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Factors Affecting Adoption of Improved Maize Varieties in Western Hills of Nepal - A Tobit Model Analysis

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ABSTRACT

Maize is the most important cereal crop of hills of Nepal which is used as food for consumption and fodder for animals. A survey was carried out in Baglung and Palpa districts of western hills of Nepal to find out the determining factors of the adoption of improved maize varieties. The number of households sampled from each of the district was 90. Semi structured questionnaire was administered to 180 households chosen using simple random sampling. The most popular improved varieties in the study sites were Manakamana-6, Rampur composite and Arun-2. There seems to be a gap between the recommended practice and current level of practice at the farmers' level in some of the factors like nitrogenous, phosphorus and potassium fertilizers, method of planting. The factors affecting the adoption of improved maize varieties were measured using the Tobit Regression model. Eight socioeconomic variables were taken into consideration for the study. The major socioeconomic variables taken in the study were age, gender, educational status, membership of the farmers' group, extension contact, family size, farm size, farming experience and access to credit. Educational status, extension contact, farm size and access to credit were found statistically significant. Each unit increase in these variables, increases the intensity of adoption of improved maize varieties by 7.14, 12.47, 1.9, 5.2 and 1.6 percentage respectively. Policy that enhances farmers' access to credit, well equipped extension workers, education will facilitate adoption through increased access to seeds of improved maize varieties and will enhance the intensity and rate of adoption.

KEYWORDS*:* Adoption, Maize, Tobit

Introduction

Maize is the second most important crop in Nepal. It is cultivated in 882,395 hectares of land. Its total production is about 2,145,291 metric tons. Its average productivity is 2,431 kilograms per hectare (MoAD, 2016). The hill area that extends from east to west is the most important maize growing area. Eastern, central and western hills are the highest maize growing areas of the country. Maize is the most important cereal crop in the hills of Nepal, where the grain is used for human consumption and the stover for animal fodder. It is usually used for food, feed, fodder, and fuel and is significant source of energy (Adhikari, 2008). Seed replacement rate in maize is about 11.3% (Pokharel, 2013). More than two thirds of the maize produced in the mid hills and high hills is used for direct human consumption at the farm level and the ratio of human consumption to total production is higher in less accessible areas (Paudel, 2008). Only about 16% of Nepal's total land area is cultivated. Of this, the terrain, where 38% of the land area is cultivated, is the most important. Maize is the third most important crop here after paddy and wheat. The second most important agricultural land area is the mid hills where 15% of land is cultivated. Out of the total maize area about 78% falls in the hills area (mid hills 70%, and high hills 8%). Maize is generally grown under rain-fed conditions in Nepal with basal application of low quantity of farm yard manure. Unavailability of quality seeds of farmer's preferred varieties at right time, in desired quantities and at reasonable price is the major constraint for increasing the production (Adhikari *et al.*, 2003). Most of the farmers keep their own seeds year after year. More than 88% of farmers used farm saved seeds (Gurung, 2011). Maize yield fluctuates seasonally and annually, especially in the hills. Although maize yields increased slightly over the past five years, there has been very little yield improvement when compared to nationwide yield 30 years ago. This is probably due to the expansion of maize cultivation into less suitable terrain, declining soil fertility, and the adoption of improved management practices. While productivity in the country is almost stagnant, the overall demand for maize driven by increased demand for human consumption and livestock feed is expected to grow by 4% to 6 % per year over the next 20 years. Thus, Nepal will have to resort maize imports in the future, if productivity is not increased substantially. National average yield of maize is 2.5 t/ha. Where maize is grown, farmers often do not apply adequate amounts of fertilizer. Even when applied, the basal application, which is crucial from the production point of view, is missed. Application of fertilizer is very important for increasing the productivity (Tiffen, 2003). The maize yield of different maize varieties respond positively to seed rate (Pinter *et al.*, 1994). Recommended seed rates usually result in increments in maize yield (Lucas, 1986). Generally, the presence of weeds for the first six, nine and twelve weeks after sowing and for the entire growing season of maize resulted in estimated yield losses of 36, 61, 80, and 85%, respectively (Assefa, 1999). The technology adoption index is a catch-all measure of technology practices of the farmers (Timsina *et al.,* 2012). Technology adoption index measures the adoption level of the number of practices of any technology. The technology adoption index in the western hills of Nepal is calculated to be 63%. Rampur composite, Manakamana-6 and Arun-2 are the popular varieties in the hilly areas whereas the varieties Manakamana-1 and Manakamana-5 are being disadopted by the farmers (Lamichhane *et al*, 2015).

The decision of whether or not to adopt a new technology hinges upon a careful evaluation of a large number of technical, institutional and socio-economic factors (Feder *et al*, 1985). Depending on the context, these can include demographic characteristics of the household (size, age of household head and gender composition, wealth, education level of the household head). Large amount of theoretical work has focused on adoption in general, only few cases have explained the factors affecting farm-level decision to adopt improved maize (Byerlee, 1994; Heisey, 1993).

Understanding the factors which affect the maize technologies adoption in the study area is vital in promoting use of the maize technologies in order to enhance its production. This current paper therefore seeks to identify and describe the major variables (factors) that underlie adoption of improved maize varieties in western hills of Nepal.

Methodology

Study Sites and Sampling

The study was based on the farm level data of maize farmers in western hills of Nepal. Two districts from western mid hills; Baglung and Palpa were purposively selected, because maize is prominently produced due to its suitable environmental conditions. Malika Village Development Committee (V.D.C) and Deurali V.D.C were selected from Baglung and Palpa districts respectively based on the accessibility. The study used mainly the primary data. Hundred and Eighty farm household heads were selected from the study area using simple random sampling technique taking into account proportional to size (number) of maize growers in each of three selected areas. Data collected include maize area under cultivation (ha) and the socioeconomic variables such as: age, gender, farming experience, level of education, contacts with extension agents, farm size, family size and access to credit.

Tools for Determining the Factors

Tobit model was used to measure the intensity of adoption (McDonald and, Moffit 1980; Kristjason *et al*., 2005; James *et al*., 2006) and marginal effect. This model was chosen because; it has an advantage over other analytical models in that, it reveals both the probability of adoption and intensity of use of the technology (Maddala, 1992; Johnston and Dandiro, 1997). Strictly dichotomous variable often is not sufficient for examining intensity of adoption (Feder *et al*, 1985). In such cases, Tobit model, which has both discrete and continuous part, is appropriate. The Tobit model is a censored normal regression model. Its estimation is related to the estimation of a censored and truncated normal distribution. The function is estimated from a censored sample where the sample population consists of both adopters and non-adopters of improved maize varieties. The intensity of the adoption of Improved Maize Varieties (IMV) is defined as the proportion of total area planted with IMV to the total maize land area. Let Y be the intensity of the use of an improved technology, Y* is equal to an index reflecting the combined effect of the explanatory variables hindering or promoting the use of an improved technology, Y* is not observable and is recorded as zero for not having area under high yielding variety.

The empirical Tobit model is expressed as:

$$Y = X\beta + \mu_i \text{ if } X\beta > \mu_i, 0 \text{ if } X\beta = \mu_i \quad (1)$$

$$Y = Y^*, \text{ if } Y^* > 0$$
$$= 0 \text{ if } Y^* \leq 0$$

Where,
X_I = vector of the explanatory variable
β = vector of the Tobit maximum likelihood estimates
μ = random error term (independently distributed with mean 0 and variance)

To examine the intensity of use of improved maize varieties, the number of hectares of land planted to improved maize is specified as a function of socio-economic and institutional factors as follows:

$$Y = \beta_0 + \beta_1 AGE + \beta_2 GENDER + \beta_3 EDU + \beta_4 MEMG + \beta_5 EXT\ CONTCT + \beta_6\ FAMILY\ SZ + \beta_7\ FSZ + \beta_8\ CREDIT + \mu_i$$

Where Y= percentage of farmers' total maize area planted to improved open pollinated varieties, β_0 = constant and μ_i = the random error term.
Table 1 describes the variables used in the Tobit model. Variables included controlling for social factors are age of the household head (AGE), Sex of the household head (GENDER), education level of the head of the household (EDU) and household membership in the group (MEMG), contact with the extension visit (EXT CONTCT), no of family members (FAMILY SZ), farm size (FSZ) and access to credit, that is if farmers had borrowed credit or not (CREDIT).

Table 1: Description of the Variables Used in the Tobit Model

Variables	Description	Unit	Expected sign
Age	Age of the household head	Years	+/-
Gender	Gender of the household head	1=male & 0= female	+/-
Education	Educational level of the household head	No of years of education	+
Membership in the group	Whether the farmers belong to any group or not	1= Yes & 0= No	+
Contact with the extension agent	Whether the farmer had contact with extension agent or not	1=Yes & 0= No	+
Family size	Number of family members in the family	No	+/-
Farm size	Total land owned by farmers	ha	+/-
Access to credit	Whether the farmers had access to credit or not	1= Yes & 0=No	+

Likewise Technology Adoption Index (TAI) was calculated and farmers were divided into different categories of adopter.

The Technology Adoption Index was calculated by using formulae:

$$TAI_i = 1/7(Ah_i/Ca_i + Sa_i/Sr_i + Na_i/Nr_i + Pa_i/Pr_i + Ka_i/Kr_i + Wa_i/Wr_i + Ra_i/Rr_i)$$

Where i= Numbers of farmers say 1, 2, 3,……………, n, TAI_i = Technology Aoption Index of i[th] farmer, Ah_i= Area under improved maize varieties (ha), Ca_i= Total area under improved maize varieties , Sa_i=Quantity of seed per hectare , Sr_i= Recommended seed rate, Na_i= Quantitiy of Nitrogen applied per ha, Nr_i= Recommended dose of Nitrogen per ha, Pa_i = Quantitiy of Phosphorus applied per ha, Pr_i = Recommended dose of Nitrogen per ha, Ka_i= Quantitiy of Potassium applied per ha, Kr_i= Recommended dose of Potassium per ha, Wa_i=Number of weeding applied Wr_i= Recommended number of weeding, Ra_i= Method of sowing, Rr_i= Recommended method of sowing.

Depending upon the extent of adoption of improved technologies the respondents will be categorized as: Low Adopters (LA) from 0-33 percent, Partial Adopters (PA) from 34 – 66 percent, and High Adopters (HA) from 67 – 100 percent.

Results and Discussion

Demographic Characteristics

Table 2 summarizes demographic characteristics of sampled farmers in the study area. The mean age of household head in Baglung and Palpa was 55 and 48 years respectively. The average size of the family in Baglung and Palpa was 5 and 4 respectively. Majority of the households were male headed households. Most of the households belong to Brahmin and Kshetri ethnicity. The average size of the lowland was 4.54 ropani in Baglung, 4.25 ropani in Palpa. Likewise the average size of upland was found to be 4.35 ropani in Baglung, 4.53 ropani in Palpa. The educational experience of the household heads in Baglung and Palpa districts were about 4.3 and 3.4 years respectively.

Table 2: Demographic Characteristics of the Study Sites

Socioeconomic Characters	Baglung	Palpa
Age of the household head	55	48
Family size	5	4
Male headed household	42	32
Female headed household	18	28
Ethnicity (number)		
Brahmin/Kshetri	51	50
Janjati	9	1
Dalit	0	9
Lowland (ropani)	4.54	4.25
Upland (ropani)	4.35	4.53
Education (yrs)	4.3	3.4

Note: 1ha = 20 ropani

Pattern and Extent of Adoption

The nature and extent of the modern variety adoption is a good measure of the crop research program. Adoption of crop varieties is measured generally by two indicators; the proportion of farmers growing modern varieties and the proportion of area under improved varieties. In overall 62.5% farmers were adopting improved maize varieties in the sampled households. Likewise out of the total maize growing area in the study sites, 62% of the area is covered by improved maize varieties. The most popular improved varieties mainly adopted by the farmers in the study sites are Rampur composite (40%), Manakamana-6 (40%) and Arun-2 (20%). The main reasons for adopting these varieties were being less prone to lodging, having good taste and having higher yield compared to the local ones. Despite of the adoption of the variety there were some varieties that were disadopted. The varieties disadopted were Manakamana-1 and Manakamana-5. These varieties were disadopted because they were prone to lodging and susceptible to diseases and pests.

Adoption Analysis of Improved Maize Technology

The responses received from the respondents were categorized as low (up to 33.33 %), medium (33.34 to 66.66 %) and high adoption (above 66.66 %). Table 3 presents the current level of practice of the different factors at the study sites taken into consideration. Average seed rate in Palpa is 40 kg/ha whereas in Baglung it is 49 kg/ha. Average use of Nitrogenous, Phosphorus and Potassium fertilizer in Palpa is 45, 11 and 10 kg/ha respectively whereas in Baglung it is found to be 75, 10 and 12 kg/ha respectively. Both districts were following the recommended number of weeding. Row planting is not followed by any farmers in both districts. Practice wise category of adoption of improved maize production technology is presented in Table 4.

With regards to recommended seed rate, all respondents in both districts were observed to be high adoption category. Suwar (1981) also found respondents to be in high adoption category regarding adoption of seed rate. With regards to Nitrogenous fertilizers, majority of the farmers in Palpa were from low adoption category whereas in Baglung majority of the respondents were from high adoption category. With regards to Phosphorus and Potassium fertilizers, all the respondents were from low adoption category. Govereh *et al.*, (2003) in Zambia also found the adoption of Nitrogenous fertilizers to be in high adoption category compared to other chemical fertilizers. None of the farmers were found to practice row planting in both districts. Ephraim and Featherstone (2001) also found that only 1% of the total sampled respondents followed the row planting in Tanzania. Data presented in Table 4 indicates that majority of respondents were found in high adoption category followed by medium adoption category and low adoption category. Etoundi and Dia (2008) report also found 70% of the respondents to be in high adoption category in adopting Maize improved technology in Cameroon. Low adoption of improved technology is due to non-availability of improved varieties' seed at proper time and lack of knowledge. The technology adoption index in Palpa and Baglung is 61% and 65% respectively.

