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Socio-Economic Factors Affecting Tree Cultivation in Home Gardens in Kandy and Kegalle Districts

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ABSTRACT. *Home gardens provide many forest products and environmental services. The objective of this study was to identify the socio-economic factors influencing cultivation of trees in home gardens in Kandy and Kegalle districts. A stratified random sample of 122 households from six villages in the two districts were interviewed with a structured questionnaire. Four multiple regression models were fitted for fruit, timber, multipurpose and all trees to find the relationship between the number of trees cultivated during a period of two years and seven selected socio-economic variables. Results show that tree cultivation is an activity of poor households and that it could potentially play a significant role in reducing rural poverty in Sri Lanka. Economic incentives to cultivate timber trees have been overshadowed by the existing heavy regulations on felling and transport. Environmental awareness programs and secured land tenure could be used to promote tree cultivation in home gardens.*

INTRODUCTION

Sri Lanka, like many other developing countries, has gone through a rapid phase of deforestation. The annual rate of deforestation between 1956-1992 was more than 40,000 ha while average annual replanting during the same period was only about 2,000 ha. Such a rapid deforestation can drastically reduce the capacity of the remaining forests to provide environmental services such as biodiversity, climatic moderation, watershed protection, recreational facilities and aesthetic values. Further, it reduces the capacity to provide forest products such as timber and non-timber forest products.

Deforestation is a land use change. Some forms of these land uses developed after clearing forests would closely resemble forests that would act as substitute for natural forests in provision of some of the forest products and services. Home gardens are an extraordinary case of successful agroforestry systems, which have evolved based on peoples' own needs and traditions. They are one of the best examples for land uses, which closely resembles natural forest. Home gardens provide many forest services and products. In an assessment made in 1986, it was found that home gardens provide 40% of the timber supply in the country (FSMP, 1995). According to the Forestry Sector Master Plan home gardens could play a major role in future wood supply in the country (FSMP, 1995). Moreover, home gardens may play a very important role in supplying some non-timber forest products such as medicinal plants, spices, ornamental plants, fruits and vegetables and generate income for poor households.

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Majority of third world rural households generates some of their income from planting timber and non-timber trees (Arnold, 1997). Donor organizations have tried to arrest deforestation and alleviate rural poverty by promoting smallholder tree cultivation in the past few decades. But these efforts in developing countries have had only a limited impact on reforestation. A more diffused approach rests on the assumption that smallholders will plant trees on their own with or without minimal external assistance, provided that they face attractive economic incentives (Godoy, 1993). As pressure leading to progressive fragmentation and overuse of arable lands increases, the ability of smallholders to achieve food self-sufficiency from their lands has been declining. Rural populations have increasingly relied on tree-based income to meet their food and other needs (Fissha, 1987; Liedholm and Mead, 1993).

Despite the widely recognized importance, the scientific information required to implement a development program for home gardens is lacking. Research effort on socio-economic aspects of tree cultivation in home gardens has also been limited. Adoption of tree cultivation varies across households. Some households may cultivate more trees due to their socio-economic characteristics, while others may cultivate few. Identification of the factors affecting adoption of tree cultivation is an initial step towards formulating polices and programs aimed at promoting tree cultivation in home gardens. Thus, the objective of this study was to identify the socio-economic factors determining tree cultivation of selected rural villages in Kandy and Kegalle districts of Sri Lanka.

THEORY

Theory and empirical evidence in a few previous studies have drawn attention to the socio-economic factors influencing smallholder commercial tree cultivation (Godoy, 1992; Arnold, 1997). However, except some related studies (Godoy, 1993; Arnold, 1997) there is no single study that provides complete coverage of theoretical relationships among commercial tree cultivation and socio-economic factors. The findings of such studies have been employed to develop the hypotheses for this study. This study includes seven socio-economic factors as determinants of tree cultivation in home gardens. The determinants of tree cultivation and their expected relationships are shown in Table 1.

In addition to the seven socio-economic factors, subsidy may affect the smallholder commercial tree cultivation. However, there are very limited or no subsidies given for tree cultivation in both Kegalle and Kandy districts. Therefore, empirical testing of the effect of subsidies on tree cultivation was not possible in this case. Employment was initially chosen as a variable. However, employment level was dropped due to its high correlation with total income.

