produce dry land crops, depending solely on rain water while areas adjoining mountain crestlines and hillocks support either forest trees or shrubs. Homegardens form a mosaic with sparse tree cover connecting the settlements. The landscape also features riverine vegetation

belts of riparian agroforests. The diversity of vegetation cover, together with morphological diversity, allows a range of agricultural options.

Hapuwala has not benefited from any modern biomass energy interventions and its energy system features traditional biomass use in cooking, use of electricity/kerosene for lighting, and fossil fuels for transportation. In the 1980s, Hapuwala was electrified under the rural electrification policy, and electricity is primarily used for lighting, and also with some household appliances. Biomass is the sole source of cooking energy. For around three decades, from the 1960s to the 1990s, with the promotion of tobacco cultivation by the Ceylon Tobacco Company, biomass in the form of wood was also used in tobacco curing. Cultivation ceased in the 1990s due to the severe effects of land degradation and associated crop failures. Tobacco introduced a major transition to the village economy by diverting chena cultivation, traditionally based on a slash and burn system, towards tobacco growing, and also instigating a shift from subsistence to commercial farming. During the 1990s, many conservation-oriented interventions took place concerning the management of the upper watersheds. The Sloping Agricultural Land Technology (SALT) has been promoted with subsidies for farmers to grow *Gliricidia* hedgerows along contours to reduce soil erosion, enhance the infiltration of water and enrich soil nutrients. These waves of different interests have influenced farming, but no attention has been given to improving the energy efficiency of the biomass used in domestic energy. Under these circumstances, Hapuwala provides an appropriate case to study traditional biomass energy usage which can be taken into consideration from the perspectives of technology development.

The broad overview presented of the area considers its agrarian nature, land-based livelihoods, rural features and the dependence of people on local resources for food, water, domestic energy, and materials for construction and other uses. Individual households remain the operational units for production and reproduction, and maintain their social and economic status through property and other achievements.

Sixty of the 316 households in the area were randomly chosen for an in-depth investigation. The total population of these 60 households is 276, of whom 14 are of Tamil ethnicity and the vast majority Sinhalese. Six households house extended families, six are women-headed units and 48 are male-headed nuclear units. 50.8% of the population are females. Agriculture is the primary source of income for 68% of the households, while for the remaining 32% it is a secondary source as they have other sources providing cash returns. A key feature is the seasonality of agriculture with a peak, during Maha – from October to February, in the patterns of employment, production and income. As a consequence, 82% of the households who rely heavily on agriculture also have seasonal employment within the area. During this rainy period, the land is covered with varieties of commercial crops, including carrots, beans, cabbages, leeks, radishes and peppers. If weather conditions are favourable, the cultivation extends into May when the paddy is harvested. May to October it is a slack season in agriculture. Nevertheless, varieties of vegetables that are less demanding of water are grown, primarily for local use and some for market. Traditional varieties include bitter-gourds, pumpkins, aubergines, snake-gourds and cucumbers. Any conditions favourable for vegetable growing are fully exploited because this is a way of increasing family income.

For about 76% of women and 62% of men, land is the main occupational space, and farming the key activity for living. Women's contacts with the land are consistent and regular, and they do not migrate to work on a regular basis. On average, farming provides around 72% of family income. Sixty-two percent of the households have a total income of Rs. 3000-7000 per month. Thirty-eight percent of the households receive state subsidies, with 42% of them receiving between Rs. 151-250 a month and 58% between Rs. 251-500 per month. Women's contribution to family income was not determined, but they consider themselves to be family farm workers. Men not only own 93% of all

household lands, they also handle most of the transactions and marketing of farm produce. Decisions on family expenditure break down into two groups. Firstly, it is primarily a joint decision for matters pertaining to non-food aspects – including housing, savings, borrowing, farming, children's schooling and social functions. Secondly, in 92% of families, decisions related to food including daily diet, food purchasing, food exchange and storage for off-season consumption is made by the women alone. The ability to produce many varieties in their family farms in addition to the produce of trees in the homegardens enables women to be very flexible in making arrangements.