Table 3: Recommended and Current Level of Practice of Different Factors Taken into Consideration at the Study Sites

Practices	Palpa		Baglung	
	Recommended Practice	Current Practice	Recommended Practice	Current Practice
Seed rate	20 kg/ha	40 kg /ha	20 kg/ha	49 kg/ha
Nitrogenous fertilizer	104.9kg/ha	45kg/ha	104.9kg/ha	75kg/ha
Phosphorus fertilizer	65.22kg/ha	11kg/ha	65.22kg/ha	10 kg /ha
Potassium fertilizer	50kg/ha	10kg/ha	50 kg/ha	12 kg/ha
Number of weeding	2	2	2	2
Planting method	row planting	sowing after plough	row planting	sowing after plough

Table 4: Frequency and Percentage of Farmers with Different Cultivation Practices

Cultivation Practices	Palpa			Baglung		
	Low Adopter	Medium Adopter	High Adopter	Low Adopter	Medium Adopter	High Adopter
Improved varieties	10(17)	20(33)	30(50)	6(10)	24(40)	30(50)
Seed rate	0	0	60(100)	9(15)	0	51(85)
Nitrogen	38(62)	5(8)	17(30)	6(10)	12(20)	42(70)
Phosphorus	60(100)	0	0	60(100)	0	0
Potassium	60(100)	0	0	60(100)	0	0
Weeding	0	5(8)	55(92)	3(5)	0	57(95)
Row planting	60(100)	0	0	60(100)	0	0

Note: figures within parenthesis indicate percentage

Analysis of the Factors Affecting the Adoption of the Improved Maize Varieties

The Tobit result shows the relationship between socio-economic factors of the respondents and the intensity of adoption of improved maize varieties in the study area. R^2 was calculated to be 0.737. The column, dy/dx in the table shows the marginal effect of an explanatory variable on the expected value (mean proportion) of the dependent variable. The estimated coefficients and t-ratios are presented in Table 3.

The coefficient of educational status is positive and significant at 10%. The positive coefficient of educational status means that there is a direct relationship between adoption of IMV and educational status, whereby as educational status increases, adoption level also increases among farmers. Per year increase in the schooling years increases the intensity of adoption by 7.1%. Similar type of findings were reported by Alao (1971).

Table 5: Tobit Model Analyzing the Factors Affecting the Adoption of Improved Maize Varieties in Western Hills of Nepal

Explanatory Variables	Maximum Likelihood Estimate	Standard Error	Marginal Effect (dy/dx)	p-Value
Constant	-0.057	0.227		0.753
Age	0.000	0.003	0.003	0.675
Gender	0.020	0.039	0.004	0.933
Educational status	0.005	0.002	0.071	0.079
Membership of farmers groups	0.003	0.003	0.167	0.864
Extension contact	0.383	0.035	0.124	0.000
Family size	-0.006	0.005	0.006	0.058
Farm size	-0.341	0.029	0.019	0.000
Farming experience	0.007	0.002	0.052	0.034
Access to credit	0.000	0.000	0.016	0.000
Log likelihood		-33.521		
R^2		73.722		
F- value		38.373		

The coefficient of contact with extension agents is positive and significant at 1% level. This agrees with the expectation that, there is a positive significant relationship between extension contact and adoption of IMV in the study area. Similar findings are reported by Kaliba *et al.*, 2000. The positive relationship suggests that, adoption of IMV increases as extension contact between the extension agents and farmers become more frequent. Contact with the extension personnel, intensity of adoption of the IMV by 12.4%.

Family size coefficient was negative and significant at 10% level of significance. The negative coefficient indicates that, the greater the family size the lower the intensity of adoption of IMV. It is likely that, farmers with relatively larger family sizes were attracted to other non-farm activities than relatively smaller households. Shakya and Flinn (1985) also found similar result.

The coefficient of farming experience was also positive and significant at 5% level and was in line with our expectation. This explains that more farming experience, higher the intensity of adoption of IMV. This result was also supported by the findings of Amaza *et al.*, 2007. Per year increase in the experience of the farmers increases the intensity of adoption by 5.2%.

The coefficient of farm size was negative and significant at 1% level. The negative coefficient shows an inverse relationship between farm size adoptions of IMV. In other words, the larger the farm size, the lower the potential of the intensity of adoption. Etoundi and Dia (2008) also pointed out that increasing the area diminishes the probability of adopting the improved variety. Increase in each unit of land increases the intensity of adoption by 1.9 %

Access to credit also had a positive coefficient and significant at 1% level. The positive coefficient indicates that adoption of IMV increase as farmers have adequate capital for the purchasing of inputs such as fertilizer and seeds. These findings were in line with that of Lawal *et al*., (2004). With the access of credit to the farmers' intensity of adoption of the improved maize varieties by 1.6 %.

Conclusions

The study was conceived with the objectives of finding the factors affecting the adoption of IMV in western hills of Nepal. Age, gender, educational status, membership of the farmers' group, extension contact, family size, farm size, farming experience and access to credit were the major socioeconomic variables taken into consideration. Educational status, extension contact, farm size and access to credit were found statistically significant. Policy should target at strengthening maize farmers to have improved access to credit. In addition, policy that provides adequately trained and equipped extension workers, higher level of education for disseminating technology information has the potential to increase the intensity and rate of adoption of the improved maize technology.

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Use of Geographically Weighted Regression to Determine Natural Rubber Productivity and Their Driving Forces: A Case Study in the Kalutara District of Sri Lanka

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ABSTRACT

The goal of this study was to analyze the productivity variation in smallholder rubber lands in Kalutara district located in the wet zone of Sri Lanka and spatial relationship of key drivers to the productivity variation. Low productivity has been a major challenge in rubber plantations in the country in recent years. In this study spatial modelling tools available in geographic information science were used to explore the spatial variability of the rubber productivity and explored the key drivers of it in spatial context. Geostatistical kriging analysis is a simple type of prediction method which includes the cross validation of prediction and error terms in forecasting techniques. The productivity of smallholder rubber lands in Kalutara district varied from 777 to 1463 kg/ha/year, while the highest average productivity was recorded in the Divisional Secretariat (DS) divisions; Palindanuwara, Beruwala and Kalutara. Low productivity was recorded in Matugama and in a few areas in Ingiriya and Bandaragama divisions. Local variation of driving forces behind the average productivity was explored using Geographically Weighted Regression (GWR) method. GWR explored the spatial variability of the relationship between productivity and fertilizer usage, weeding, soil conservation, number of tappable trees and age of trees under tapping. All the variables were found to present significant spatial variabilities. Apart from generating global significant value, the model resulted local variation of each parameter estimates with respect to the projected coordinates of the area. Emerge of sign change of local parameters observed in some areas cannot be observed globally. It is necessary to understand the significance level of local coefficient subject to the multicolinearity and spatial auto correlation.

KEYWORDS: Geographically weighted regression; Kriging geostatistical analyst; Spatial auto correlation

Introduction

Rubber sector plays a vital role in the Sri Lankan economy, in terms of export earnings valued about US$ 0.8 billion in year 2016 (Sri Lanka Customs Department, 2016). The Sri Lankan rubber sector comprises of smallholders (land extent less than 20 ha) and large estates (land extent equal or more than 20 ha). The average land productivity of rubber plantations was recorded as 819 kg ha^{-1} yr^{-1} in 2016 (ANRPC, 2017). However, this is far below the potential productivity which is about 2500 kg ha^{-1} yr^{-1} with the new recommended clones.

The average productivity has decreased in the country due to various reasons; *viz*. land fragmentation, low level of soil fertility and conservation practices, low quality of tapping and several rubber plant diseases recorded in the country. Among the major rubber producing countries, highest average productivity has been recorded as 1680 kg ha^{-1} yr^{-1} in Vietnam while Philippine has recorded the lowest productivity as 694 kg ha^{-1} yr^{-1} among the members of the Association for Natural Rubber Producing Countries in year 2016 (ANRPC, 2017). Further, average productivity varies with the geographic location within the country due to different environmental and management practices. Awareness on recommendations which is dependent on the effectiveness of extension services is generally related to adoption of management practices. However, finding a solution to low productivity issue is problematic due to unavailability of farm level information. Use of recommended agronomic practices and the way of land management by farmer vary from one land to another. Investigation of all possible reasons isn't a practical application. Hence, quantification of prevailing management practices by land is an essential requirement before applying any solution. Effect of agronomic and land management conditions and productivity has a spatial variability. Use of Spatial analysis tools in forecasting of unknown locations for the agronomic practices as well as the average yield is possible, and similar techniques are successfully used by many scientists in different occasions. Therefore, agricultural extension workers and policy decision makers have capability in deciding the level of improvement of agro-management practices to achieve desired productivity in the field. This is especially important in devising demand driven extension programs in the rubber sector.

With the advancement of Information Science, the Geographic Information System (GIS) has been used extensively to demonstrate the spatial variability of interested attributes for scientific and policy level decision making. GIS is a computer based information system which integrates hardware, software and data for capturing, managing, analyzing and displaying all forms of geographically referenced information. GIS also helps to answer questions and solve problems by looking at available data in a way that is quickly understandable and easily shared (Anon, 2012). Use of GIS in socio-economic applications including different policy sectors, has become an important tool in scientific research (Higgs *et al.,* 2003). Geostatistics is one of the most important spatial analyst tools that can be used for analysis of point data and combinations with various GIS layers. One of the common uses of Geostatistics is spatial interpolation or prediction which is used to predict values of a sample variable over the whole area of interest.

In order to model and understand the relationship and effect of different factors and rubber productivity at a given point of spatial location, Geographically Weighted Regression (GWR) can be applied as a method of quantitative analysis which facilitated global and local understanding of the processes. GWR is a method of analyzing spatially varying relationships. It is increasingly being used in geography and other disciplines that deal with spatial data. Recently, this technique has extensively applied in the disciplines of economics, urban studies and environment. It has also been used to study spatial variability in areas such as industry and nutritional poverty (Jaimes *et al.,* 2010). The behavior of variables at local level on deforestation of the state of Mexico has been analysed in that study. Several authors have found that socio-economic variables; land ownership, availability of credits, biophysical variables and other proximity variables have spatially varying relationships. Also some proximity variables of wood processing industry, *viz.* distance to highways and land allocation to households have been found as drivers of afforestation and there have been a positive and negative correlations with significant spatial variability in the Northern Vietnam (Clement *et al.,* 2009). Spatial heterogeneity is evident in most geographical phenomena. Partridge *et al.,* 2008 has observed the spatial heterogeneity of non-metropolitan growth mechanism including employment growth of US using GWR and has compared them with global estimates. It reported that influence of different variables have spatial variation but their predictive capacity depends on the location. In certain cases, global regression suggested that there is no average effect on growth, while such variables have positive and negative effects for some regions. GWR allows individuals to explore and understand the spatial distribution of variables or processes by fitting a regression equation to any point in space. For this study, GWR is used because unlike the "classic" methods it considers the location of the phenomenon studied. This paper does not seek any causal depth in its models, but it rather concerns about providing an approach to an explanation of relationships that occur spatially.

Land productivity is among the key indicators which drives the sustainability of the rubber sector. Analyzing this indicator in the spatial domain is important in extension planning and various policy implications. Currently, it is being realized that GIS provides easy access to spatial information for policy makers and administrators. This reflects in the growing interest in the concept of Spatial Data Infrastructure (SDI) at national and global levels. Since SDI helps to provide geographic information to decision makers, it offers the prospect of better decision-making in the management and development of resources and, hence, improves socio-economic growth.

Kalutara district, which was considered in this study, has a rubber land extent of 19,053 ha according to the rubber land census conducted by Rubber Development Department (RDD, 2011). The extent of land in Kalutara district is the second highest when the country's total rubber extent, *viz.* 134,000 ha, recorded in year 2014 is concerned (MPI, 2015). The study is focused on the smallholder rubber sector in Kalutara district with the objectives of estimating the land productivity and developing maps employing GIS tools for the purpose of efficient decision making especially in extension activities.

Methodology

Study Area

The study area is located between 6^0 46' and 6^0 25' (Northern latitude) and 80^0 09' and 80^0 18' (Eastern longitude). Rubber is found in all 14 Divisional Secretariat (DS) divisions (Several Grama Niladari regions form a DS division) in Kalutara district belonging to agro ecological regions, WL_1 and WL_4.

Data Collection

Data were collected from a primary survey carried out in Kalutara district. Based on the number of smallholders in Kalutara DS division, the sample was selected by using stratified proportionate random sampling technique. The sample consisted of 250 smallholder farmers covering the rubber growing areas of Kalutara district. Sampling frame was decided based on the rubber smallholdings with mature rubber lands. The sample included farmers from all DS divisions based on the proportion of rubber lands in each division.

Preparation of Spatial Data Layers

Average productivity of smallholder farmers was calculated using production (kg) and mature extent of the land. ArcGIS version 10.2 was used for Geostatistical prediction to estimate the Productivity in unmeasured locations in Kalutara district. Ordinary kriging was practiced as the type of kriging while using optimum semivariogram model selection. The model for simple kriging explained in this study is given in equation 1. The spatial analysis framework which involved kriging is depicted in the Figure 1. All prediction were masked using smallholder natural rubber area map of Kalutara District.

$$Z(s) = \mu + \varepsilon(s) \qquad (1)$$

Where, μ is a known constant (mean) and ε is the error term. Simple kriging uses the semivariogram or covariance model. Cross validation was carried out in the final steps of kriging methodology. Cross-validation and validation help to make an informed decision as to which model provides the best predictions. Average standardized error and root mean standardized error were calculated to assess the prediction performance. If the prediction errors are unbiased, the mean prediction error should be around zero.

Geographically Weighted Regression (GWR)

Geographically weighted regression analysis was done using GWR tool developed by Geoda center for geospatial analysis and computation, Arizona State University US. (Brunsdon *et al.,* 1998; Fotheringham *et al.,* 2002). Gaussian type of model and geographically variability test was selected as model settings. Regressions were carried out in the localized points within Kalutara DS area. The regression model can be expressed as follows (eq.2) (Fotheringham *et al.,* 2002).

$$Y(u,v) = b_0(u,v) + b_1(u,v)x_1 + b_2(u,v)x_2 + \ldots + b_n(u,v)x_n + e(u,v) \qquad (2)$$

Coefficients $b_1,..b_n$ represent the magnitude of effects of the exploratory variables $x_1,..x_n$ and variable Y is the yield per hectare. The coefficient, b_0 is the constant term. Error term is described by e while u and v represent different influences on each specific location. GWR was carried out using management practices; fertilizer application, weeding and soil conservation as independent variables. Further, the tapping stand (tappable trees/ha) and age of tappable trees were used as independent variables to represent cultivation information. Exploratory variables in unmeasured survey locations were interpolated using kriging spatial interpolation method which is similar to the procedure described in Figure 1. While ordinary kriging was practiced for the tappable trees and age of trees, indicator kriging was applied for management practices; fertilizer application, weeding and soil conservation. Probability of receiving those management practices were calculated for the non-sample points.

