Proceedings of 15th Agricultural Research Symposium (2016) 106-110

Stated Preference on Growing Fuelwood Crops under Coconut Plantations

Y.P. SENANAYAKA and H.M.L.K. HERATH

Department of Agribusiness Management, Faculty of Agriculture and Plantation Management, Wayamba University of Sri Lanka, Makandura, Gonawila (NWP), 60170, Sri Lanka.

ABSTRACT

There is a growing demand for fuelwood from the industry to be used as a renewable energy source. At the moment there is a continuous supply through disorganized channels of which the sources and the sustainability is arguable. This might create some pressure on existing vegetation including home gardens and forests creating many social, economic and environmental issues in the future. Consequently, initiatives have been taken by various parties including the government to promote growing fuel wood plantations, which have not been well accepted at the grower's side due to numerous reasons, although it is very much important in the current context. This motivates us to engage in this research to investigate the stated preference on growing fuelwood under coconut plantations which have already been identified as a high potential system for establishing fuelwood plantations. A discrete choice experiment was implemented as the research tool and found that fuelwood species, cropping system, fuelwood certification and purpose of use are significant attributes on the utility of coconut smallholders to maintain their coconut lands on fuelwood plantations. They value these attributes at a high rate in terms of the price received for their product which is not unfavorable outcome towards promoting growing fuel wood in the current context. But it should be seriously taken up, especially in the policy context, if growing fuelwood crops under coconut need to be promoted.

KEYWORDS: Choice experiment, Conditional logistic regression, Fuel wood, Willingness to accept

INTRODUCTION

The total demand for energy sector in Sri Lanka can be classified under three major sectors. They are households and commercial sector, industrial sector and transport sector. In 2014, the percentage share of each sector were 44.69%, 25.8% and 29.38% respectively. Petroleum usage for those three sectors were 3.5%, 2.5% and 29.38% while Sri Lanka's petroleum products imports were 2816.64 tons in 2014. Furthermore, the average total petroleum product imports from 2010 to 2014 were 2831.57 tons per year (Anon, 2014). Though Sri Lanka has been successful in developing an extensive hydro-power infrastructure, its further expansion was aborted as it has reached to a maximum level. Since country hasn't adequate fossil fuel available, at present, the key economic aspects such as energy security, economic viability and productivity, cost of living and investment in economic development are not being adequately addressed. Under this scenario, development of alternative energy sources has been accepted in a top priority area (Gunathilaka *et al.*, 2006).

Biomass is the most common source of energy supply in the country, where the majority usage coming from domestic sector for cooking purpose (Sugathapala, 2007). In 2003, the estimated consumption of fuelwood was 11,273,106 kg, of which 72.4% was consumed in the domestic and commercial sectors and the balance in the industrial sector. So government in Sri Lanka has begun to recognize that biomass is a good resource that can be used for large scale power development and that it can shift power generation away from full reliance on expensive fossil fuels.

Using biomass as an alternative energy source is more beneficial as it is the most abundant resource in the world. The advantages of using biomass energy are being renewable depending on coppicing trees, availability to convert easily from its natural form into concentrated, high energy fuels, low cost of production, low thermal emissions, reducing landfills and reduction of dependency on fossil fuels.

Exploitation of biomass for electricity generation is gaining a new momentum in Sri Lanka. Encouragement is therefore now being given for dendro plantations from both semi-utilized lands being used for the estate crops with tea and coconut and using largely the unutilized lands.

The most important recent development in this sector of the country relates to government policies. Several policy initiatives have been formulated by the government to develop the biomass energy sector. The government has already declared *Gliricedia sepium* as the fourth plantation crop. In addition, the government is also in the process of revising the technology of renewable energy based electricity generation. However, the importance of biomass as a sustainable energy source as well as the issues associated with the development of this sector has been largely undervalued by planners and policy makers.

At present, some dendro power plants are under construction and few are already running. Moreover, the industry is converting from fossil fuel to biomass for their energy needs. Though there is a continuous supply of fuel wood to satisfy the current demand, the source of supply is unknown and there is no any sustainable nature in the supply. This may create some pressure on the existing tree cover including the forest cover creating adverse environmental issues in the future. Thus attention should be given on cultivation of energy crops with proven coppicing ability.

Cultivation of crops for biomass is not currently so popular although lots of emphasis and encourages are given by various sources including the government. This may be due to lack of information available among farmers especially on the cost-benefit side of biomass plantations due to various reasons. Moreover, poor infrastructural facilities, lack of continuous demand, unsatisfactory price ranges, their doubts on whether this will be a sustainable venture and loss of trust due to failures of their previous attempts led by some ad hoc programs launched on biomass plantations have created poor perception and motivation on the potential growers of biomass plantations.