Nearly 64% of the families have permanent houses, and men own 94% of the dwellings. 36% live in relatively low-quality houses having only either temporary roofs and clay floors or clay floors and walls. The poor quality houses are occupied by the poorest social sector. These households do not have their own water sources or water-sealed toilets. Drinking water is a serious problem for about 42% of the households who rely on gravity water running down from the springs, while 20% use dug-wells and 38% use pipe-borne water. During the dry spells some of these sources become unreliable and, as a result, drinking stream water becomes common for those who do not have their own dug-wells. People who live in the low-lying areas and close to rivers and springs have the benefit of running water. Overall, 60% of households have water-sealed toilets, 40% use pit toilets.

### *4.3.2 Energy use in Hapuwala*

Energy is specifically linked up with the expected services, and gender-related features are associated with this. The conventional patterns of men's and women's work in production and reproduction, and their engagement in social work have a direct bearing on energy use. Electricity is used primarily for lighting and in four cases also for production including milling and welding work. The village was electrified in the late-1970s, and 59% of the houses use electricity for lighting with the other 41% using kerosene. Woodfuel is the source of energy for cooking, but in 16 cases electricity is used occasionally to boil a kettle. LPG is used in eight households for occasionally warming food or boiling water. In terms of fossil fuel usage, four households have vehicles for transporting farm produce, two more have tractors and two have passenger vehicles, and eight households have motorcycles.

Transport is essential for agriculture because farm produce is sold to local collectors for distant market outlets. Fossil fuel is thus essential for the functioning of the village economy and sustaining the production system. Key features of energy use are influenced by the nature of the services created and the type of benefits. For instance, the biomass energy system is led by women from the gathering of bulk biomass through to its combustion. This is connected to their responsibility for family food security and its domestic service nature. Men use fossil fuel for moving farm produce and other marketable goods. Energy for lighting is considered as a family service with shared responsibility. Where the households use kerosene for lighting, efforts are made to limit its consumption to keep down family expenditure on energy. Biomass is used for cooking and processing food for the unproductive seasons using labour and services provided by women. Improved technology for energy efficiency and conservation, and other benefits, was promoted in the area in the 1980s with a focus on watershed management. Sixty-four percent of the households have kitchen chimneys. Nearly 42% of the households have installed cookstoves, but these are only occasionally used, mainly during the slack agricultural seasons when additional cooking to feed farm workers is not needed. Improved stoves are installed for cooking small quantities. The technology used is local and traditional, with three types of hearths used for different reasons (see Table 16).

**Table 16. Technology using biomass and the reasons for each type**

| Hearth type | Reasons for using/advantages |
|---|---|
| Semicircular mud hearths (all households) | ▪ Easy to construct, manage and repair;<br>▪ Need less woodfuel;<br>▪ Residues can be burnt;<br>▪ Less smoke;<br>▪ Released energy is captured for food processing;<br>▪ Can construct double or triple units in a line in a narrow space;<br>▪ Heat/smoke is used for drying food in smoke trays and for conserving seeds, nuts and food;<br>▪ Hearth heat is available for several hours for keeping water warm for drinking and preparing tea;<br>▪ Technology and materials are local and easy to handle. |
| Three-stone hearths<br>(62% of the households) | ▪ For cooking large pots for social occasions and farm workers;<br>▪ For processing food;<br>▪ Par-boiling rice;<br>▪ For using unsplit pieces of logs, roots and thorny wood;<br>▪ Easy to construct using stones/bricks as required;<br>▪ Ability to move and reassemble outside the kitchen. |
| Improved stoves<br>(42% of the households) | ▪ For use with small family-sized pots;<br>▪ Less woodfuel is required;<br>▪ Less smoke. |

Each hearth type has its own advantages for a farm family, but the semicircular mud stove is consistently used. Three-stone stoves are reported as being essential but they are assembled as needed, often outside the kitchen. Improved stoves are available in 42% of the households as a supplementary option. Women construct and install the semicircular type in various sizes by themselves using local materials. The semicircular stoves are widely accepted, the technology is local and traditional, and does not require materials from outside. This zero-cost technology is widely popular, and women do all the repairs and plastering using new clay.

The average per capita consumption of woodfuel is 1.5-2 kilograms per day, and this is met from a range of sources. Family woodfuel consumption is higher during the peak agricultural season and, naturally, extended family units tend to use more. Getting woodfuel to provide hot meals for farm labourers is an additional burden for women. A common practice is to collect and store woodfuel stocks in anticipation of the peaks in demand. The division of labour indicates women's and men's roles in the system.

