Sustainability assessment of cinnamon biomass for energy generation

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ABSTRACT - Affordable and Clean Energy is the 7th Sustainable development goal of United Nations and to achieve this goal, renewable energy is one of the perfect solutions. Recently gliricidia has been nominated as the 4th energy crop and used for the electricity generation in Sri Lanka. With the increasing demand for Sri Lankan true cinnamon in the global market, there is a gradual growth of cinnamon plantation in Sri Lanka. Hence it was able to generate high yield of cinnamon biomass which would be a promising renewable energy source for energy generation. In this study, it was evaluated whether it is sustainable to use cinnamon biomass for energy generation under the three sustainability pillars; socio, economic and environmental. The study concluded that cinnamon biomass also has the potential as an energy source as well as gliricidia that can contribute for the Sri Lankan energy requirement.

Keywords: Cinnamon biomass, sustainability, gliricidia, biomass energy

INTRODUCTION

Biomass is one of the major energy sources utilized in Sri Lanka that accounts more than 40% [1] of the total energy requirement. Due to high availability of biomass within the country, the government has focused power generation through Drendo plants powered by gliricidia biomass which are currently established and provide 24 MW to the national grid. In this regard *Gliricidia Sepium* has been declared as the fourth plantation crop in the country. Gliricidia is recognized as a source of nitrogen fertilizer, used as a boundary fence in rural area and important in pepper cultivation as a backing. It can be cultivated all over Sri Lanka except in coastal areas, on mountain tops and in arid areas.

However, there are some issues regarding the use of gliricidia as a commercialized fuel due to its high initial moisture content, poor drying characteristic, decaying during storage etc. that requires some other alternative fuels to address Sri Lankan energy sector. Therefore, identification of alternative sustainable biomass resources such as sawdust, rice husks is crucial with high potential of energy characteristics. Cinnamon can be identified as one such potentialized crop which is identified as a well-established export crop for decades in Sri Lanka.

Sri Lankan cinnamon has acquired long-standing reputation in the international market due to its unique quality, colour, flavour and aroma. Currently Sri Lanka is the world's largest producer and exporter of cinnamon. The country produces almost 90% of true cinnamon produced to the world-market. [2] This study examines the potential of using cinnamon biomass for energy generation in Sri Lanka under socio, economic and environmental aspects having gliricidia as the bench mark.

METHODOLOGY

2.1 Economic sustainability

Net calorific value (NCV) cinnamon biomass samples were determined by using Bomb calorimeter. Powdered

cinnamon biomass was obtained from using a saw machine kept in the oven in 60 ^{0}C for drying until acquiring a constant weight. Then it was heated and compressed to obtain a flat pellet to prevent the dispersion inside the bomb calorimeter while ignition. Moisture Content (%) was measured using digital moisture balance. Field work involved to determine the biomass cost, harvesting period, biomass yield, transportation cost etc. The data taken from the field, laboratory, and literature was analysed to determine the biomass yield, advantages as a cash crop and energy content.

2.2 Environmental sustainability

Average annual greenhouse gas emission from rubber processing and tea processing have been calculated by using WBCSD, 2011. (The British Standard Institution 2011) CO_2 capturing rate of Cinnamon has been calculate and the ash content and nutrient removal of *Gliricidia Sepium* was determined from literature [4]. Finally, ash content of cinnamon was calculated. (Laboratory analytical procedure for Biomass proximate analysis given by National Renewable Energy Laboratory).

2.3 Social sustainability

Social sustainability of cinnamon cultivation in Sri Lanka was assessed according to the main four dimensions of social sustainability; social, socio-economic, socio-institutional, socio-environmental. Social statues, economic situation, trainings, human capital and environment factors regarding the side of society such as protests were discussed under those four dimensions of the social sustainability.

RESULTS AND DISCUSSION

3.1 Economic sustainability

Both gliricidia and cinnamon has almost the same harvesting period but freshly planted cinnamon plant needs 3 years for the maturation, but it is 2 years for the gliricidaia. Transportation cost is depending on distance between farmland to the process plant.

Table 2 Economic parameters of biomass

Property	Cinnamon	Gliricidia
NCV at 20% moisture	17314.4 kJ/kg	13030 kJ/kg. [3]
Biomass yield	27 Tons/ha (Well-maintained plantation)	26.7 tons/ha (OFI Index No 15/84 gliricidia provenance) [4]
Moisture Content	55% (Freshly Harvested)	60% (Freshly Harvested)
Drying rate	6 days to achieve 20% moisture content (temp = 30^{0}C/ humidity = 80%)	30 days to achieve 20% moisture content (temp = 30^{0}C/ humidity = 80%)
Price for Farmers	RS 6/kg	RS 2/kg

3.2 Environmental sustainability

Cinnamon cultivation is a good agricultural practice with rewards such as significant nitrogen fixation, reduction of acidity of the soil, providing good habitat to animals and birds and protection of ground water [5]. The ash content of cinnamon is 23% and there the ash content and nutrient removal are higher in cinnamon when comparing with *Gliricidia Sepium*.

Greenhouse gas emission of Rubber processing industry is 110174.18Mt per annum and for tea processing industry, it is 149475.768Mt per annum [6] In this regard, cinnamon biomass can be utilize with the concept of zero emission to fulfil energy requirements in the local industries with an annual CO_2 absorption rate of 106.151Mt/hectare per year. [7]

3.3 Social sustainability

Age group of workers in cinnamon plantation was identified as middle age from 40 to 50. They do not get any proper trainings regarding their job roles.

Currently, social concerns of cinnamon plantation are not well addressed; the rural poverty, unemployment, increasing food insecurity and the lack of labours due to urban drift. There is a clear lack of enabling policies to ensure that cinnamon smallholders have sustainable livelihoods. Land tenure and land use policies are not designed to ensure that economies of scale in production and cropping and that farming systems are sustainable in the long run. [8]

CONCLUSION

The sustainability analysis performed in this study provide a distinctive enhancement that paves the way to use cinnamon biomass in energy generation in both household activities and in the industry. Since Sri Lanka is a developing country, new process industries will be established in future that requires sustainable energy resources. So cinnamon biomass will be sound beneficial to be identified as a prominent carbon neutral renewable energy source as well as gliricidia biomass. Above all, government intervention is necessary to attract the serious involvement of leading plantation owners to the business and to promote cinnamon export market that will ultimately increase the availability of cinnamon biomass within the country.

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