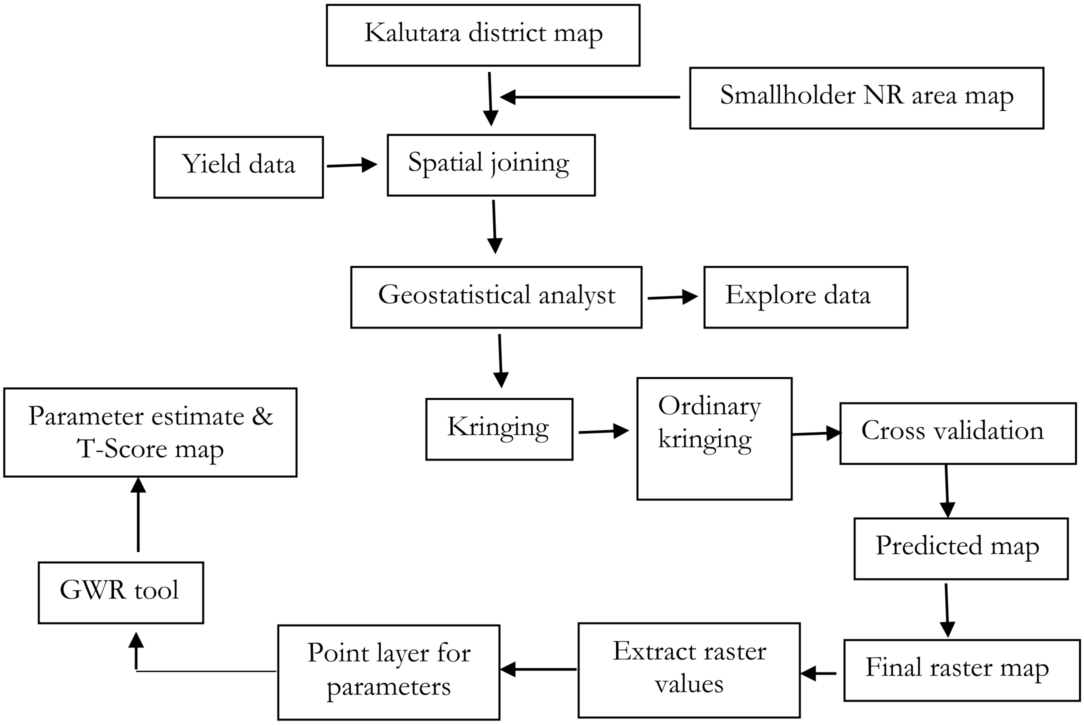


Figure 1. Flow Diagram of Kriging Spatial Analysis

Different forms of kriging, namely ordinary kriging for continuous variables and indicator kriging for categorical variables were used to create the surface maps. Summary of the methods deployed together with kriging model is depicted in Table 1.

Table 1. Different Forms of Kriging Methods Applied to Create Continuous Surfaces

Parameter	Kriging interpolation type
Tapped trees	Ordinary
Age of plant	Ordinary
Fertilizer application	Indicator
Soil Conservation	Indicator
Weeding	Indicator

Probability values of Non-sample points were extracted using centroid of the each Grama Niladari division in Kalutara district. It was observed that the GWR model parameters best explain the driving forces of productivity change in Kalutara district. One of the important GWR model result was the spatial variation of the model fit. In this case local R^2 values for the fitted model was calculated.

Results and Discussion

Productivity Variation in Kalutara District

Geostatistical analysis generated a continuous map that depicts the average productivity in Kalutara district (Figure 2.). Higher, Medium and Lower productivity values have shown in the Figure 2. Predicted average productivity was high in Palindanuwara (1208 kg ha^{-1} yr^{-1}), Beruwala (1202 kg ha^{-1} yr^{-1}) and Kalutara (1196 kg ha^{-1} yr^{-1}) DS divisions followed by Dodangoda DS (1176 kg ha^{-1} yr^{-1}). According to the statistics released by Rubber Development Department, highest extent of rubber lands are available in Bulathsinghala DS division followed by Palindanuwara (2443 ha) and Horana DS (1300 ha). About 540 ha of rubber lands are available in Beruwala DS and only 225 ha are available in Kalutara DS division. While the maximum productivity recorded in the Walallawita and Kalutara DS divisions, the minimum was predicted in Ingiriya and Millaniya DS divisions. Descriptive statistics of Predicted Productivity are summarized in the Table 2.

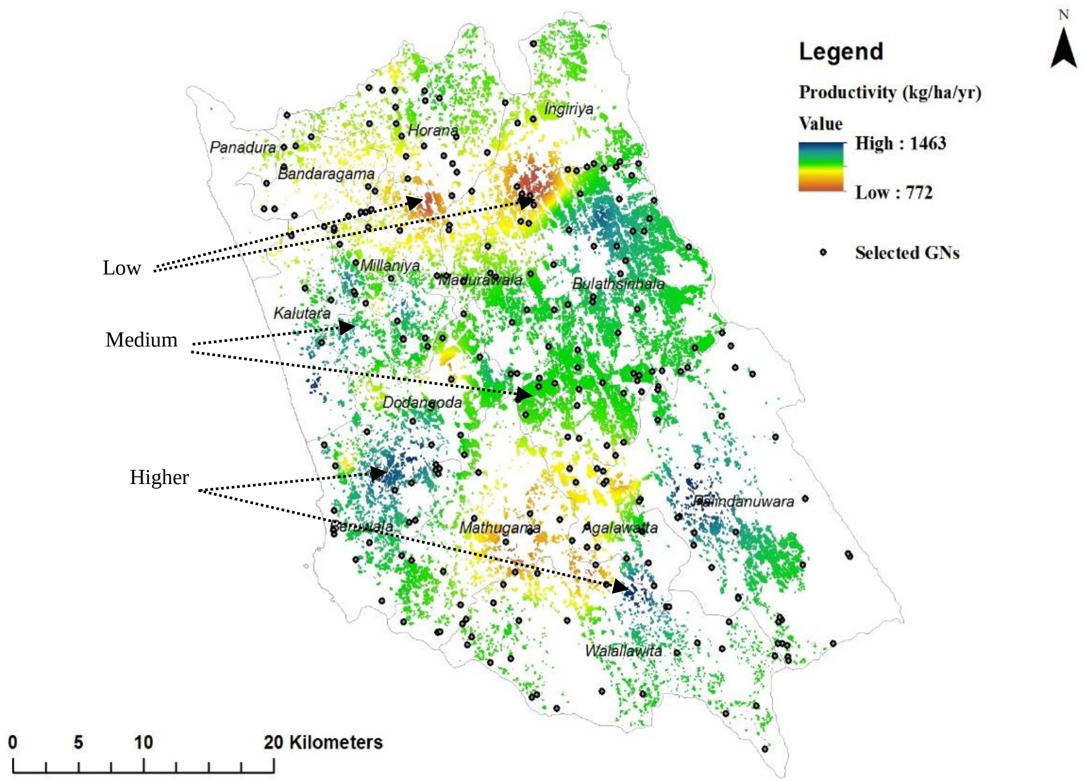


Figure 2. Predicted Productivity Raster Map for Kalutara District

Table 2. Summary Statistics of Productivity Values (kg ha^{-1} yr^{-1}) of Different DS Divisions in Kalutara District

DS Division	Mean	Max	Minimum	Standard Deviation
Agalawatta	1124	1331	982	49
Bandaragama	1082	1122	1033	18
Beruwala	1202	1351	1017	49
Bulathsinghala	1173	1310	958	48
Dodangoda	1176	1373	946	61
Horana	1102	1178	905	43
Ingiriya	1075	1169	772	96
Kalutara	1196	1384	1051	70
Madurawala	1120	1202	951	57
Matugama	1075	1243	872	67
Millaniya	1108	1307	849	82
Palindanuwara	1206	1374	971	60
Panadura	1090	1143	988	24
Walallawita	1160	1463	894	78

Validation of the Geostatistical Model for Productivity

The root mean square standardized error which reflects the model accuracy reported as 1.03. This should be close to one if the prediction standard errors are valid. If it is greater than one, the model is underestimating the variability in predictions. The reported value suggesting that predicted productivity values at non-sample points were close to the actual values against the collected sample points (250 sample points) which were used for validation.

The Spatial Drivers of the Productivity

Summary of the fitted GWR model is depicted in the Table 3. Global t-value explains the direction of relationship in the area and the statistical significance level change in the GWR. The Global regression estimates or parameters are given in column 2 of Table 3. Variables selected in the analysis were significant at 95% confidence interval in the global model and there were spatial variability in the area. However, some variables indicate weak significant spatial variability in the area. Variables which were significant in the GWR can either give a positive or negative spatial variability. Mapping of local-pseudo t-values was done to draw more attention on such cases and to distinguish different variables.

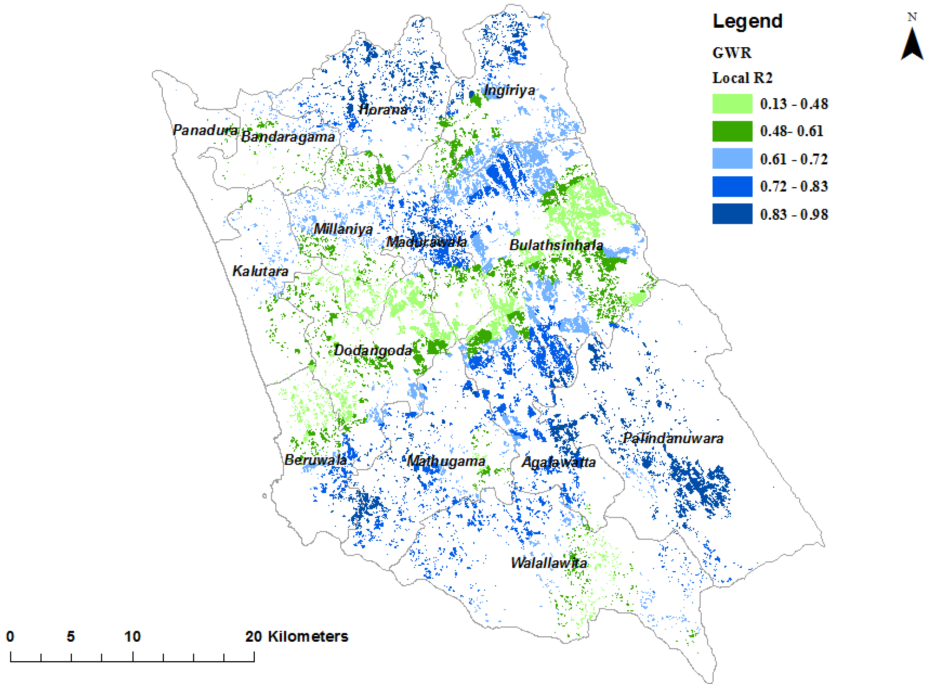


Figure 3. Local R^2 Value of GWR

Table 3. Results of Geographically Weighted Regression (GWR)

Variables	Global t-value	p-value*	GR estimate	GR SE	DIFF C
Intercept	624.54	0.00001	1146.84	1.83	-1229.68
Fertilizer application	2.66	0.004	5.43	2.03	-129.49
Weeding	4.48	0.00001	10.77	2.40	-165.05
Soil conservation	11.02	0.00001	26.41	2.39	-73.86
Age of trees	-9.21	0.00001	-18.89	2.05	-139.88
Tappable trees	5.55	0.00001	11.53	2.07	-122.50
N	1337				
AICGR	15,051				
AICGWR	12,934				
GR adjusted R^2	0.23				
GWR- adjusted R^2	0.85				
GWR F value	49.71				

*Note: GR: Global regression; GWR: Geographically weighted regression, AIC: Akaike information criterion, DIFF C: Difference of criterion, N= number of samples selected. GR SE: Global regression standard error of estimate. *All variables were significant at 95% confidence interval*

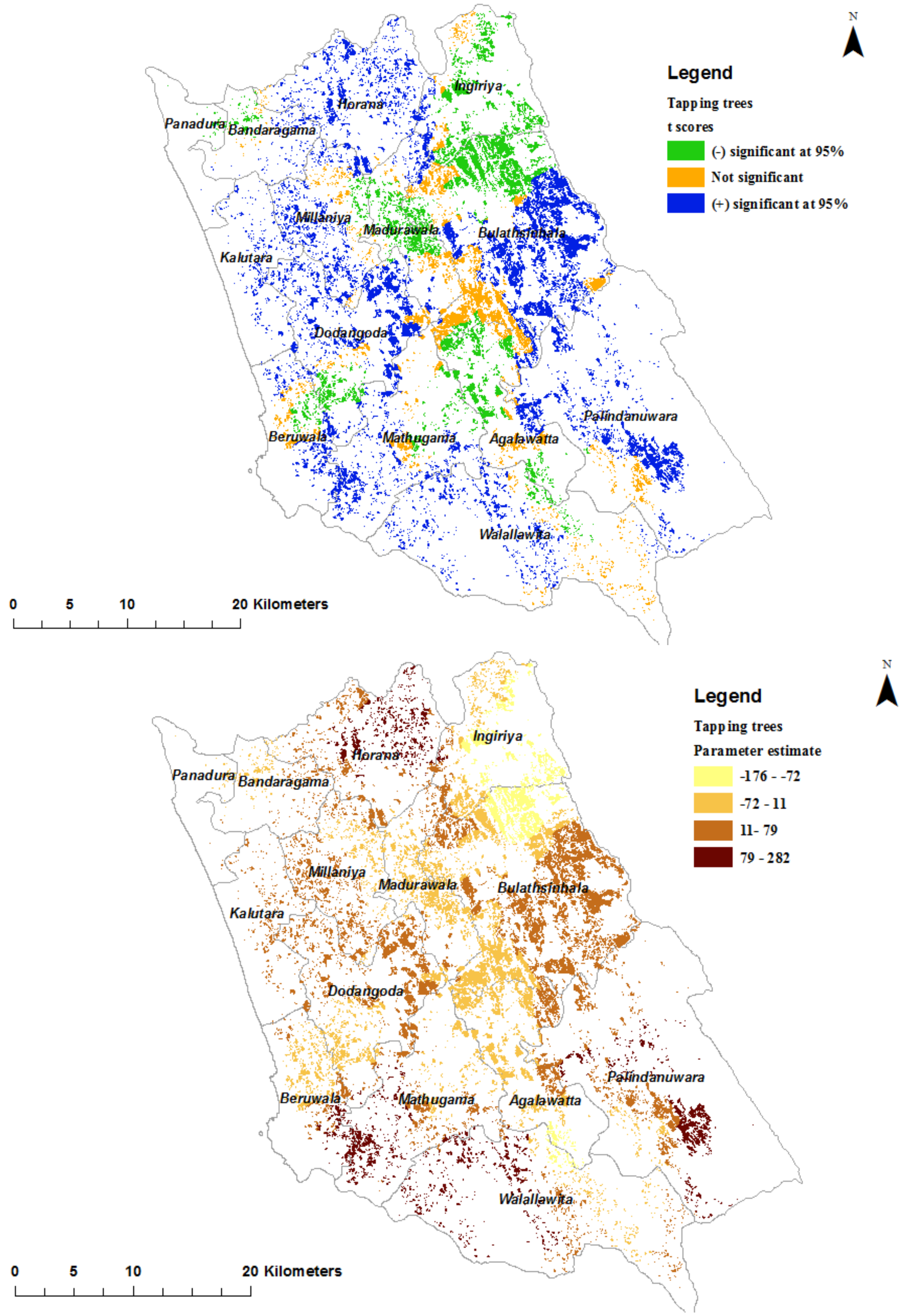


Figure 4a. Spatial Variability of Parameter Estimate and t-values of the Variable Tapped Tree

An important spatial distribution obtained from the GWR analysis was the spatial variation of the model fit. Spatial variation of the local adjusted R^2 values for the fitted model is shown in Figure 3. Local adjusted R^2 values were higher than the global model which varied from 0.13 to 0.98. It is important to note that compared to OLS or GLM where regression coefficients are fixed, GWR are variable regression coefficients across space. This enables to model the local variability of the rubber productivity more meaningfully when compared to the global model.