### *4.3.3 Gendered features in the biomass energy system*

The biomass energy system reveals some common as well as some fairly unique features in relation to resource access, control, gender roles, activities and accomplishments. This system connects the multiple supply sources with the kitchen domain, and the solid biomass with the cooking sphere. Women are the key players in activating this (see Table 17). The system consists of a wide range of tasks and sources connected through women's energy.

**Table 17. Gender specific roles for sustaining the system**

| Role | Task | Activity by gender | |
|---|---|---|---|
| | | Women | Men |
| Management of supply system/sources | • Maintaining trees in homegardens and farms;<br>• Upkeep of fences and hedges;<br>• Conserving state property (forest and reservations). | • Enrichment planting;<br>• Nurturing;<br>• Collective engagement in gathering woodfuel from state property;<br>• Managing coppice growth from tree stumps. | • Enrichment planting;<br>• Coppicing and branch pruning. |
| Activate woodfuel supply mechanism | • Gathering and carrying wood from outside sources. | • Collection of agro-residues;<br>• Collection of woody biomass;<br>• Trimming;<br>• Carrying for domestic use;<br>• Processing;<br>• Maintaining stocks. | • Harvesting (occasional);<br>• Cross-cutting;<br>• Transportation in trucks (rare and limited to special occasions). |
| Generating energy for cooking | • Efficient combustion of wood and agro-residues. | • Maintaining kitchen hearths;<br>• Cooking food using woodfuel for the family, farm workers and social occasions;<br>• Processing food;<br>• Cleaning hearths;<br>• Attending to ash and soot. | • Assisting women occasionally in cooking. |

No transportation options exist for supplying woodfuel, so portaging is a cumbersome but crucial element in the process. A feature specific to this area is the heavy dependence on farm residues and therefore gathering residues off the farm for domestic energy security consumes human energy. Rather than maintaining a dense tree cover in the homegardens, seasonal vegetable cultivation is undertaken since this is profitable in terms of producing for the market. As a consequence, homegardens only produce about 20% of the biomass needed for family cooking. Women in around 80% of the households collect farm residues, including crop stalks and husks, for fuel; and hedges provide 40% of the woody biomass.

Collection of wood with a high calorific value for cooking has become possible only from scattered forests and reservations. The competition for state-owned common sources has increased with forest degradation. The expansion of vegetable cultivation and the reduction in fallowing practices in the highlands also contributes to domestic energy insecurity.

Despite all of this, no production systems intentionally integrate energy, considering it to be essential for food and nutritional security, into land management. Similarly, in the allocation of household land, labour and time, no provisions are made that enable women to attend to these energy-related tasks. Women collect whatever materials can be found in farms, homegardens and elsewhere while attending to other tasks and in between them. Women use distant forests and shrubs, and gather pruned and coppiced branches.

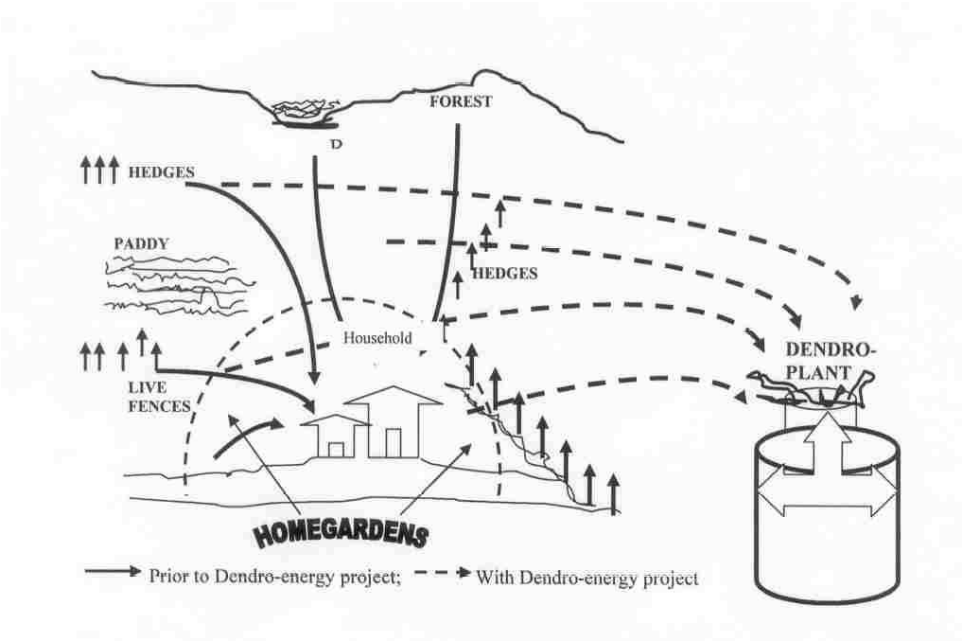
### *4.3.4 Gender, energy and poverty linkages*