Expected income from trees was obtained by using net present value (NPV) criterion. Trees provide income over a period of time. Therefore, the decision whether to plant trees depends on the present value of the income stream over time. General economic intuition suggests that if a type of tree provides more income, people tend to cultivate more of them. Therefore, it is hypothesized that commercial tree cultivation is positively related to the expected income.

Table 1. Expected relationships of selected variables and tree cultivation.

Independent variables	Expected relationship
Expected income (NPV) (X_1)	Positive
Total family income (X_2)	Negative
Attitude (X_3)	Positive
Family size (X_4)	Positive
Education level (X_5)	Positive
Land size (X_6)	Positive
Land tenure (X_7)	Positive

As the household income level increases people diversify their economic activities (Godoy, 1993; Gunatilake *et al.*, 1993; Gunatilake, 1998; Gunatilake and Chakravorty, in press). High income earners employed in both private and public sector shows little interest toward tree cultivation due to lack of time. Such groups may want to cultivate ornamental trees and flowers, rather than commercial trees. Therefore, it is hypothesized that tree cultivation is inversely related to the family income. A negative relationship between family income and tree cultivation was found in homesteads of smallholders in Orissa, India and in Brazil (Hecht *et al.*, 1988). Family income was also found to have negatively influenced on forest products' collecting activities in dry lands in India (Jodha, 1990). Forest products provide higher proportion of income of poor families in Sri Lanka (Gunatilake *et al.*, 1993; Gunatilake, 1998). These findings are consistent with the results of case studies conducted under different situations (May *et al.*, 1985; Falconer, 1990; Leach and Fairhead, 1994).

A person with a positive attitude towards an activity would tend to undertake more of that activity. Thus, it is hypothesized that tree cultivation is positively related to attitudes. Family size is directly related to the expenditure of the households. Moreover, large families may provide extra labour for tree cultivating activities. Many studies have suggested that family size, in low-income groups in rural areas of developing countries, is positively related to tree cultivating activities (Godoy, 1993; Arnold, 1997). Therefore, it is hypothesized that family size is positively related to the tree cultivation activities in Sri Lanka.

A better education level will enhance job opportunities in any society. They may reduce the need to cultivate trees to meet family food and other needs. In addition, highly educated people who are employed outside the rural community may face time constraints for cultivating trees in their home gardens (Gunatilake and Chakravorty, in press). However, as the level of education increases, the awareness on environmental aspects also improves. Environmental awareness may persuade people to cultivate more trees in their home gardens. These two effects of education may work against each other. Therefore, it

is an empirical question whether education increases tree cultivation or not. In this study we hypothesized that education level and tree cultivation are positively related.

Land is perhaps the most critical factor for tree growing. The larger the land holding, greater the number of trees which can be grown. Although this is generally true, when the land is bigger than a certain critical level, it allows commercial monocultures. This study hypothesized that land size is positively related to tree cultivation. Many studies suggest that smallholders must have security over land or trees, before they cultivate and care for trees (Godoy, 1990). If society denies them a stake in the future benefits arising from trees or tree products, they would not want to plant trees (Fortmann and Bruce, 1988). The failure of many countries to promote more sustainable forest management after nationalizing forests and failure of community forestry over private forests support this idea (Repetto, 1988). It has been observed that smallholders introduced long-term crops, instead of shifting cultivation, when they have been assigned secured tenure (Fortmann and Bruce, 1988). Therefore, it is hypothesized that commercial tree cultivation is positively related to the secured land tenure.

MATERIALS AND METHODS

Data required to develop smallholder tree cultivation models for both Kegalle and Kandy districts were collected using semi-structured questionnaire. Six *Gramaseva Niladhari* Divisions (GND), namely Mahakanda, Sarasawigama and Galaha for Kandy district, and Beragala, Gangoda and Welimannathota for Kegalle district were selected for the study. The selection of villages was based on the information collected by a rapid appraisal, conducted prior to the field survey. Secondary information on tree cultivation activities was collected at the village level from the *Grama Niladharis*.