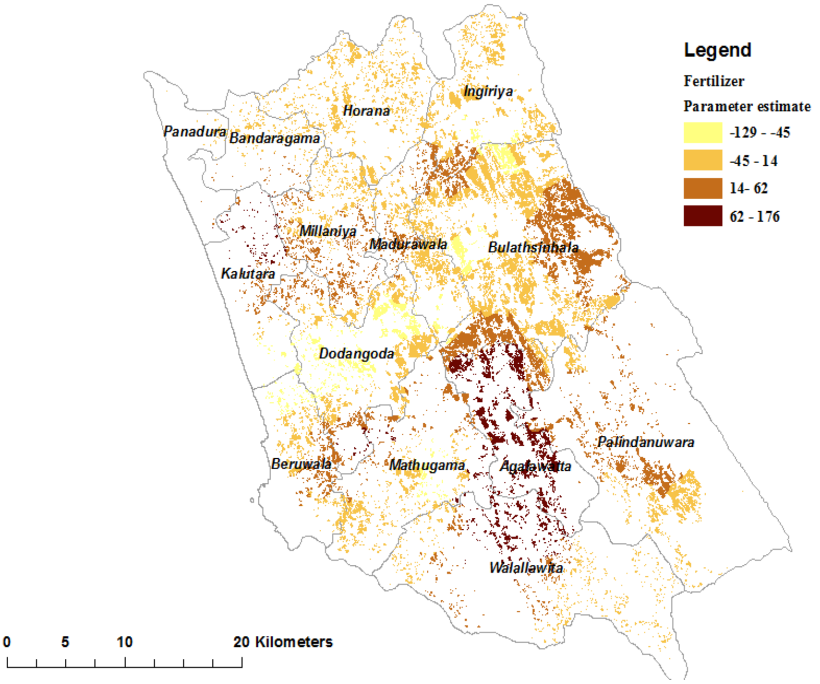
Moreover, the increase in adjusted R^2 confirms that GWR-adjusted model explains the variance of the data better than the global model. Higher R^2 values, permits that the correlation of the selected variables in the model and productivity are captured better by the GWR model.

When GWR results were mapped, estimated parameters and t values changed throughout the area. Furthermore, 95% confidence level was considered to map the t-values change throughout the region. Model results show that variable related to tapped trees have significant positive and negative spatial variability (Figure 4a.). The parameter estimates for tapping tress were positive for most divisions except for Ingiriya, Dodangoda and Agalawatta areas.

It was identified that the spatial distribution of the use of fertilizer is considered as an important driver of rubber productivity (Table 3). Estimated regression parameters for the fertilizer use were positive in most of the areas except for few areas in Ingiriya, Dodangoda, Horana and Matugama divisions (Figure 4b.). The Sri Lankan government has continued the fertilizer subsidy for small holder farmers for the last consecutive three years. However, most of the farmers haven't applied fertilizer during the last two years in Mathugama area.

As for the soil conservation variable in the model, it shows a significant variability while impact of relationship was positive and negative in areas of Kalutara district (Figure 4c.). The values for the estimates showed that Millaniya, Bulathsinghala and Agalawatta areas reported positive relationships (for the estimated parameters), while the Dodangoda, Horana and Ingiriya areas reported a significant negative relationship. No responses were received from most of the farmers in Dodangoda and Beruwala area regarding any soil conservation methods practiced during the cultivation since most of them haven't applied considerable measures for soil conservation in their lands.

Improvement of soil conservation practices maintaining the soil cover and minimizing the soil disturbance are important land management practices. Weeding is another important land management practice. Proper weeding management enhances the nutrient absorption by natural rubber without wasting fertilizer. The estimated parameters for weeding practices in the field shows significant variability in Kalutara district, and they were significantly negative in Mathugama, Beruwala, Ingiriya and Madurawala areas (Figure 4d.). Proper weeding practices were mostly recorded in Bulathsinhala, Agalawatta and Walallawita areas while weeding practices didn't produce significant positive variability in most of the areas in other divisions.



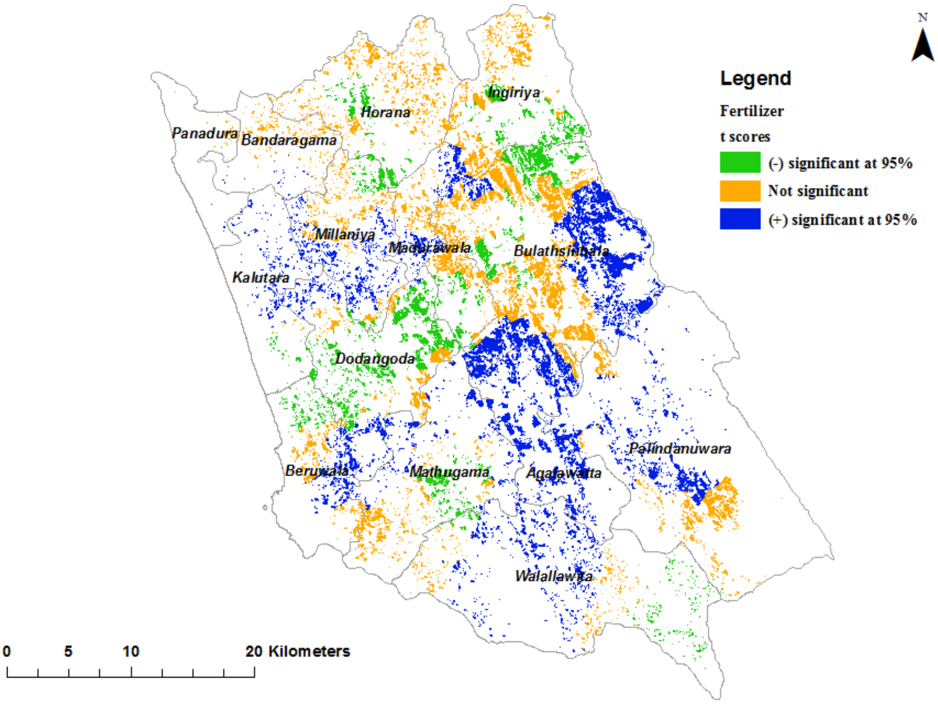


Figure 4b. Spatial Variability of Parameter Estimate and t-values of the Variable Fertilizer

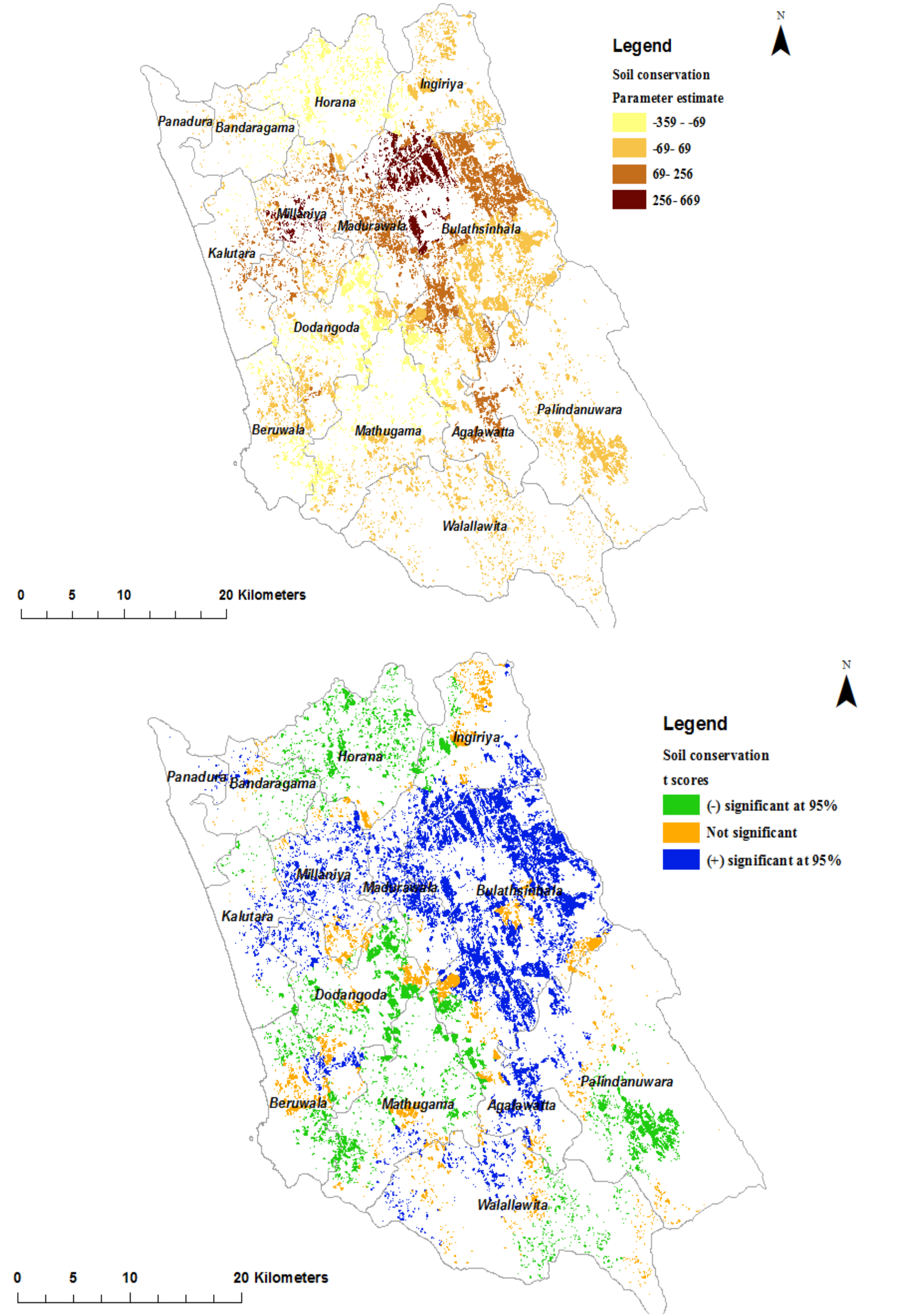


Figure 4c. Spatial Variability of Parameter Estimate and t-values of the Variable Soil Conservation

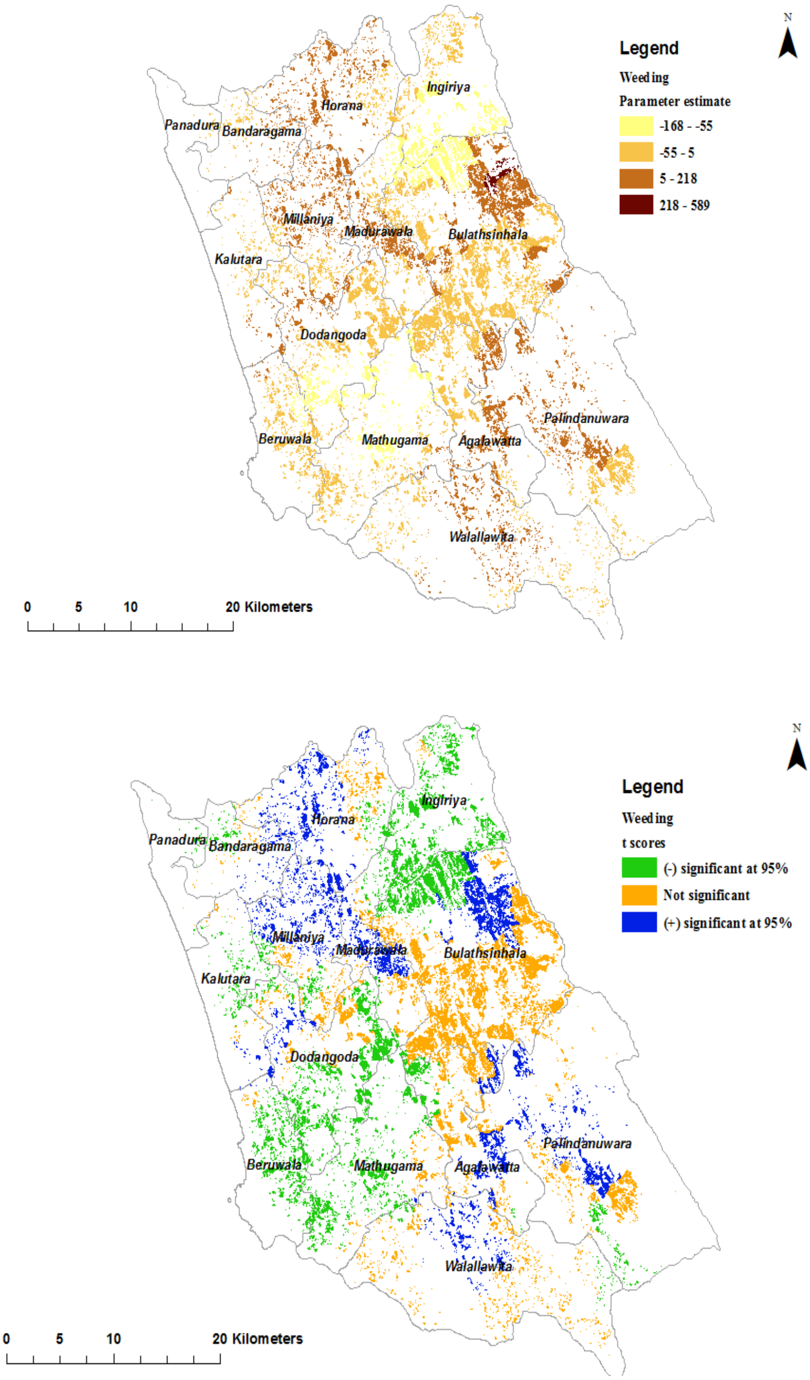


Figure 4d. Spatial Variability of Parameter Estimate and t-values of the Variable Weeding