Biomass is the primary source of energy for cooking for every household in Hapuwala. Even the high-income families are reluctant to adopt alternatives. One reason is that their income is not adequate to pay for clean energy, another that it is seen as an unnecessary burden on the family. Estimates indicate that even if only the basic family meals were cooked using either LPG or electricity the monthly energy cost would be well over 1000 Rupees. Women saw energy and water as commodities they could manage without burdening the family. Such management allows them to save money to spend on other items such as health, education and clothing. Income poverty is thus an impediment to accessing clean energy services. Women being a free source of family labour, and not having employment opportunities or cash earned by themselves to adopt alternatives, have no way of making a choice.

The biomass supply sources in Hapuwala are evaluated by women using several parameters including access to supply sources, right to use them, type of biomass needed for domestic cooking, amount available to them, time and energy required, and the nature of the work involved and their ability to handle it.

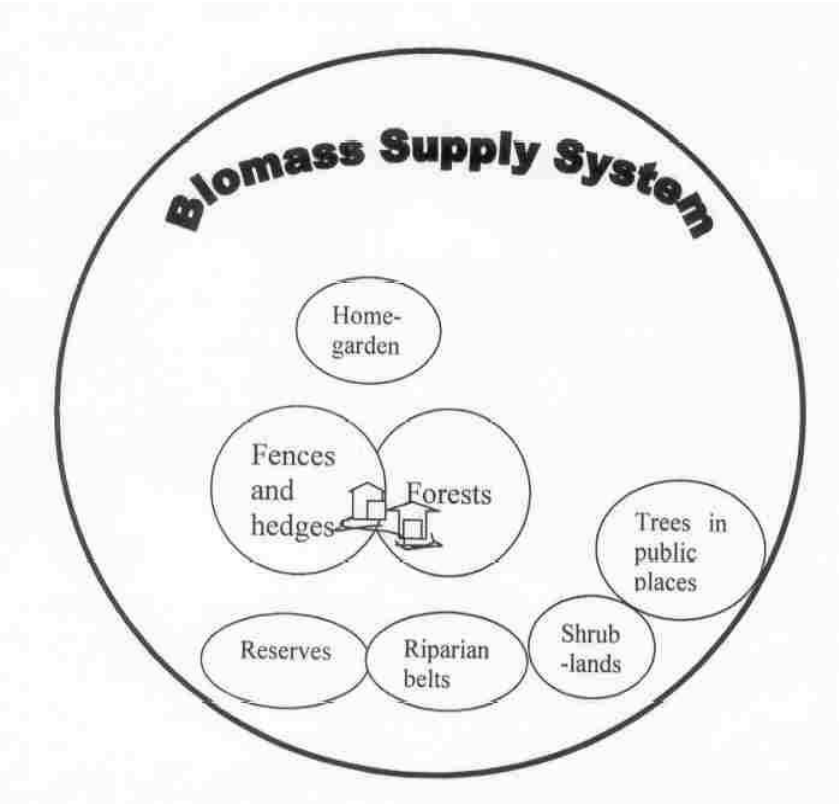
The relative importance of the sources is based on these parameters. The overall picture shows that household production systems including homegardens, farmlands, and fences and hedges are the prominent sources for women (see Figure 4). Reserve lands, riparian agroforests alongside canals in paddy tracts, riparian vegetation along drainage lines are the next most important sources. Forests, shrub land and public places are distant sources that women use occasionally. It was found that the choices of sources by the poorest women differ significantly. They are the ones with less than half an acre of land.