A total sample of 122 households (15.8% of the total households in the six villages) was divided among six villages and a random sample of 24 was interviewed from each village. The sample selection was purposely restricted to the smallholders who have undertaken tree cultivation activities during 2000-2001. In this study, tree cultivation was treated as an investment. If a household does not have any space to cultivate trees in the home garden, that household was not included in the sample. This may introduce a sample selection bias, if one treats the population as "all tree cultivators". The population of the present study is defined as the "current tree cultivators", because from a practical policy point of view, what matters is current tree cultivation. Tree cultivation is a long-term investment and today's action determines income and environmental amenities in the future. Therefore, examining the determinants of the current tree cultivation is more relevant from policy perspective. With this reasoning, the individuals, who did not participate in tree cultivation during the selected time period, were not considered for the study.

Field data collection was carried out during January to May 2002 using a semi-structured questionnaire. Data on general household information and tree cultivation patterns were gathered for the period from January 2000 to December 2001. To promote effective implementation of the study the selected households were fully informed about the purpose and objectives of this study. In addition to the general household information, nature of the ownership of the land and the data on smallholder tree cultivation such as types of cultivated trees, number of trees, objectives of tree cultivation, the total harvest that

could be obtained from those trees, methods of growing trees and utilization of the trees (timber, fuel wood, food, medicinal) were also collected.

The smallholder commercial tree cultivation model is specified with the following variables.

$$Y = \sum_{i=1}^{7} X_i + U_i$$

where;

Y - total number of cultivated trees; X_i - expected income (Rs.)
X_2 - total households income (Rs.); X_3 - attitudes; X_4 - family size
X_5 - education level of the head of the household; X_6 - land size (ha)
X_7 - land tenure; U_i - error term

Smallholder tree cultivation was grouped as timber, fruits, multipurpose and all trees and a separate regression model was fitted for each category. In measuring independent variables, some of the information were obtained directly from the questionnaire. Most of the data collected from the survey were, however, not directly amenable to the econometric analysis. Therefore, the collected data were transformed to useful forms before fitting regression models. Expected income of tree cultivating was obtained by calculating the net present value (NPV), aggregating the benefits of cultivated trees over 30 years for each household with social discount rate of 6%. If a lifespan of a tree is less than 30 years, adequate cycles were considered assuming the repetition of cultivation of the same trees. This was done to have comparable values of short term trees with timber trees. Educational level was grouped with five categories such as no schooling (1), primary education (2), secondary education (3), tertiary education (4) and higher education (5). Income level was calculated based on the yield, prices, salaries and other relevant information obtained from respondents.

Farmer's attitudes towards tree cultivation were measured using eight different aspects. To measure each attitude eight questions about tree cultivation was given to the respondents. The response to each question was recorded as strongly agree (5), agree (4), neutral (3), disagree (2) and strongly disagree (1), for favourable statements and *vice versa* for unfavourable statements. To get an idea on overall attitudes, total scores for all the eight attitude responses were summed up. Land tenure was used as a dummy variable. Only two categories of tenure were considered; owned and otherwise (all the other type of land tenure systems like joint, rental, encroach). Size of the land was measured in hectares.

Since there was no prior knowledge about the relationships, scatter plots were used for preliminary scrutinizing of the independent variables. Coefficient of determination was below 0.3 for all the models. Examination of the covariance matrix indicates that there was no severe multicollinearity in the data for all the tree cultivation models. However, heteroscedasticity was present in all the models. The low R^2 shown in the OLS models may be due to the presence of heteroscedasticity. Table 2 shows the test statistics and critical values of χ^2 tests for heteroscedasticity for the four regression models. Final models were fitted using the HET command in Shazam for correction of heteroscedasticity.

Table 2. Diagnostic test statistics for heteroscedasticity.