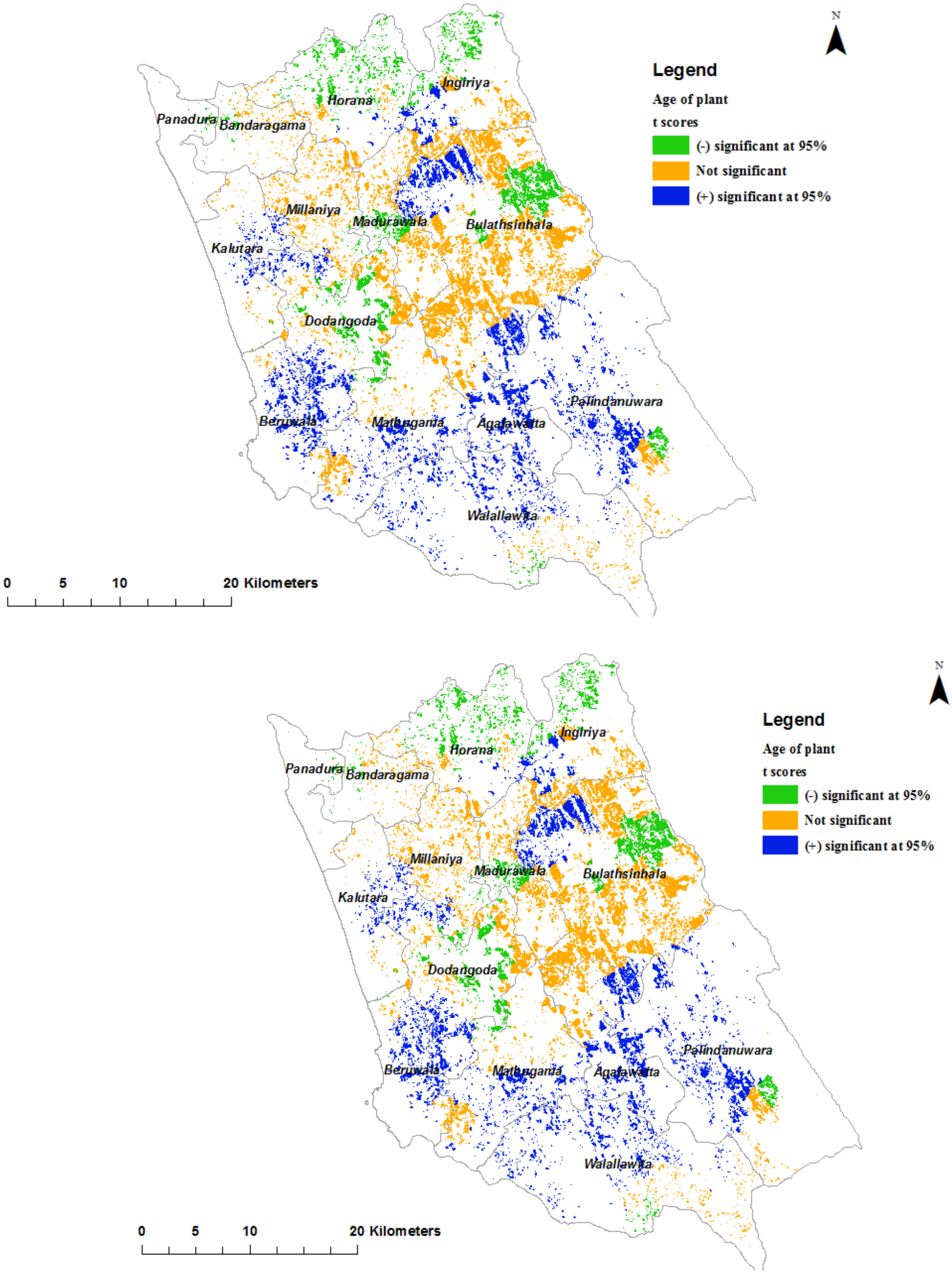


Figure 4e. Spatial Variability of Parameter Estimate and t-values of the Variable Age of Tappable Trees

Significance of the estimates for the age of rubber plantation shows considerable variability and it depends on the age profile of surveyed sample. The estimates for the age of rubber presented here display a significant positive variation for Agalawatta, Walallawita and Beruwala areas (Figure 4e.). According to the yield curve of natural rubber, yield increases up to age of 19 years. Thereafter, yield shows a negative relationship with the age. (Munasinghe *et al.,* 2008; Wijesuriya *et al.,* 2012). Mature extent of rubber lands in Kalutara district was different within the district. Highest extent of mature areas was recorded in the Bulathsinhala divisional secretariat followed by Palindanuwara and Walallawita. Lowest mature extent was recorded in Panadura area. With respect to age class, Bulathsinghala and Palindanuwara followed by Agalawatta and Walallawita areas were having higher land extents in age between 10 to 19 years than mature lands in other categories.

Conclusions

GWR explored the behavior of variables in the model at a local level and revealed significance of their spatial variability. This is further enhancement of understanding of a local analysis, rather than obtaining global average for the entire district. One of the important contributions of this study is that it enables the spatial variability of results to be studied. This has facilitated the identification of those parameters which exercise influence throughout Kalutara district. Results obtained from the GWR demonstrated that explanatory variables such as fertilizer, weeding, soil conservation, age of plant and tapped trees do not have constant homogenous parameters across the study area. This study has thus identified spatial variability of parameters.

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Vegetable Buying Behavior in Kurunegala District

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ABSTRACT

Dietary patterns rich in high vegetable intake are associated with a myriad of health benefits. The objective of this study was to explore the vegetable consumption behavior of consumers within the Kurunegala District. The specific objectives were to identify vegetable consumption rate among the cohort, to identify the barriers over vegetable consumption and to establish a relationship between factors affecting vegetable consumption. The results of descriptive analysis showed that females were making purchasing decisions in urban and semi urban areas except rural areas. Fair is the most popular place where rural (52%), semi urban (50%) and urban (42%) respondents purchased vegetables. The highest percentage of semi urban respondents (28%) used to purchase vegetables from groceries, while most of the respondents of rural area cultivated their own vegetables. Daily vegetable intake of majority of the respondents from rural and semi urban areas were below the World Health Organization (WHO) recommended amount of 260 grams of vegetables per day. However, low income level households consume vegetables below the standard rate while, the high income level households intake vegetables above (336.2 g/day) the recommended rate. The results of the Binary Logistic Regression indicated that consumers in the urban sector have higher probability of consuming required rate of vegetables.

KEYWORDS: Consumption, Kurunegala district, Vegetable intake

Introduction

In culinary terms, a vegetable is an edible plant or its part, intended for cooking or eating raw. In biological terms, "vegetable" designates members of the plant kingdom. Vegetables are consumed in fresh, cooked, tempered, fried, boiled and Salad forms, as part of main meals and as snacks. The nutritional content of vegetables varies considerably, though generally they contain little protein or fat. Vegetables are rich sources of many essential micronutrients, including vitamin C and K, folate, thiamine, carotenes, several minerals, and dietary fiber (Clay *et al.*, 2004). Vegetables are the most sustainable and affordable dietary source of micronutrients (AVRDC, 2004). The fiber content of vegetables have been reported to have beneficial effects on blood cholesterol and aids in the prevention of large bowel diseases, while in diabetic subjects, they improve glucose tolerance (IFT, 1990). Vegetables also play a key role in neutralizing the acids produced during food digestion because of the fiber content and roughages which promote digestion and helps in preventing constipation (Rai and Yadav, 2005).

There is mounting evidence to the effect that bioactives present in fruits and vegetables help protecting against a number of diseases such as coronary heart diseases, hypertension and cancers (British Dietetic Association, 2011). Thus, the general advice is to consume significant proportions of fruits and vegetables to ensure the protection from Non Communicable Diseases (NCDs). In this context, World Health Organization (WHO) has set standards with respect to consumption of fruits and vegetables by recommending a minimum of 400g per day. Currently, NCDs have overtaken communicable diseases and are now the leading causes of mortality, morbidity, and disability. In 2001 NCDs accounted for 71% of all deaths in Sri Lanka (WHO, 2011). In 1995, more than 20% of cancers in Sri Lanka were attributable to inadequate fruit and vegetable intake and it has predicted that this value will further increase in the future. It has been reported that two billion people suffer from malnutrition due to inadequate consumption of vegetables (AVRDC, 2004). World Health Organization (WHO) places low intake of fruit and vegetables, sixth among 20 risk factors for global human mortality, just behind such better known killers as tobacco use and high cholesterol (FAO, 2006). According to the FAO food balance sheets in 2004, the per capita vegetable consumption was 70g, which is much lower than the recommended quantities by WHO (FAO, 2004).

Although vegetables are essential for human health, most people in developing countries do not have affordable access to this food. Though vegetable production is increasing at a higher rate in Asia, compared to other major food crops, post-harvest losses and inadequate income contribute to widespread malnutrition. Many persons in Asia, especially in South Asia, consume less than half of the vegetables they need to live a healthy life (AVRDC, 2004).

Worldwide production of vegetables has risen at an impressive rate of 4.97% per year (FAO, 2004). The top five vegetable producers are China, India, Vietnam, Nigeria and Philippines. Sri Lanka is ranked 38th in the vegetable production worldwide (FAO, 2012). According to Weinberger and Lumpkin (2007), a strong vegetable sector is an engine for economic growth. Fruit and vegetable consumers are influenced by the availability, desirability and accessibility of the products (Clay *et al.,* 2004). Vegetable is the most important cultivation in the Sri Lankan agricultural sector after paddy. An average consumer spends nearly 6% of his expenditure only on vegetables (Central Bank of Sri Lanka, 1986/87).

Consumer preference is an indicator of how much of a product consumers are willing to purchase, and is a function of income, relative prices and consumer priorities, preferences and choices. Identification of customer needs and desires constitute a critical aspect of marketing. Taste and perception have varying degrees of importance to different consumers. Convenience, that is the time and ease of preparation and consumption, is a significant factor as consumers want products that fit into busy lifestyles. Producing the same horticultural products will not necessarily contribute to increased consumption or to improving nutrition unless people want to purchase the products and can afford to do so (Clay *et al.,* 2004).

The objective of this study was to explore the vegetable consumption behavior of consumers in Kurunegala District. Urban, semi urban and rural people can be easily found in the Kurunegala area, further the vegetable sellers, producers and distributers are available within Kurunegala area. The specific objectives were to identify vegetable consumption rate among the cohort, identify the barriers over vegetable consumption, to establish a relationship between different factors influencing consumption behavior of vegetable.

Methodology

Data Collection and Analysis

The study was conducted within the Kurunegala District during the period from April to June 2013. The data were collected from a sample of households (n=150), selected randomly from Urban, Semi urban and Rural areas of Kurunegala District. The Kurunegala municipal area was considered as urban area, suburbs of urban area up to 5 kilometers was considered as semi urban area and remote areas were considered as rural areas. A pre-tested structured questionnaire was administered to gather the data from the respondents via face-to face interviews. The questionnaire was consisted of five main question categories including; general information of the consumers, amount of vegetable consumption per week, perception on vegetable consumption, vegetables purchasing location and barriers for vegetable consumption. Barriers for vegetable consumption were investigated through simple-dichotomous statements.

Data were analyzed using descriptive analysis and inferential statistics. Data were analyzed with statistical package Minitab 15. Binary Logistic Regression (BLR) was used to investigate significant factors that influence the vegetable consumption rate of the respondents. Consumption rate was calculated by dividing the total grams of vegetables purchased by the number of family members. The WHO recommended vegetable consumption rate for an individual per day is 260 grams. Consumption rate above the recommended rate was considered as one and consumption rate below recommended rate was considered as zero. These values were used in logistic regression as dependent variables. Further, households were categorized into two different groups by considering their level of income as low level of income (below 25,000 monthly income) and high (above 25,000 monthly income). One sample t-test was carried out using Minitab 16 software to detect weather the households consume vegetables below or above the standard rate when their level of income varied.

Results and Discussion

Descriptive Statistics

Socio economic characteristics of respondents are shown in Table 1. Most of the respondents of rural area were males (58%) while majority of respondents in Urban and Semi Urban area were females (54%, 56%) respectively. This is attributed to the fact that males dominate the decision making due to the cultural factor that encourage males to go out to purchase materials needed for the family in rural areas.

Table 1: Socioeconomic Characteristics of the Respondent

Parameter	Rural	Percentage	Semi urban	Percentage	Urban	Percentage
Gender						
Male	29	58%	22	44%	23	46%
Female	21	42%	28	56%	27	54%
Level of Education						
No Schooling	3	6%	0	0%	0	0%
Primary	15	30%	19	38%	12	24%
Secondary	23	46%	15	30%	17	34%
Tertiary	8	16%	5	10%	13	26%
Higher	1	2%	11	22%	8	16%
Marital status						
Married	44	88%	45	90%	46	92%
Un married	6	12%	5	10%	4	8%
Occupation						
Government Servant	9	18%	28	56%	15	30%
Own	13	26%	15	30%	4	8%
Private company	19	38%	4	8%	30	60%
No job	9	18%	3	6%	1	2%
Income Level						
<15000	1	2%	12	24%	1	2%
15000 -25000	36	72%	18	36%	9	18%
25000 - 35000	11	22%	11	22%	24	48%
35000 - 45000	2	4%	8	16%	11	22%
>45000	0	0%	1	2%	5	10%

When considering level of education, considerable number of respondents from urban and semi urban areas 22% and 16% respectively have completed higher education. It's due to easy access to higher education. Majority of the respondents from all three areas were married. This indicates that parents make the purchasing decisions in the majority of the households in all three areas. Majority of the income level of respondents of rural area were in the range of Rs.15,000 – 25,000. Income level of respondents of urban area mainly lies within the range of Rs.25,000 – 35,000.

Consumer Purchasing Habit

Respondents' vegetable purchasing markets are shown in Figure 1. The majority (52%) of respondents in rural areas purchased their vegetables from the fair, 26% from groceries and 22% got vegetables from their own cultivation. Majority (50%) of the respondents from semi urban areas purchased their vegetables from the fair, 28% from the grocery and 8% from the hawkers and 4% from own cultivation. Forty two percent of the respondents from urban area purchased vegetables from fair and 22% from super markets. It's attributed to the facts of close proximity and the time availability for the purchasing of the vegetables. Fair and grocery are most popular forms of vegetable markets in Kurunegala District. Fair is the leading vegetable market in Sri Lanka.

People are of the view that vegetables can be bought for cheap price from fairs. Also, the fact that vegetables are bought for fairs directly from main markets contribute to this factor. Another factor is vegetable fairs are widely spread in the district.