**Figure 4. Woodfuel flows from production systems for dendro plant**



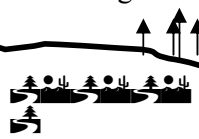
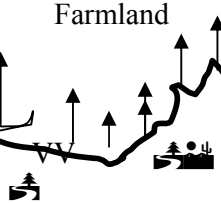
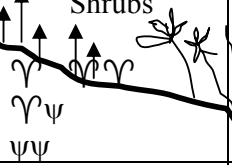
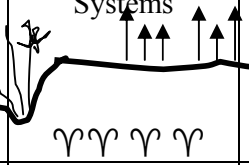
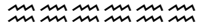
Twelve women from poor families indicated that forests, fences and hedges are their crucial sources; followed by shrub land and trees in public places, riparian belts and reserves (see Figure 5). Their homegardens are small and used to grow vegetables, so make an insignificant contribution. Comparing the field discussions and information consolidated into these two diagrams highlights several points.

**Figure 5. Relative importance of sources for the women from poor families**




The transect of supply sources constructed by women shows that they do not have control or authority over the sources of domestic supply (see Figure 6). The authority and control over village supply sources are held by men and they exercise their ownership of resources and take decisions regarding trade, cash and external linkages. Women's choice are restricted by men's control over family sources and also the state's authority over non-household supply sources. Woodfuel collection from these sources is done on a customary basis. Rights to woodfuel and women's resource contacts are often informal and unauthorised. Often decisions over farm trees with tremendous woodfuel potential are made by men.

**Figure 6. The resource transect of the supply sources**

| **Sources** | Homegarden | Fences and Hedges | Farmland | Forests and Shrubs | Riparian Systems | Public Places | Reservation |
|---|---|---|---|---|---|---|---|
| |  |  |  |  |  |  |  |
| **Type of Biomass** | • Thinnings – woody segments<br>• Residues<br>• Thinnings | • From pruning and coppicing<br>• Woody segments | • Agro-residues<br>• Branches from pruning of trees | • Woody biomass<br>• Sticks and dead wood | • Bamboo<br>• Palm leaves<br>• Stalks | • Branches | • Wood residues |
| **Issues** | • Inadequate supply<br>• Irregular supply<br>• Limited harvest<br>• Lack of control | • Limited availability<br>• Limited options<br>• Lack of control | • Seasonal supply<br>• Lack of control<br>• Limited harvest | • Distance<br>• Access<br>• Lack of authority<br>• Restricted use | • Distance<br>• Harvesting risks<br>• Lack of authority<br>• Restricted use | • Limited and irregular availability<br>• Lack of authority | • Distance<br>• Lack of authority<br>• Restricted use |

# 5 Conclusions

Turning back to the two research questions:

1. Should gender relationships constitute a key variable in designing dendro-energy interventions and do they contribute to achieving the goals of the intervention?
2. Is a dendro-energy intervention effective in contributing to the process of improving the wellbeing of women and empowering them, and how can it best do this?

The analysis of the findings from this study enables one to draw the following conclusions:

1. The energy policy of Sri Lanka and the strategy introduced by the Bio Energy Association of Sri Lanka reflect a commitment to enhancing energy supply through multi-stakeholder involvement, new partnerships and mobilising investment and finance services for dendro-energy development in Sri Lanka;
2. Dendro-energy policy provides a broad framework enabling interventionists to mainstream gender while addressing poverty to reap the expected benefits. Both pilot projects reveal that goals related to resources, the environment, economic and social advancement, management and technology have to be realised within the scope of gender and poverty (see Table 18);
3. The comparison of findings from the different situations reveals that:
    i. Patterns of using energy sources and the involvement of men and women in providing basic energy services for household wellbeing have not changed;
    ii. The two dendro-energy projects differ in terms of the nature of community involvement;
    iii. Conventionally established gender relationships are not altered by men's legal ownership of land, and their continuing control over sources of income and mobility;
    iv. Some transitional effects seem to have emerged in the community-level dendro-energy project. The community organisation formed through mobilisation has created enabling opportunities for men and women, as family members, to make decisions over feedstock supply and gain the benefits of the electricity provided for lighting; and
    v. With no village enterprises established, there is no sign of energy enhancing income through production, but perhaps it is too early to expect such developments.