Model	Harvey test statistics	Glejser test statistics	Critical value
All tree model	795.5	123.7	14.1
Fruit tree model	91.7	115.4	14.1
Timber tree model	409.2	68.1	14.1
Multipurpose tree model	131.4	88.9	14.1

RESULTS AND DISCUSSION

About 89% of the total cultivated trees were short-term trees (72% of fruit trees and 17% of multipurpose trees) in the study area. Papaya and banana contributed to 22% of the total short-term trees. Eleven per cent out of the total cultivated trees was timber trees and the rest was multipurpose trees (17%). The heteroscedastic model did not provide a goodness of fit measure similar to R^2.

In all tree cultivation model all the variables confirmed the expected signs by the postulated hypotheses, except for NPV (Table 3). In this model, all tree types were aggregated thus resulting in distorted result. When there are large numbers of low-income generating trees together with few high-income generating trees, it is possible to observe a negative relationship between number of trees and expected income.

Table 3. Relationship of variables to tree cultivation of all tree model.

Variable name	Estimated coefficient	Standard error	T-ratio	P-value
Expected income (NPV)	-74.049	14.57	-5.081	0.000
Total family income	-2052.9	370.3	-5.542	0.000
Attitude	0.55404E+06	0.2052E+05	2.700	0.007
Family size	0.56764E+06	0.2125E+05	2.672	0.008
Educational level	0.27308E+07	0.1033E+06	2.643	0.008
Land size	4.2946	3.769	1.139	0.255
Land tenure	0.35641	0.8372E-01	4.257	0.000
Constant	18424	2265	8.133	0.000

The education levels of the families were positively related to the tree cultivation ($P<0.05$). People with higher literacy would promote tree cultivation. Smallholders' attitude is positively related to the tree cultivation ($P<0.05$) as expected. Thus, results show that positive attitudes help to promoting tree cultivation. Family size showed a statistically significant ($P<0.05$) positive relationship with tree cultivation. As the family size increases, it provides extra labour for tree planting. Moreover, larger family size demands more food and other non-food materials, indicating that, people would plant more trees as family size increases. Land tenure showed a statistically significant ($P<0.05$) positive relationship with tree cultivation. This result indicates that when the holder owns the land, tendency is to cultivate more trees. Total household income showed a statistically significant ($P<0.05$) negative relationship with the tree cultivation. This shows that lower income households rely more on tree cultivation as an income generating activity. Therefore, the results are in harmony with the theory discussed earlier.

Results obtained from the fruit tree model are given in Table 4, where dependent variable is the number of fruit trees cultivated within the study period. The fruit trees reported in the survey include guava, butter fruit, rambutan, ramontchi (uguressa), lemon, mandarin, mangosteen, papaya, banana, sapota (sapadilla), durian, tamarind, rose apple (jambu), water apple (pini jambu), golden apple (belli), wood apple, jamaica plum (amberella), pomegranate, avocado, mauritius plum (lovi), olive (veralu), and cherimoya (anona). Although only woody perennial trees were considered, bananas and papayas, which are grown extensively by smallholders, were also included in this sample.

Table 4. Relationship of variables to tree cultivation of fruit tree model.

Variable name	Estimated coefficient	Standard error	T-ratio	P-value
Expected income (NPV)	9.3148	4.253	2.190	0.029
Total family income	-447.09	52.46	-8.523	0.000
Attitude	-0.15964E+06	0.1787E+05	-8.932	0.000
Family size	0.39678E+06	0.3735E+05	10.62	0.000
Educational level	0.13327E+07	0.1624E+06	8.208	0.000
Land size	-26.005	2.436	-10.68	0.000
Land tenure	-1.7729	0.1516	-11.69	0.000
Constant	0.12256E+06	0.1087E+05	11.27	0.000

Unlike in the previous model, the NPV showed a statistically significant ($P<0.05$) positive relationship with the number of fruit trees, *i.e.*, when the expected income goes up, the smallholders prefer cultivating more fruit trees. This confers that smallholders behave in an economically rational manner. Papaya and banana are the dominant fruit trees found in the sample. The ability to obtain an income within a short term as well as the ability to fulfil household consumption needs were the primary reasons for this. This result also

indicates that getting more income within a shorter time period has become one of the objectives of tree cultivators. A long gestation period to provide benefits is one of the reasons to have less preference for timber and other trees compared to fruit trees.