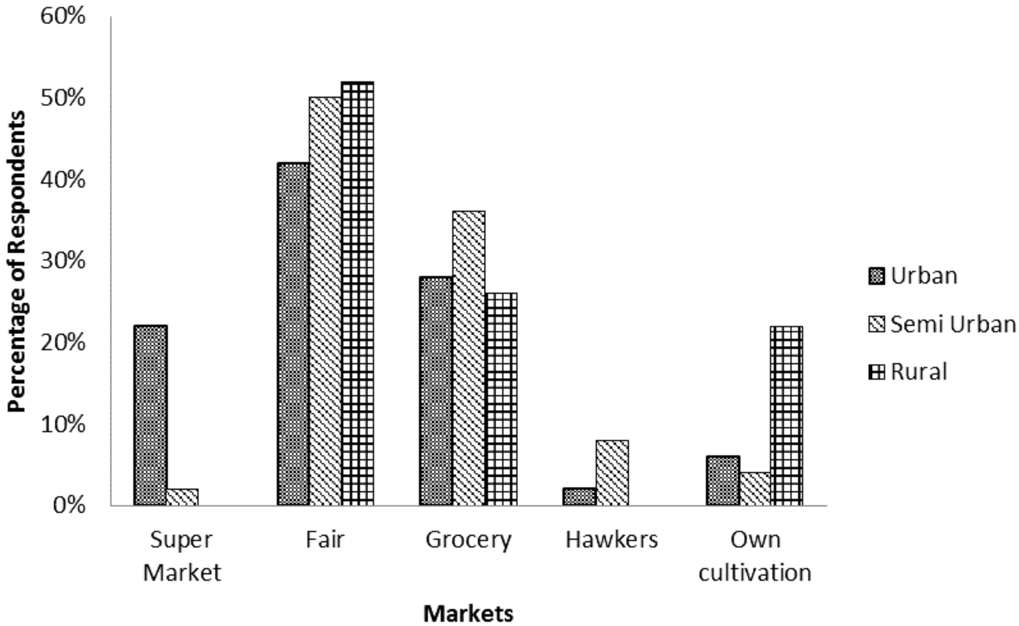

Figure 1. Vegetable Purchasing Market

VegetableConsumption Rate

According to WHO recommendation it is important for an individual to consume 260 grams of vegetables per day. According to the respondents rural area only 46% (Figure 2) of respondents consumed more than 260g of vegetable per day and in semi urban area 50% of the respondents consumed more than the standard amount. Only in the urban area majority of the respondents consumed 62% more than the standard rate.

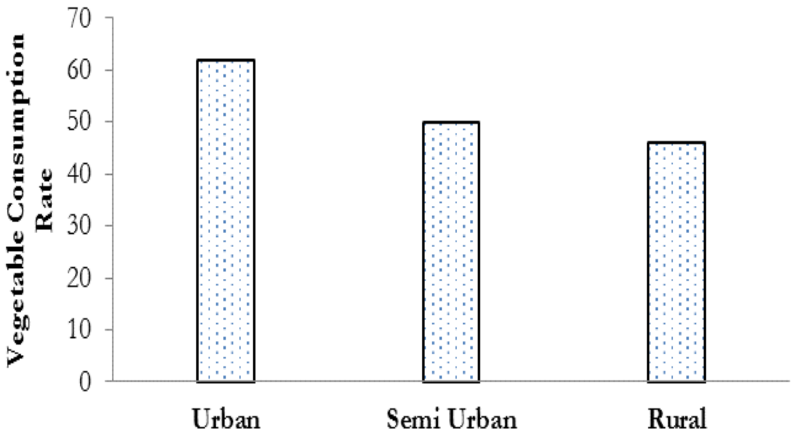

Figure 2. Vegetable Consumption Rate

Table 2: Vegetable Consumption Rate with Level of Income of Households

Variables	Mean	P value
Low income	233.2	0.021
High income	336.2	1.000

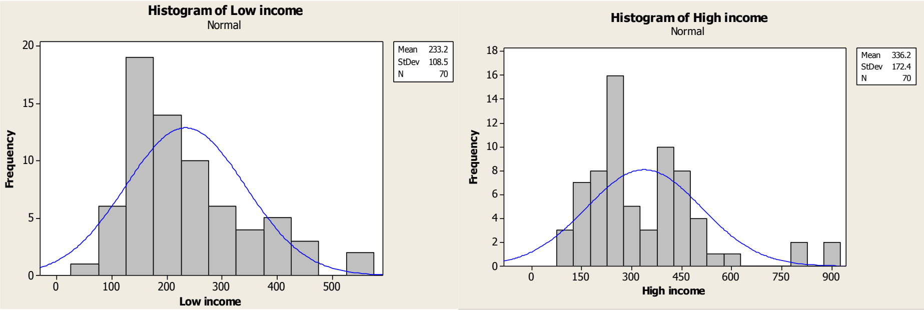

Figure 3. Vegetable Consumption Rate with Level of Income of People

Further, households were categorized into two different groups by considering their level of income as low income (monthly income is less than 25,000) and high income (monthly income is above 25,000). According to the Table 2**,** there is a significant difference of vegetable consumption among the low income level people while there were no significant differences of vegetable consumption among the high income level households within the Kurunegala District. However, the low income households consume vegetable (233.2 g/day) below the standard rate (<260g/day) while, the high income level people consume vegetables (336.2 g/day) above the standard rate (Figure 3).

Factors Affecting the Vegetable Consumption Rate: The Binary Logistic Regression

The results of BLR analysis are shown in the Table 3. The model showed p-value of 0.075 indicating model is marginally statistically significant ($a = 0.1$). Logistic regression results indicated that rural and semi urban areas have same impact on the vegetable consumption rate whereas consumption rate of urban area significantly differ from other two areas. According to the results there wasn't significant difference between male and female vegetable consumption rates. Results didn't show any significant difference in vegetable consumption rate between different education levels. Also results didn't show significant difference in consumption rate due to diseases. There is significant difference in vegetable consumption rate between respondents of income level '<Rs.15,000' and 'Rs.15,000-25,000'. There is also significant difference in the vegetable consumption rate between income level category of '<Rs.15,000' and '25,000-35,000'. However, there was no significant difference in vegetable consumption rate for further higher income earning respondents as they were not aware about the nutritional value of vegetables.

According to coefficients most of the factors have positive relationship. However, Level of education has negative relationship with the consumption rate. It's attributed to the fact changing lifestyle of the people.

Table 3: Results of Logistic Regression

Variable	Coefficients	Probability
Area		
Semi Urban	0.209	0.672
Urban	1.239	0.015
Gender		
Female	-0.503	0.175
Level of education		
Primary	-1.526	0.249
Secondary	-1.489	0.254
Tertiary	-0.359	0.791
Higher	-1.224	0.384
Disease		
Yes	-0.132	0.765
Income		
15000-25000	1.179	0.097
25000-35000	1.769	0.02
35000-45000	0.706	0.393

Barriers to Vegetable Consumption

Barriers for vegetable consumption are listed in Table 4. Out of the barriers listed, the highest frequency recorded was 145, therefore it can be mentioned that the most important barrier for vegetable consumption was the unstable prices of vegetables. Further, the frequency was more than 100 (Table 4) in high vegetable prices, unavailability of fresh and superior vegetables in the market. Therefore, these barriers were concerned as the other reasonable barriers for the vegetable consumption within Kurunegala District.

Table 4: Barriers to Vegetable Consumption

Factors	Frequency
Clean vegetables are not available in the Market	86
Vegetable prices are high	112
Fresh vegetables are not available in the Market	102
Low quality vegetables are available in the market	108
Vegetable damaged during transportation are mostly available in market	119
Most of the vegetables don't have stable price	145
Most vegetables available in the market are smaller in size	72

Conclusions

This study examines the behavior of respondents towards vegetables. According to the study, other than in rural area majority of females were making purchasing decisions. Majority of the respondents usually purchase vegetables from fair. Considerable amount of respondents cultivated their own vegetables. The daily intake of vegetable of majority of the respondents from rural and semi urban areas were below the WHO recommended amount of 260g per day. Many factors influenced on the consumption rate of vegetables. Households with higher income consume vegetables above the standard amount. Vegetable consumption and education level has a negative relationship.

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Price Formation, Seller Satisfaction and Degree of Competition in the Colombo Tea Auction

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ABSTRACT

Colombo Tea Auction is the main marketing channel to dispose bulk tea in Sri Lanka. This study was carried out to assess the price formation, market concentration, degree of competition among buyers and to examine the sellers' satisfaction at the Colombo Tea Auction. Primary data were collected from tea producers (sellers), brokers and officers of Sri Lanka Tea Board (SLTB). Secondary data were collected from Colombo Brokers Association, SLTB and selected brokering companies. Tea price formation factors, market share and competitiveness of buyers at the auction were analysed using Multiple Linear Regression, four firm Concentration Ratio (CR4) and Herfindahal-Hirshman Index (HHI) respectively. The results revealed that, tea grade, elevation, previous auction price, valuation price and net quantity of the tea lot affected 93.9% for the price formation. Results further revealed that CR4 and HHI were 28% and 370.9 respectively indicating that the public auction is operating on a relatively more competitive scale and also showing a favourable market among stakeholders due to the relatively quick return on investment, transparency and lowering of the risks than the other marketing channels. A few buyers dominate in the auction influencing negatively to the degree of competition. The study suggests that the price given to producers should mainly depend on quality rather than on other contributory factors and for competitive trading. This should be developed as a policy revision by the SLTB and Colombo Tea Trader Association.

KEYWORDS: Colombo tea auction, Market channels, Market concentration

Introduction

The Tea industry in Sri Lanka has always been a vital component of the economy contributing a vital amount to the country's Gross Domestic Product (GDP) and government revenue earnings (SLTB, 2015). It has been the second largest agricultural industry in the country. For the Year 2016, tea represented approximately 2 percent of overall GDP and 12.3 percent of total export earnings (Central Bank of Sri Lanka, 2016). Furthermore, it is also the country's largest employer providing employment both directly and indirectly to over two million people (De Alwis, 2011). In the global tea industry, Sri Lanka is the third largest tea exporting country with 17 percent market share preceded by Kenya and China (Plantation Sector Statistical Pocket Book, 2015).

In Sri Lanka, tea is sold through four major marketing channels namely the Colombo Tea Auction (CTA), private sales, direct sales and forward contracts. A very small volume of tea is marketed via factory sales (SLTB, 2015). More than 95 percent share of the tea with the Ceylon tea logo was marketed through the CTA in 2016 (Annual Report of SLTB, 2016). The CTA is considered as the largest single tea auction centre in the world which handles more than 300 million kilograms of black tea annually. The average price per kilogram of tea in the CTA has increased up to Rs. 466.43 in 2016 as compared to the Rs. 402.07 in year 2015 (Annual Report of SLTB, 2016)

The Colombo Tea Traders Association (CTTA) in conjunction with the Ceylon Chamber of Commerce (CCC) conduct the public auction under the by-laws and conditions of the SLTB. This union ensures a stable, reliable and credible procedure for the sale of tea. The CTA is held twice a week on Tuesdays and Wednesdays in the CCC building. The participants in the auction are the brokering firms and buyers (CTTA Annual Report, 2016). The government has little influence on the price at the auction. Brokers play a vital role in the auction (CTTA Annual Report, 2016). Tea producers offer the tea for sale through brokers and the brokers as auctioneers sell the tea. Eight brokering firms which are members of the Colombo Broker Association (CBA) operating at the Auction sell the tea for the highest bidder (Annual Report of CTTA, 2016).

Price formation (price discovery) at the tea auction is itself a complex process and its outcome is a result of a complex interplay of various factors (Thudugala, 1987). However, the auction system was criticized by various parties claiming that the lowering of prices at the CTA is due to collusion or unfair competition amongst the buyers leading to dissatisfaction among producers (Thudugala, 1987). These factors result in a situation where sellers do not receive a fair price for their processed tea. The CTA is the most efficient and professionally operating tea auction in the world (Annual report of CTTA, 2016). According to founding ideals of the auction system, it closely approximates to a perfect market where prices are determined by supply and demand rather than by individual buyers or sellers (Motha *et. al.*, 2004). However, in practice various imperfections in the world market, notably the domination of the market by a small number of buyers as a result of the existence of a concentrated market share in the hands of a few buyers has led to unfair competition amongst the buyers.

Therefore, specific objectives of this study were to investigate the variables which determine the CTA prices, assess the relationship that exists between the CTA price and those variables that influence it, to find out the degree of competition among buyers and to identify the seller's satisfaction at the CTA. The outcome of this research will help the policy makers to understand the nature of price determination and the influences of the CTA.

Methodology

Data Collection and Analysis

In-depth interviews were held with selected tea managing directors, marketing managers of selected plantation companies and managing directors of brokering firms to collect information on the tea trade, on sellers' satisfaction and the auction mechanism. Secondary data (prices on highest selling ten main grades of tea) were collected from three brokering firms and SLTB from June 2016 to August 2017. Data were analysed using Microsoft Excel software and inferential statistics with the statistical package Minitab 17 version.

Theoreticalframe Work

To identify the relationship of the factors that affect the price formation at the CTA, a Multiple Linear Regression model was used as given below.

$$Y = \beta_0 + \beta_1 NQ + \beta_2 PP + \beta_3 VP + \beta_4 B + \beta_5 H + \beta_6 L + \beta_7 BOP + \beta_8 BOP1 + \beta_9 BOPF$$
$$+ \beta_{10} FBOP + \beta_{11} FBOP1 + \beta_{12} FBOPF1 + \beta_{13} OPA + \beta_{14} PEK + \beta_{15} PEK1 + \varepsilon$$

Where, Y is the unit price in rupees per kilogram which is the dependent variable. The Independent variables are namely,

NQ	=	Net Quantity (Kg)
PP	=	Previous Auction Price (Rs)
VP	=	Valuation Price (Rs)
B	=	Broker
H	=	High Elevation
L	=	Low Elevation
BOP	=	Grade BOP
BOP 1	=	Grade BOP1
BOPF	=	Grade BOPF
FBOP	=	Grade FBOP
FBOP1	=	Grade FBOP1
FBOPF1	=	Grade FBOPF1
OPA	=	Grade OPA
PEK	=	Grade PEK
PEK1	=	Grade PEK1
β_0 -β_{15}	=	Coefficients to be estimated
ε	=	Error term

Market Power Concentration

Market concentration is a function of the number of firms in a market and their respective market shares. Herfindahl-Hirschman Index (HHI) a commonly accepted measure of market concentration was used in this study. It is calculated by squaring the market share of each buyer competing in the auction and then summing the resulting numbers. The HHI number can range from close to zero to 10000. The HHI expressed as,

$$HHI = \sum_{i=1}^{n} (Si)^2$$

Where, Si is the market share of i[th] firm in the market, and n is the number of firms. HHI reflects distribution of the market share, competition, and also adds a proportionately greater weight to the market share of the large firms in accordance with their relative importance in competitive interactions. The HHI approaches zero when a market consists of a large number of firms relatively equal in size. The HHI increases both as the number of buyers in the auction decreases and as the disparity in buying volume between those buyers increases. According to the U. S. department of justice and the Federal Trade Commission, the spectrum of Market concentration as measured by the HHI, is divided into three regions that can be broadly characterized as un-concentrated or competitive (i.e. HHI below 1000), moderately concentrated (i.e. HHI below 1000 to 1800) and highly concentrated (i.e. HHI above 1800) (Anon, 2017).