Therefore, specific objective of this study is to assess the willingness to accept growing fuelwood (wood biomass) plantations taking coconut plantations as an example. The outcome of this research will help the policy makers to understand the nature of preference of growing fuelwood plantations as a source of biomass energy by the growers together with the determinants on their preference.

METHODOLOGY

Decision maker's perception on different attributes can be observed by using two methods. They are stated preference (SP) and revealed preference (RP) methods (Casellas and Berges, 2009). In stated preference, decision makers make their choice from a particular set of alternatives which may be real world alternatives or hypothetical alternatives. Stated preference method is based on hypothetical data to estimate *ex ante* willingness to accept for certain attributes. But in revealed preference method, researcher does not directly ask from the decision maker about their decision, but collect data observing their behaviors in the decision making process. It focuses on *ex post* willingness to accept. Out of these two concepts, the stated preference method is used if there is not enough information to use the revealed preference method. The discrete choice experiment is one such popular stated preference technique which is conducted using choice cards that contain several selected attributes and their levels (Ryan *et al.,* 2012).

Theoretical Framework

The random utility model by McFadden (1974) is used as the theoretical basis to analyze choice data. Accordingly, in this technique, a utility function, U_{ij} has derived for the experiment by integrating specified option chosen by different respondents by random utility approach, where utility of a choice is comprised of a deterministic component (V) and an error component (e) which is depicted in equation (1).

$$U_{ij} = V(Z_j, S_i) + e(Z_j, S) \qquad (1)$$

For any given farmer i, a given level of utility will be associated with any alternative fuelwood growing system j. Attributes (E.g.: certification, fuel wood species) of fuelwood growing are denoted by U while social and economic characteristics of the respondents are regarded as S. This equation can be estimated using a conditional logit model. Once estimated, parameters of the model could be used to obtain a part-worth or implicit price formula for the marginal rate of substitution between income and an attribute concerned as,

$$MWTA = \left(\frac{\beta_{attribute}}{\beta_{monetory\ attribute}}\right) \qquad (2)$$

This is the marginal welfare measure that seeks for a change in any of the attributes sometimes known as, marginal willingness to accept, MWTA (Kuruppu *et al.*, 2014).

Construction of Choice Sets

Combining selected attributes and their attribute levels were result a large number of hypothetical alternatives. With five attributes and three levels each result in 162 possible choice alternatives. These all possible outcomes are called as full factorial design (Aizaki, 2009). Presenting this type of a full factorial design to a respondent is practically difficult and time consuming; perhaps the respondent may be confused on his choice.

Therefore, using orthogonalization procedure, they were reduced up to 16 choices (Birol, 2006) based on orthogonal arrays creating a fractional factorial to recover only main effects. Since asking a respondent to choose from 16 choices is difficult, it was reduced up to four choices by breaking it into four blocks. Consequently, four choice sets were prepared and each choice set consists of four different options (Herath *et al.*, 2014).

Study Location and Data

The study was carried out in Pannala, Makandura and Yakwila areas which belong to the Pannala Divisional Secretariat in the Kurunegala district. Primary data were collected through a choice based pre tested questionnaire survey using planned set of choice cards. A focus group discussion was carried out to identify the most important attributes and their levels regarding the experiment. The chosen attributes and their levels are given in Table 1. An orthogonal choice set with four blocks were obtained using SPSS version 16.1. So that main effects of the selected attributes can be estimated. Over the period from March to April 2016, 120 small scale coconut growers were randomly selected and interviewed.

Table 1. Attributes and their levels used in the choice experiment

Attributes	Levels
Fuel wood species	Gliricedia
	Ipil-Ipil
	Calliandra
Cropping system	Coconut only
	Intercropped with pepper
	Intercropped with betel
Certification on fuelwood	With
	Without
Purpose of cultivation	Selling
	Consumption
	Selling and consumption
Price (Rs. per kg on wet basis)	3.00
	2.50
	2.00

Data Analysis

Data were analyzed by using software STATA version 11.2. Conditional Logit approach was used for the data analysis process. For the population represented by the sample, indirect utility of the experiment attributes take the form

$$V_{ij} = \beta_0 + \beta_1 In\ (fuel\ wood\ type) + \beta_2 In\ (cropping\ sysytem) + \beta_3 In\ (Certification) + \beta_4 In\ (purpose\ ) + \beta_5 In\ (Price) \quad (3)$$

Where β_0 refers to the co efficient, which is specified to account for the proportion of choice of participation. β_1 to β_5 refer to the vector of co efficient associated with the vector of attributes of the experiment.