Family income showed a statistically significant ($P<0.05$) negative relationship with the number of fruit trees. This indicates that when the family income increases, smallholder tree cultivation activities become less important for rural households. With the above results we can deduce that cultivating fruit trees in their gardens has become an important income for low-income people as well as an important source of food. The attitude of the smallholders is negatively related ($P<0.05$) to the fruit tree cultivation. In the all tree model, attitude showed a positive relationship with total number of trees (Table 3). The number of members in the family showed a statistically significant ($P<0.05$) positive relationship to fruit trees. This result also shows that cultivating fruit trees has been a main source of income of low income families and further it may be a main way of increasing nutrition in the family. Education level is also a factor, positively contributing to fruit tree cultivation as in the all tree model. Level of education may encourage fruit cultivation through a better understanding of the nutrition requirements of the family.

Land size showed a negative relationship ($P<0.05$) to the fruit trees. This result is not in harmony with the theory discussed earlier. It is generally expected that bigger land sizes have a positive impact on tree cultivation. This result may imply that if the people have large home gardens, they may be able to use the land for commercial monocultures such as tea or rubber. Land tenure also showed a statistically significant ($P<0.05$) negative relationship with number of fruit trees. This result is also in contrary to the expectations. However, prominence of the short-term fruit trees in the study area explains the results. As insecure land tenure persuades more short-term trees in home gardens, there is a negative relationship of land tenure and number of trees.

The results of the timber tree cultivation model are given in Table 5. The survey reported six timber tree species, namely teak, nadun, halmilla, mahogany, champaka (gini sapu) and ginikooru cultivated by the smallholding sector which is 11% of the total sample.

Table 5. Relationship of variables to tree cultivation of timber tree model.

Variable name	Estimated coefficient	Standard error	T-ratio	P-value
Expected income (NPV)	-96.54	13.67	-7.064	0.000
Total family income	-2633	299	-8.807	0.000
Attitude	0.512E+06	0.543E+05	9.305	0.000
Family size	-0.113E+06	0.2546E+05	-4.470	0.000
Educational level	-0.6545E+06	0.1455E+05	-4.499	0.000
Land size	-30.887	33.79	-0.9141	0.361
Land tenure	4.7671	0.5324	8.954	0.000
Constant	-0.1831E+07	0.1789E+05	-10.24	0.000

The behaviour of the expected income of the timber tree model is similar to the results of the all tree model. Expected income is negatively related ($P<0.05$) to the number of timber trees. This result is not consistent with the theory discussed earlier. It implies that income may not be a major objective in planting timber trees. This finding, provides an important policy implications. Existing heavy regulations on felling and transporting timber has taken the property right of timber trees from the owners to the government. Even if a smallholder plants a timber tree today, it is not assured whether they will be able to sell the trees under the existing regulations. The institutional set-up may be one of the reasons for this unexpected result. Moreover, when returns occur in the distant future, discounting complicates the situation. Therefore, expected income may not be a factor to be consciously considered by smallholders, in the case of timber trees. Forestry Sector Master Plan expects the smallholding sector to act as a main source of supply of timber (FSMP, 1995). The results of the present study however, indicates that incentives for growing trees (the expected income) is not directly related to the cultivation of timber trees in home gardens.

Family income shows a statistically significant ($P<0.05$) negative relationship with timber tree cultivation, which is consistent with the results of the all tree and fruit tree models. This further highlights the importance of trees for poor households. The attitudes of people on timber trees were positively related ($P<0.05$) as expected. The attitude statements mostly dealt with the environmental concerns. Therefore, people may cultivate timber trees with environmental rather than economic objectives. This also explains further why the attitude variable did not provide expected results in the fruit tree model. People seem to cultivate fruit trees for economic objectives while timber trees may serve some environmental objectives. The results also show that people tend to cultivate few timber trees when family size is large. As timber trees do not provide the current needs of the family, they tend to cultivate more short-term trees, which provide such needs. Due to land limitation other trees that provide current needs compete with the number of timber trees cultivated. The negative relationship shown in this model between the level of education and cultivation of timber trees may be due to measurement errors. Land tenure for timber trees showed the expected positive relationship ($P<0.05$). The model for fruit trees showed a negative relationship in this variable (Table 4). This also reveals that people tend to cultivate trees that provide long-term benefits than shot-term benefits, if the ownership of the land is secured.