Market Structure

Market power concentration gives an idea of the degree of market power that firms enjoy in its respective industry and refers to the number of and relative size distribution of buyers /sellers in the market. The market concentration ratio, which measures the percentage of traded volume or share accounted for by a given number of participants. Kohls and Uhl (1985) suggested that a four-firm concentration ratio (CR4), that is the combined market share of the largest four firms. A value of less than or equal to 33 percent is generally indicates a competitive market structure. A concentration ratio of 33 percent to 50 percent indicates a weak and a concentration above 50 percent indicates a strongly oligopsony market structure.

Results and Discussion

In-depth discussions revealed that the CTA has a number of strengths and opportunities to become the major marketing channel for tea. Those were, SLTB registered 719 sellers, 362 buyers and 8 brokers who participated at the public auction in 2016 with high transparency; qualified tea tasters from brokering and buyer companies who check each and every tea lot before entering the auction system and decide on the relevant price relating to the quality; very high competitive rivalry among both buyers and sellers that causes the unconcentrated market; the Ceylon tea logo being the mark of the quality for Sri Lankan tea and the CTA being strictly regulated by the government through the SLTB.

As per the results of the linear regression analysis (Table 1), coefficient represents the implicit price for the change of variables. Grade dust 1 and medium elevation were taken as dummy variables. All the variables were significant in the study.
Regression function explained unit price by 93.9 percent of its independent variables. When all other variables are kept constant, with the increase of every additional kilogram of net quantity, unit price of tea decreased by Rs. 0.009, with every additional

rupees of previous auction price and valuation price increased unit price of tea increased by Rs. 0.630 and Rs. 0.269.

Table 1: Estimates of the Multiple Linear Regression

Variable	Coefficients	P value
Constant	52.985	0.000
Net Quantity	-0.009	0.000
Previous Auction Price	0.630	0.000
Valuation Price	0.269	0.000
Broker A	10.110	0.000
High Elevation	1.916	0.006
Low Elevation	14.969	0.000
BOP	-4.676	0.000
BOP1	10.965	0.000
BOPF	-3.548	0.001
FBOP	7.136	0.000
FBOP1	3.571	0.023
FBOPF1	8.635	0.000
OPA	-5.147	0.000
PEKOE	2.162	0.005
PEKOE1	12.020	0.000

Note: R-Sq. (adj) = 93.9%

When changing the brokers, the price of the tea increased by Rs. 10.11. With respective to the medium elevation, high elevation and low elevation tea price increased by Rs. 1.92 and Rs. 15.0 respectively.

Compared with the price of dust 1 price of tea, the tea grade BOP, BOPF, OPA and PEKOE1 decreased price by Rs. 4.68, Rs. 3.55, Rs. 5.15 and Rs. 12.0 respectively whilst price of BOP1, FBOP, FBOP1, FBOPF1 and PEKOE increased by Rs. 11.0, Rs. 7.14, Rs. 3.57, Rs. 8.63 and Rs. 2.16 respectively.

In year 2016, the total tea production was decreased by 11 percent of annual tea production as compared to year 2015(Annual report of SLTB, 2016). The bad weather conditions that prevailed throughout the tea growing areas was the main factor that contributed for this decline. The Cost of Production (COP) was dropped by 3.42 percent when compared to 2015. According to the reports of the SLTB, in 2015 the total COP during the year was Rs. 475.31. In 2016 it decreased to Rs. 458.84. Compared to other tea producing countries, COP of Sri Lankan tea is high and identified as the major problem as it reduces the profits (Annual report of SLTB, 2016). Therefore, reduction of COP makes a favourable impact on the industry. It is noted that the regular increment in the COP during the past several years had reduced after 2015. According to the views expressed by sellers and brokers, they discovered that the cost effective new machinery implementations and the product diversification are required to reduce the COP and to increase the quality of products.

During the years 2013 to 2016 (Figure 1) indicate that the quantity sold at the CTA had decreased from 99 percent to 95 percent.

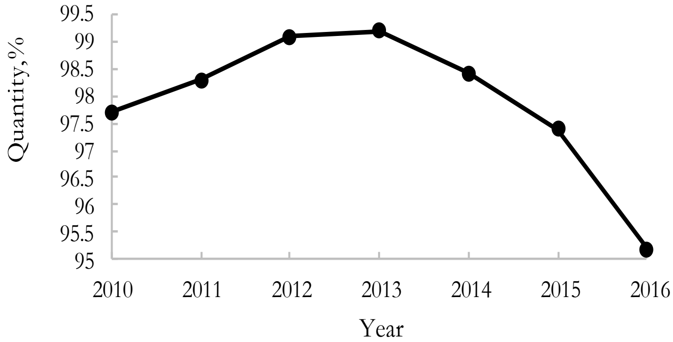

Figure 1. Quantity Sold at the Colombo Tea Auction as a Percentage of the Total Production from Year 2010-2016

However, in 2015 with the price reduction (Figure 2) the quantity sold out of the total production at the CTA also reduced. Results showed that the large price reduction in 2015 made a big impact on the quantity sold in 2016 at the CTA, even though the average price increased to Rs. 466.43.

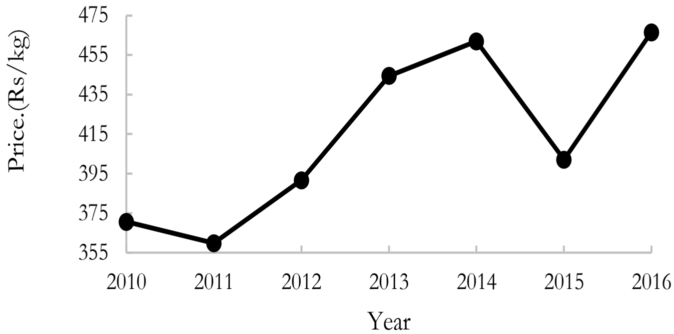

Figure 2. Average Prices at the Colombo Tea Auction (Rupees per Kilogram)

Black tea amount of 296.9 million kg in 2004 (Motha *et al., 2004*) was sold through the CTA. It was 86.4 percent of the total quantity. After one decade it had increased up to 97.4 percent. The quantity was 317.3 million kg.

Table 2: Volume of Tea Marketed through Various Channels (Mn. kg.)

	Year		
Marketing Channels	**2014**	**2015**	**2016**
Public Auction	332.2	317.3	276.25
Privet Sales	3.2	3.1	2.72
Direct sales	2.07	2	1.87
Total	337.47	322.4	280.84

Source: Sri Lanka Tea Board

In 2014 to 2016, more than 98 percent of made tea were disposed through the CTA (Table 2). In 2014 and 2015, disposal amount was 98.4 present. But in 2016 it reduced to 98.3 percent. However, results show that the CTA is the main marketing channel to dispose made tea in Sri Lanka.

Market Structure

Table 3. Quantities Purchased by the Four Major Buyers (2016 Jan - Dec)

Buyer	Quantity (Mn.kg)	Share %
Akbar Brothers	36.393	13.4
Anverally & Sons	16.614	6.1
Empire Teas	12.094	4.4
Unilever Lipton Ceylon	11.172	4.1
Other	196.188	72

Source: Sri Lanka Tea Board

In 2005, top four market share holders were Akbar Brother, Stassen Group, Jafferjee Brothers and Ceylon Tea. After one decade, still Akbar Brother was the number one (Table 3), others were replaced by Anverally & sons, Empire Teas and Unilever Lipton Ceylon.

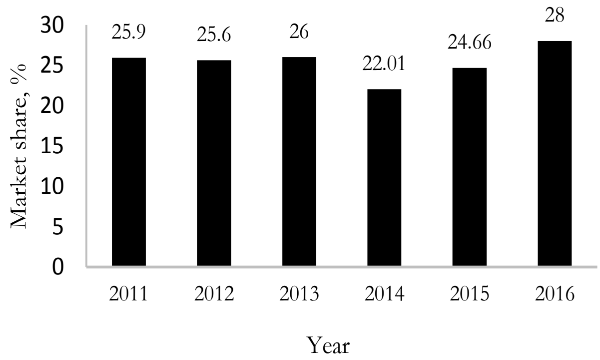

Figure 3. Variation of CR4 Values

In the CTA the total quantity of tea bought by 290 buyers from January to December 2016 was 272,463,654 kg. The quantity bought by the major four buyers was 76,274,477 kg. According to 2005 figures the CR4 value was 33.3 percent of the total purchased. It indicated a weak oligopsony market (Motha *et al.,* 2004), in 2016 the CR4 value was 28 percent of the total purchased (Figure 3). According to CR4 concept, this indicates a Competitive Market Structure (Kohl and Uhl, 1985).

Thus, the HHI market power concentration of the CTA in 2016 was 370.9. It was the highest value for the past five years (Figure 4). From January to December results showed that HHI values varied from 342 to 446.45. The highest HHI value of 446.45 was observed in November (Figure 5). As these values were below 1000 they revealed that the CTA is an unconcentrated or competitive market.

Market Power Concentration

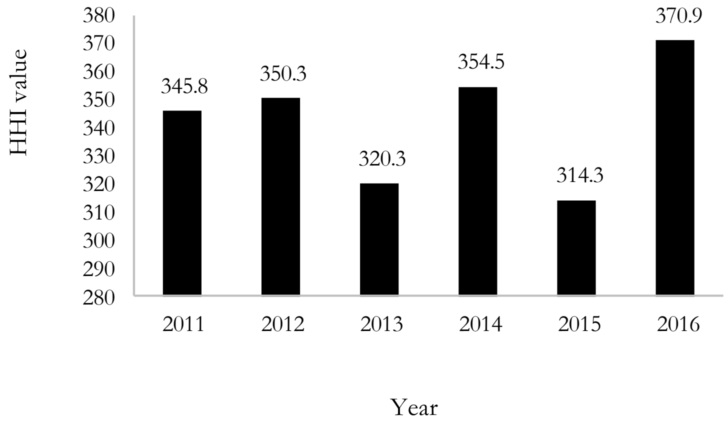

Figure 4. HHI Value Variation (2011-2016)

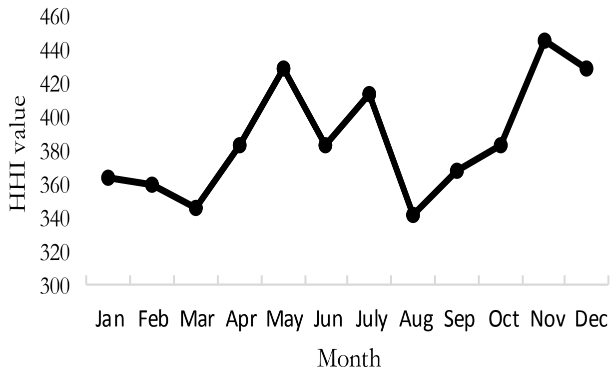

Figure 5. Variation of HHI Value for 2016

At the in-depth discussions, the respondents were asked specifically about the satisfaction of the CTA prices. Most of the sellers felt that the price at the auction is often fair. However, the weather pattern, global market trends, policies, financial stability, selling mark, connections of foreign buyers, interrelationships among buyers, sellers and brokers, experience and knowledge of the tea market, make a big impact on the CTA price.

According to the stakeholders, current threats of the price at the CTA were, adulteration of quality teas which tarnishes the image built over hundreds of years, risk of turning the present buyers' market domain in to an oligopolistic one, inexperienced purchasing of buyers. These may lead to a drop down in price at the market. According to the views expressed by sellers, they prefer to export the tea rather than going to the CTA due to the high price of tea.

Those threats were created due to the quality, quantity and number of buyers and sellers having always been uncertain factors, limited bargaining power of sellers exporters dictating prices in keeping with the overseas market, new entrants to the market that have moderate impact on the auctioning system as several large companies try to dominate the market. Furthermore, weather patterns, global market trends, and external environmental factors could severely impact on the prices at the CTA.

Conclusions

This study revealed that the market power concentration indicates a competitive market structure. A very high bargaining power of buyers can enhance the competitiveness. To gain a remunerative price for tea, producers can enhance the price by reducing the cost of production by the process of product diversification the introducing cost effective new machinery for harvesting and processing. Improvement of the acceptance of quality certifications can enhance quality of the tea and product standards. Sellers' satisfaction is high regarding CTA. However, sellers preferred to export tea rather than going to the public auction due to the high prices on offer. For competitive trading policy revision, implementation of a code of conduct by SLTB and CTTA to ensure equal buyer participation, controlling market dominance among buyers, suppression of adulteration of quality tea which tarnishes the image built over hundreds of years and determination of prices for producers based mainly on quality rather than many other contributory factors.

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Do Urban Households Prefer Medicinal Plants for Landscaping? A Case Study in Kurunegala Municipal Area

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ABSTRACT

Sri Lankans use medicinal plants for curative and therapeutic values and in other social, cultural and religious activities. However, there is a potential of using medicinal plants in landscaping to provide aesthetic and other benefits. Therefore, the present study was conducted with the objective of assessing the preference of selected home garden owners on selected medicinal plants in view of introducing these plants for landscaping. For this, a survey was conducted in Kurunegala Municipal limits using a pretested questionnaire. Friedman and Mann-Whitney tests were carried out to analyze preferences. Results revealed a high preference towards medicinal plants by households and among the species studied, Komarika, Vishnukranthi and Thebu received a significant preference. Komarika and Vishnukranthi can be used as a ground cover while Thebu can be used as a specimen plant or can be introduced into borders. Therefore, this study stresses the importance of popularizing medicinal plants in home garden landscaping as it will give an aesthetic value in addition to medicinal and other benefits.

KEYWORDS: Landscaping, Medicinal plant, Urban households

Introduction

A home garden is a piece of land around the dwelling with clear boundaries and it has a functional relationship with its occupants related to economic, biophysical and social aspects (Weerakoon, 2011). Home gardens in Sri Lanka offer a highly diversified and economically viable form of land use. A home garden often consists of a mixture of annual and perennial crops and they produce a variety of products such as food, fruits, medicine, spices, fuel wood and timber (Ariyadasa, 2002). Home gardens are widespread and vary in species composition. Traditionally the development and maintenance of a home garden is a collective effort of family members and according to Weerakoon, (2011), the cultivation of varied species of plants around the house is usually unplanned. In the back garden people tend to grow vegetables and culinary plants such as Karapinchcha and Rampe. However, due to the popularity of the concept of landscaping, nowadays people tend to grow ornamental plants in the front garden of a home. Still in Sri Lanka, the main objective of landscaping is to provide aesthetic benefits. However, according to Hull and Revell, (1989), landscaping is the art and science of arranging outdoor space for human use and enjoyment, which can be directly perceived by a person visiting and using that environment. Therefore, it is clear that a well-planned landscape can provide not only aesthetic benefits but also some functional benefits. In this context multipurpose plants which include medicinal plants can play a significant role in home gardens.