4. The development of dendro-energy plants in village situations demonstrates that biomass has a potential to promote energy enterprises for income, improving the quality of life and contributing towards reducing poverty. However, it needs to be designed with due attention to the current and the future use of biomass in domestic cooking by women, and the possible adverse effects of diverting it from the domestic domain to commercial supply lines. The ranking of the problems associated with the dendro-energy project by women in Kumbalgamuwa demonstrates that this intervention has created some problems (see Table 19). This reflects that, in order to cater for the expanded consumption through the energy plant, the supply side has to be enhanced. In this regard, women's access and control over production for the sustainable supply of feedstock is essential. It is unrealistic to exclude cooking energy needs from the biomass energy system and discard women's contribution to enhancing and enriching the supply chain; and
5. Community-level organisations handling production and supply have the capacity to empower women. Men respect and accept women's contributions to the traditional biomass system, and consider electricity generated by converting farm biomass to be an enabling opportunity for women.

**Table 18. An overview of the dendro-energy intervention policy, its gender and poverty implications**

| Goal | Expected benefits | Impacts on gender | Impacts on poverty |
|---|---|---|---|
| Resource | Development of underutilised/unutilised resources (land, trees);<br>Resource rehabilitation and enrichment. | ❑ Women's traditional use of resources and woodfuel;<br>❑ Customary practices of using land and woodfuel;<br>❑ Women have wider decision-making opportunities | ❑ Enhanced resource conditions for livelihood security;<br>❑ Reduced cost for soil enrichment;<br>❑ Natural regeneration and diversity; |
| Environmental Goals | Greening land;<br>Environmental rehabilitation, biodiversity and resource enrichment. | ❑ Sustainability of land resources;<br>❑ Land rehabilitation; | ❑ Reduced land degradation;<br>❑ Land-based livelihood security;<br>❑ Greater reliance on land;<br>❑ Soil enrichment through green manure; |
| Economic | Cash for tree growers;<br>Enhanced land productivity;<br>Other incentives for growing trees, diversification of farm income;<br>Market value for farm produced-woodfuel. | ❑ Commercialisation of woodfuel.<br>❑ Use of farm space for woodfuel;<br>❑ Promotion of bio-energy industry in place of customary woodfuel uses;<br>❑ Cash income for farm family;<br>❑ Opportunities for accessing services;<br>❑ Food security through enhanced income; | ❑ More income from land/biomass;<br>❑ Labour efficiency;<br>❑ Cash for farm biomass;<br>❑ Remuneration for labour;<br>❑ Employment opportunities; |
| Social | Local participation;<br>Electricity for community/household use from the off-grid community-based system. | ❑ Decisions by NGOs, CBOs, feedstock suppliers, contractors and landowners;<br>❑ Reciprocity;<br>❑ Motivation for landowners, biomass producers;<br>❑ Weakening of woodfuel flow for domestic use; | ❑ Social safety and sharing;<br>❑ Social inclusion;<br>❑ Collective action for community benefits; |
| Management | Sustainable land use, supply of feedstock through integration and intercropping<br>and coppicing (periodic cutting to<br>stimulate shoot growth), efficient<br>utilisation of produce. | ❑ Space for women in local organisation for bio-energy development;<br>❑ New partnerships;<br>❑ Men as new set of suppliers/contractors; | ❑ Equal opportunities and respect;<br>❑ New skills; |
| Technology | Promotion of bio-energy technology. | ❑ Leisure and social uplifting;<br>❑ Changes in length and hours of work;<br>❑ Technology/domestic electrical appliances;<br>❑ Clean and modern energy for family and community; | ❑ Reducing family expenditure;<br>❑ Better quality of output;<br>❑ Reducing danger from using risky sources;<br>❑ Self-confidence in technology;<br>❑ Time and energy to invest on production;<br>❑ Energy for using machinery/utensils; |

**Table 19. Ranking by women in Kumbalgamuwa of dendro-energy project problems**

| Problem | Perceived as problem | Not of concern | Total response |
|---|---|---|---|
| Alienation of women's energy use and needs | 176 (83%) | 36 | 212 |
| Diversion of women's woodfuel sources for NationalGrid | 160 (83%) | 32 | 192 |
| Lack of energy benefits for family | 174 (81%) | 41 | 215 |
| Loss of women's control over village woodfuel source | 162 (80%) | 41 | 203 |
| Control of woodfuel by private sector | 161 (80%) | 40 | 201 |
| Loss of control over decisions | 148 (78%) | 49 | 190 |
| Loss of control over farm use and woodfuel production | 161 (70%) | 66 | 227 |
| Lack of local control over the system | 141 (70%) | 61 | 202 |
| Tendency for them to depend on leftovers | 134 (69%) | 60 | 194 |
| Lack of opportunities for women to involve/get benefits | 132 (69%) | 58 | 190 |

# 6 Recommendations

Recommendations, including for energy policies, capacity and partnership building, and social mobilisation, are drawn from the findings of this study.