The results of the multipurpose tree cultivation model are given in Table 6. The survey reported nine multipurpose tree species in the home gardens, *i.e*, jack, margosa, mango, coconut, garcinia (goraka), pihambiya, haverinuga, cashew, tamarind and arecanut, cultivated by smallholders in the selected period of time. In this model, the significant positive relationship shown between expected income and number of multipurpose trees indicated that, the increase in expected income lead to cultivate more multipurpose trees. A negative relationship is shown between multipurpose trees and the total income, giving the same result as the previous models. Thus, when the income of the family is lower, smallholders tend to cultivate more multipurpose trees. Multipurpose trees provide long-term as well as short-term benefits. Mainly fruits and wood fuel are harvested in short-term and timber is harvested in the long-term. Eighty-nine households of the selected sample had cultivated coconut. This tree has many primary uses in short-term than in the long-term.

Table 6. Relationship of variables to tree cultivation of multipurpose tree species model.

Variable name	Estimated coefficient	Standard error	T-ratio	P-value
Expected income (NPV)	131.68	21.04	6.259	0.000
Total family income	-89.869	10.06	-8.935	0.000
Attitude	-53587	6030	-8.886	0.000
Family size	22332	9242	2.416	0.016
Educational level	0.54101E+06	0.6164E+05	8.777	0.000
Land size	-13.580	2.198	-6.180	0.000
Land tenure	0.45391	0.1402	3.238	0.001
Constant	0.15734E+06	0.1714E+05	9.182	0.000

The attitudes showed a negative relationship ($P<0.05$) with cultivation of multipurpose trees. This unexpected result may indicate that environmental concerns are of less importance in the case of multipurpose trees. People may give more economic consideration in this case. Household size was positively related ($P<0.05$) to multipurpose trees. Results also showed the economic importance in the cultivation of multipurpose trees with the increase of family size. The reason is due to that, multipurpose trees fulfill many needs such as food, medicines and cash income in the short-run. Further, a positive relationship ($P<0.05$) was observed between education level and multipurpose trees. When people's education level is higher they tend to cultivate more trees. There is a negative relationship ($P<0.05$) between the land size and multipurpose trees. As explained earlier, when the land area is large, people tend to grow tea, rubber and coconut monocultures. Land tenure is positively related ($P<0.05$) to the number of multipurpose trees as in the previous cases.

CONCLUSIONS

All the models consistently showed that tree cultivation is a poor household activity as family income consistently showed a negative relationship with number of trees. The present study indicated that smallholder tree cultivation may have a potential as a poverty alleviation measure. Tree cultivation reduced with the increase in land holding size. This finding may imply that trees play a significant role in provision of food, other materials and cash income for poor households. Moreover, large families grow more trees that provide short-term benefits. All these findings suggest the importance of tree cultivation for poor households. Planners who work on poverty alleviation in rural areas can take this fact seriously in their planning activities.

Results with respect to expected income from trees vary among the models. When short-term benefits are prominent, expected income increases the tree cultivation. Negative

relationship between expected income and number of timber trees cultivated should draw attention of the policy makers. Despite the expectations of Forestry Sector Master Plan for the home gardens to play the major role in timber supply, it appears that the economic incentives for growing timber trees is not reaching the smallholders. This may be due to the severe restrictions on the timber market through felling and transport permits.

Attitudes and education level play a role in tree cultivation among the smallholders. Despite the variation in the direction of relationships, the results show that environmental awareness programs may be able to enhance tree cultivation to some extent among the smallholders. Land tenure is another variable that deserves attention of the policy makers. Results consistently show that people grow more trees when tenure is secured. When people are confronted with insecure land rights, they tend to cultivate more short-term trees. Many home gardens have been established in government owned lands. Provision of land titles for these lands may increase the tree cover in the country.

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