In Sri Lanka ayurveda and the traditional system of healthcare have been systematically used for over 2000 years to treat illnesses (Mahindapala, 2004) and out of 4150 flowering plants recorded in Sri Lanka (Senarathne, 2001), about 208 medicinal plant species are widely used in Ayurveda system. Out of that, 50 species are heavily used in Ayurveda medicine (Pallegedara, 2003). In addition to their curative and therapeutic values, Sri Lankans use medicinal plants in rituals, cultural activities, religious functions (Mahindapala, 2004), in cosmetic industry and as a source of health foods from time immemorial in Sri Lanka (Jayaweera,1981b). In the Sri Lankan context, in most of the front gardens, people widely use popular exotic plants which mainly provide aesthetic benefits in addition to some functional benefits such as shade, dividing space, providing privacy, directing people etc. Thus, incorporation of medicinal plants into the home garden landscapes, can provide diverse benefits to the land owner. Some of the medicinal plants are attractive. In addition, certain plants can be used as food (Thebu, Anguna), as a gruel (Hatawariya, Wel-penela) tonic (Iramusu), as a home remedy (Komarika, Ginger) and for beautification (Komarika). Additionally, nearly 80 medicinal plants are now considered as threatened (Mahindapala, 2004) and therefore, it can also contribute to the conservation of rare medicinal plants. Certain medicinal plants are capable of attracting wildlife such as Woodfodia fruticosa attract sun birds (Napagoda and Yakandawala, 2008), Osbeckia octandra attract bees and serve as a butterfly host plant (Weerasinghe and Yakandawala, 2009). Further, in some instances it can also provide an additional income to the owner as certain plant products have a demand in the local market. Therefore, the concept of introducing medicinal plants as a soft landscape element is important. Further, depending on their height, growth habit, canopy density, form, texture and colour, certain medicinal plants can be incorporated into designs instead of traditionally used ornamental plants (as a hedge) or some can be mixed with ornamentals (in a mix border). Therefore, the present study was conducted with the objective of assessing the preference home garden owners to medicinal plants which also have an ornamental value that can be incorporated into landscaping.

Methodology

Experimental Design

A commonly used ground cover plant Rhoeo spathacea and shrub Durantha repens were selected as popularly used ornamental plants. While based on experience Vishnukranthi, Komarika and Iramusu were selected as alternate to Rhoeo while Bowitiya, Katukarandu and Thebu were selected as an alternate to Durantha to evaluate the preference. The morphology, striking features and medicinal values of all the eight plants were recorded (Table 1 and Table 2). Photographs of plants depicting habit of the plant, leaves and flowers were taken and eight descriptive illustrations were made separately for each medicinal and ornamental plant, which also include their landscape potential and medicinal values where relevant in order to describe the plants to the interviewees who indicated their preferences in a Likert scale. A questionnaire was also developed to gather background information and it was pretested using a sample of 10 people before going into the full scale survey.

Table 1. Landscape Potential, Striking Features and Medicinal Values of Selected Gounrd Cover Plants

Species	Morphology	Striking feature	Medicinal value
Rhoeo spathacea (Ornamental plant)	Herb	Leaf-Green upper surface Lower purple surface Flower-White colour	No
Iramusu (*Hemidesmus indicus*)	Semi shrubby twine; prostrate or accent	Leaf-Green surface with white midrib Flower-White colour	Tonic drink, home remedy (Skin and urinary diseases), root for fever and skin diseases. **
Komarika (*Aloe vera*)	Herb	Leaf-Green colour fleshy Flower-Red colour	Home remedy (burning wound) For beauty culture, cure eye diseases. ***
Vishnukranthi (*Evolvulus alsinoides*)	Herb; Prostrate wiry stem	Leaf-Green colour Flower-Purple colour	To make oil for hair growth, make decoction, cure nerve debility. *

*Note: *Source: Jayaweera(1980); **Source: Jayaweera (1981a); ***Source: Jayaweera (1981b).*

Table 2. Landscape Potential, Striking Features and Medicinal Values of Selected Shrubs

Species	Morphology	Striking feature	Medicinal value
Duranta repens (Ornamental plant)	Height-6 m Spreading branching	Leaf-Small green colour Flower- Violet colour	No
Katukarandu (*Barleria prionitis*)	Height-0.6 m-1.4 m	Leaf -Green colour Flower-Orange yellow colour	To make oil, cure for diabetic, catarrhal fever Rat bites poisoning. **
Thebu (*Costus speciosus*)	Height-2-3 m Spreading horizontally	Leaf-Green colour Flower-White colour with yellow center Specimen plant	Leave for salad, to cure joints, catarrhal fever, Cough, worm and skin diseases. ****
Bowitiya (*Osbeckia octandra*)	Height-2-3 m	Leaf-Green colour Flower-Purple colour	Tender leaves curry, Mature leaves salad cure for diabetics, Treat fractures. ****

*Note: **Source: Jayaweera (1981a); ****Source: Jayaweera (1982).*

Data Collection

Three Grama Niladhari (G.N.) Divisions viz. Udawalpola, Theliagonna and Gangoda representing Kurunegala Municipality area were selected for the survey. Face to face interviews were conducted using the questionnaire from a randomly selected 100 households from June to August in 2011. Each questionnaire included questions with regard to demographic characteristics, details of landscaping practices and attitude towards medicinal plants. To evaluate the preference of medicinal plants compared to popularly use ornamental plants, households were asked to rank the ornamental and medicinal plants according to their preference. Descriptive illustrations which include the pictures of the plants and characters were shown to the households to facilitate better ranking.

Data Analysis

Descriptive statistics were used to describe demographic characteristics. The Friedman test was used to evaluate preference of the selected medicinal and ornamental plants. The Friedman test statistic can be depicted as,

$$X_r^2 = \frac{12}{bC(C+1)} \sum_{j=1}^{c} R_j^2 - 3b(C+1) \qquad (1)$$

Where;

C = number of treatment level
b = number of block
R_j = Total of ranks for a particular treatment level (column)
j = particular treatment level (column)
$X_r^2 \approx X^2$, with df = C -1 (Black, 2001)

The level of significance was set at 5%. Lowest sum of rank value denoted that there was high preference rate. Highest ran sum value was denoted lowest preference level. Mann-Whitney test, the Non parametric counterpart of the t test, was done for each plant pairs to see whether there is a difference between ranks (Black, 2001).

Results and Discussion

Descriptive Statistics of the Sample

The sample comprised of 76% females and majority of them (47%) were housewives. In terms of level of education, 85% have studied up to (A/L) or above (Table 3).

Table 3. Demographic Features of the Sample

Attributes	Levels	Percentage
Age (Years)	≤40	25%
	41-50	30%
	51-60	30%
	≥61	15%
Gender	Male	24%
	Female	76%
Occupation	Government	26%
	Private	11%
	Self employed	16%
	House wife	47%
Education level	Primary	15%
	Secondary	63%
	Diploma	9%
	Degree	13%

Attitude towards Medicinal Plants

Because many medicinal plants are used in treatments in Ayurveda, respondents' belief of this treatment system was assessed. Majority of the respondents (52%) strongly agreed to the idea of using Ayurveda medicine as a successful treatment followed by 41% of them agreed. Only 4% disagreed with the idea. While none of the respondents strongly disagreed (Figure 1).

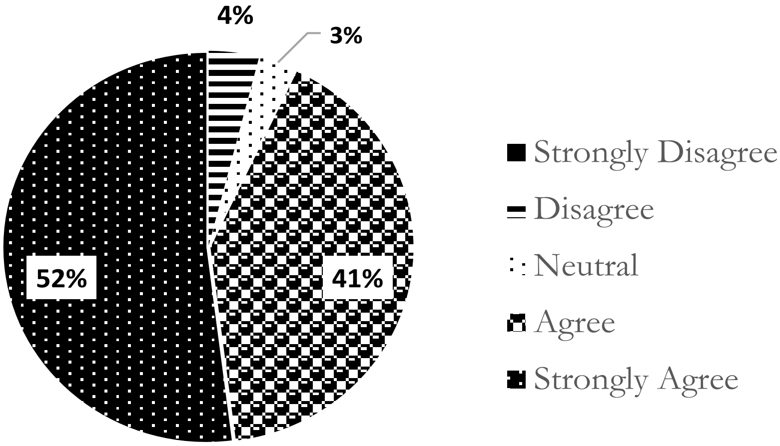

Figure 1. Belief of Ayurveda Medicine as a Successful Treatment Method

Perception of the sample with regard to the possibility of using medicinal plants for minor ailments is given in Figure 2. The majority of the sample (62%) agreed to the idea of the possibility of using medicinal plants for minor ailments while 28% strongly agreed.

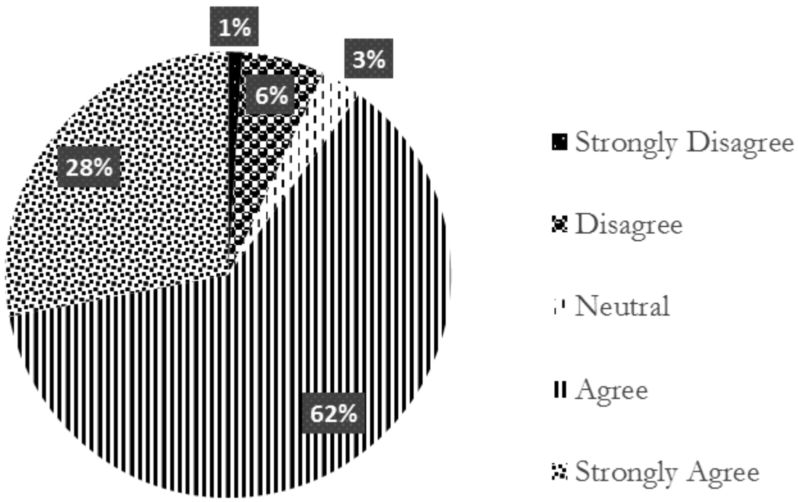

Figure 2. Medicinal Plant Usage for Minor Ailments

The preference for medicinal plants in home gardens were found to be high, evidenced by agreement to the idea of using medicinal plants as ornamental plants in landscaping by the majority (88%) (Figure 3).

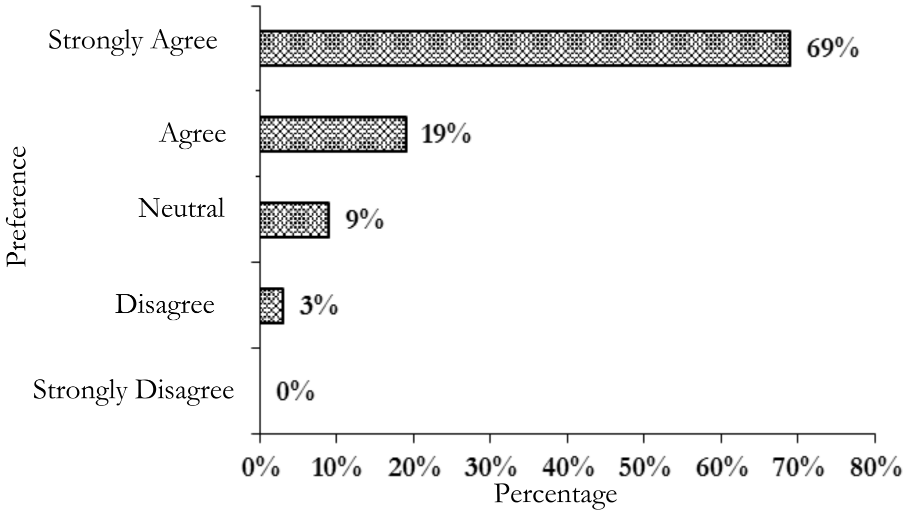

Figure 3. Preference for Medicinal Plants to be Used as Ornemental Plants

Preference for Use as Medicinal and Ornamental Plants

In the Friedman test carried out to assess the comparative preference of the selected plants for this study, Thebu received a low rank sum value (201), where Durentha obtained the highest rank sum value (304). The comparable rank sum value obtained for Katukarandu and Bowitiya demonstrates that respondents have given similar preference for both (Table 4)

Table 4. Preference of Shrubs

Preference	Est. median	Sum of rank
Thebu	1.6[a]	201
Katukarandu	2.7[b]	247
Bowitiya	2.2[b]	248
Durentha	3.3[c]	304

Note: Based on Man-Whitney test pairs with different letters are statistically significant at $p<0.001$

Of the ground cover plants assessed, Komarika and Vishnukranthi received the lowest rank sum values (195, 200 respectively), where Rhoeo received highest rank sum value (Table 5).

Table 5. Preference of Ground Cover Plant

Preference	Est. median	Sum of rank
Komarika	1.5[a]	195
Vishnukranthi	2.2[a]	200
Iramusu	2.7[b]	253
Rhoeo	3.5[c]	352

Note: Based on Man-Whitney test pairs with different letters are statistically significant at $p<0.001$

Thus, out of the four ground cover plants used in the study, the most preferable plants were Komarika and Vishnukranthi. Of which Komarika is popular in beauticulture while Vishnukranthi produce attractive purple coloured flowers. Whereas the popularly used ornamental plant *Rhoeo* received a significantly lower preference. Some respondents stated that water can accumulate within *Rhoeo* leaves hence which can contribute to Dengue. With regard to shrubs, Thebu received a significantly high preference (Table 5) followed by Katukarandu and Bowitiya. Thebu can be used as a specimen plant in landscaping and its leaves used to prepare a popular salad. In this group the ornamental plant *Durantha* received the lowest preference too.

Conclusions

In urban areas there is a high demand for landscaping and people widely use popular ornamental plants. However, medicinal plants with ornamental value can be incorporated into front gardens. The present study revealed the high preference towards medicinal plants by households in the Kununegala Municipal area. Among the species studied Komarika, Vishnukranthi and Thebu received a significantly high preference. Komarika, Vishnukranthi can be used as a ground cover while Thebu can be used as a specimen plant or can be introduced to borders.

Most respondents were not aware about the possibility of using medicinal plants for landscaping. Therefore, in future an awareness programs can be conducted to educate people about the ornamental value of medicinal plants. Further research should also be conducted to identify specific landscape use of medicinal plants. So that this information could be passed during the awareness programs. In addition to the identification of highly preferred medicinal plants these should be propagated and distributed at a reasonable price in view of promoting them in landscaping.

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