RESULTS AND DISCUSSION

Nature of the Sample

Majority of the sample were males (82.3%) and rest was females (17.7%). From them, 42.5% have educated up to GCE (A/L) and 40% have educated up to GCE (O/L). The age of respondents ranged from 80 to 25 years old. The family size of respondents ranged from one to six. When considering the land area under coconut cultivation, 72.5% of respondents owned a land area between 1-5 acres. A 21% of the respondents owned lands of 5-10 acres in extent. From the total sample, the percentage of respondents who are gaining the annual income which is more than Rs.150,000 was 65.83%. And the percentage of respondents who are gaining an income between Rs. 100,000-150,000 reported as 13.33%.

Descriptive statistics of the sample are given in Table 2. About 72% of the respondent owned a plot of coconut lands as a mono crop while 86% respondents owned a coconut land intercropped with an alternative crop such as pepper, betel and pineapple. About 52% of the sample maintained their coconut land for both selling and own consumption while about 39% of them use it solely for selling. Majority of the respondents maintained a part of their home garden as a coconut plantation either with or without intercropping.

Table 2. Descriptive statistics of the sample

Variables	Frequency	Percentage (%)
Cropping System of coconut		
Coconut and betel	37	30.83
Coconut and pineapple	32	26.67
Coconut and pepper	34	28.34
Coconut	86	71.67
Purpose of coconut plantation		
Home use and selling	63	52.50
Only home use	0	00.00
Only selling	47	39.17
Selling fuel wood		
Yes	14	11.66
No	106	88.33
Domestic consumption of fuel wood		
Cooking	95	79.17
Commercial cooking	4	3.33
Heating/ drying	57	47.50
Heating water	61	50.83
Other	15	12.50
Awareness about shade tree cultivation for fuel wood		
Low	22	8.33
Normal	37	0.83
Medium	12	10.00
High	33	7.50
Very high	16	3.33
Attitude towards probability of earning profit from that		
Yes	71	59.17
No	49	40.83

About 94% of the sample was using fuel wood for domestic use while around 12% of the respondents was selling fuel wood for some extra income. Out of the fuel wood users, the highest percentage (79%) was recorded using fuelwood for domestic cooking. Very few of the users was using fuelwood for commercial purpose. Out of the total sample, about 30% of respondents had some level of awareness about the cultivation of shade trees like gliricedia, ipil-ipil and calliandra for fuel wood. However, the majority was not either interested in or unaware about growing plants for selling as fuelwood for which the reason should be further investigated. Though there was a low level of awareness about growing fuel wood species, majority of the farmers were in a positive attitude towards the idea of gaining profit from fuel wood cultivation combined with their coconut cultivation.

Table 3 illustrates the results obtained from the conditional logistic regression applied on the choice data with five attributes as the regressors. Estimates for each attribute have interpreted with compared to the respondent's base levels calliandra, coconut intercropped with pepper, without certification and for domestic use respectively for each attribute listed in Table 1. It can be noticed that gliricedia and ipil-ipil are statistically significantly preferred as a fuel wood species by the respondents compared to their preference on calliandra. The highest preference can be seen towards gliricedia as a species that can be grown for fuelwood which may be due to very high awareness about gliricedia among the respondents observed during the study. Moreover, gliricedia was observed being commonly cultivated in most of the coconut land, especially in coconut based intercropping systems owned by the respondents. The results showed that people prefer more the lands with a coconut monoculture and coconut intercropped with betel to be used for growing fuelwood plantations compared to the preference on using coconut pepper intercropping system. Among those two, coconut-betel intercropping system showed the highest preference. That is because coconut-betel intercropping system generates high additional income than coconut monoculture.

It can be noticed that coconut small holders valued certified fuel wood over the uncertified fuelwood. Moreover, respondents are highly interested in maintaining fuelwood plantation for both selling and domestic use apart from growing fuelwood solely for either selling or own consumption.

The monitory attribute imposed in to the logistic model is statistically significant with a positive coefficient by which indicates more price per kilogram of fuelwood will increase willingness to grow fuelwood plantation by coconut smallholders in the study area. MWTA on different levels (compared to the base level) of different attributes of coconut plantation based fuelwood growing model is given in Table 4.