- **Community partnership for dendro-energy development:** Modern biomass technology for off-grid electricity supply as a clean energy type should be a priority. A clear understanding of the existing biomass fuel system and the potential for expanding its consumption to include energy generation is a prerequisite. Also required is the internalisation of a project through community mobilisation and by assessing the short- and long- term feasibility focusing on the existing system, its role in the rural economy, potentials to grow feedstock, and contribution to gender empowerment.
- **Engendering energy policies and programmes:** The dendro-energy development projects and programmes should use gender as a key variable in introducing modern energy technology. It should be used as a framework for gathering and analysing information, energy use and needs, and as a variable in researching into energy systems and the consequences of intended output and as a tool to mobilise men and women to become involved in the process. This would facilitate the process of designing energy projects and assuring internalisation and sustainability. Looking at the implemented projects, where gender has not been considered as an important element, an analysis of gender impacts amounts to searching for side effects. Engendering is essential from the perspectives of sustainability, mobilising men and women, building their capacity to have control, and monitoring a project's performance and contribution.
- **Gender integrated planning and guidelines**: For projects on modern energy technology it is essential to understand gender-integrated planning procedures. Training should be delivered for policymakers, projects and programmes. In this regard, guidelines for gender-integrated planning for the promotion of gender-sensitive interventions should be made available.
- **Mobilisation of social capital and local organisations:** It is also recommended introducing a strong and sound mobilisation process to take care of social capital and local organisations, and so mobilise women as local capital to enrich production and form an organisation of dendro suppliers at the village level. An externally enforced supply chain leads to marginalising women, resource conflicts, divisions, seclusion, and demoralisation at village level. Institutionalisation of partnerships and building competence and recognition is essential for alleviating poverty.
- **Gender disaggregated information for planning:** The comparison of two models of dendro-energy projects makes it clear that there are demoralising and disempowering effects on women if they are not recognised as partners, traditional biomass managers and key players. To avoid these limitations pre-feasibility studies should prepare a gender-disaggregated information base on which projects could be designed, implemented and monitored.
- **Gender-sensitive renewable energy policy:** The country's energy policy has focused on rural development by including several aspects beyond rural electrification. It is quite clear that wood is a promising renewable source for the both grid and off-grid electricity generation. Yet, renewable options that cover the major concerns of women – the key stakeholders in the energy sector - require policy measures that also meet cooking energy needs. Since dendro-energy is based on an exploitable, replenishable, and renewable energy resource managed by women, wider policy planning is essential that creates opportunities for women to contribute to economic growth through access to clean energy.
- **Clean energy technology for domestic cooking:** This should be an integral part of national policy and projects. It has never been considered as part of the energy mainstream. The reason may be the myth that biomass and women's labour are available at zero cost to be used as needed in securing energy services. To recognise that a huge portion of energy is used for domestic cooking, as one block of the energy mainstream, requires a paradigm shift accounting for its direct and indirect contribution to the economy, society and the environment.

- **Energy enterprise and services:** The community-level dendro-energy project demonstrates that when woodfuel is diverted for an energy enterprise the cash returns to a household could be sufficient to meet most of the recurrent electricity costs. Expansion of the supply is essential to meet cooking energy needs. The scope and services of the dendro-energy project should be expanded enabling women to promote the production of woodfuel on state land on a community basis, to use dendro-energy for cooking, and also to receive an income for their woodfuel to meet their electricity costs.
- **Integrated energy technology:** Avenues for economic growth, poverty alleviation, equity and economic opportunities for women to use their labour, building capacity to organise and manage technology interventions, should be integrated as key elements in energy interventions. With regard to this, it is essential to include indicators in a project design to measure its achievements – not only in term of energy units, but also in relation to changes that occur and its objectives.
- **Training:** Village/community level training for men and women on energy development and management, and training on gender-integrated energy planning for policymakers, regional and local administrators, NGOs and civil society organisations are also prerequisites for assuring gender-sensitive modern energy technology for rural areas.

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