Table 3. Results of the conditional logistic regression

Variables	Co- efficient	P value
Gliricedia	5.04	<0.001
Ipil-Ipil	1.96	<0.001
Coconut monoculture	1.32	<0.001
Coconut intercropped with betel	3.97	<0.001
With certification	2.45	<0.001
Cultivating for selling	0.60	0.280
Cultivating for selling and home use	1.38	<0.001
Price per kilo gram of fuel wood	0.37	0.020
Log likelihood	-179.01	

Table 4. MWTA compensation values by the respondents

Variables	MWTA (Rs./kg)
Gliricedia	22.90
Ipil-Ipil	5.50
Coconut monoculture	3.57
Coconut intercropped with betel	10.73
With Certification	6.65
For selling and domestic use of fuel wood	3.73

MWTA- Marginal Willingness to Accept

In terms of monetory value (on the basis of per kilogram), coconut smallholders value gliricedia as a fuelwood generating crop over the calliandra from Rs. 22.90 per kilogram, if the utility on growing fuelwood plantation is increased by 1%. Because when comparing with other fuel wood types, gliricedia provides numerous benefits such as Nitrogen fixation, supportive tree *etc.* Secondly, coconut betel intercropping system derived the largest value (Rs. 10.73 per kilogram) if the utility on growing should be increased by 1%, as it generates an additional income.

Respondents have a better attitude towards the certification as they prefer more to sell their fuel wood with an appropriate quality certification. Based on the coconut growers in the study area, utility of growing can be increased by 1% if certification is valued by Rs. 6.65 (on the basis of price per kilogram of fuelwood) over without certification. Rather than solely sell or use fuelwood only for domestic use, farmers value more cultivating fuelwood for both selling and own consumption.

CONCLUSIONS

This study reveals that coconut smallholder's utility on growing fuelwood plantations significantly depends on some attributes like fuelwood species, cropping system, certification and purpose of cultivation. Moreover, this study should be extended further to find out other attributes which has a significant impact on the utility of growing fuelwood plantations. Among these findings, the most valuable and notable point is the significance of preferring a quality certification on the fuel wood that they are producing.

Moreover this study alarms that people place more value on the attributes under the investigation on the basis of price per kilogram gain if the utility of growing fuelwood plantations is increased by 1% which is not a favorable feature in promoting fuelwood plantations under coconut smallholders. This matter should be seriously taken up in the policy context especially by the authorities who are planning to promote growing plantations for fuelwood under coconut as a solution to meet the increasing demand for fuelwood by the industry.

ACKNOWLEDGEMENTS

Authors wish to express their profound gratitude to Mr. L. Rajapaksha, coconut development officer of Yakwila area and Mr. D.C.I. Nishantha for the support given.

REFERENCES

Aizaki, H. (2012). Basic functions for supporting an implementation of choice experiments in R. *Journal of Statistical Software, Code Snippets*, **50** (2), 1-24.

Anon. (2012). Ministry of power and renewable energy, available form: http://www.info.energy.gov.lk/

Casellas, K. and Berges, M. (2009).Consumer's willingness to pay for milk quality attributes at conference of The International association of agricultural economics.

Birol, E., Smale, M. and Gyovai, A. (2006). Using choice experiment to estimate farmer's valuation of agro biodiversity of hungarian small farms, *Environmental and Resource Economics*, **34**, 439-469.

Gunathilake, H.A.J., Joseph, P.G., Peiries, T.S.G. (2006). Sustainable biomass production of Sri Lanka and possibilities for ago-forestry intervention.

Herath, H.M.K.N.B., Jayasinghe-Mudalige, U.K., Guruge, T.P.S.R. and Herath, H.M.L.K. (2015). Impact of information shock on consumer preferences on food quality: case of milk powder products. In: proceedings of 14th Agricultural Research Symposium, 25-26 June, 2015 Wayamba University of Sri Lanka, 417-418.

Kuruppu, I.V., Edirisinghe, J.C., Herath, H.M.L.K. (2014). Farmer's valuation of agro biodiversity in home gardens: A case study in Kurunegala district. In: proceedings of 13th Agricultural Research Symposium, 7-8 August, 2014 Wayamba University Of Sri Lanka, 62-63.

Ryan, M., Kolstad, J., Rockers, P. and Dolea, C. (2012). How to conduct a discrete choice experiment for health and workforce recruitment and retention in remote and rural areas: a user guide with case studies. World Health Organization and Capacity Plus: World Bank.

Sugathapala, A.G.T. (2007). Biomass gasification in Sri Lanka. Tech monitor 2007.