APPLIED BIO-SYSTEMS TECHNOLOGY

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Socio Economic Drivers of Vegetable Farming in Kalpitiya

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Abstract

Background: Different agricultural practices along with many food utilization patterns could be observed around the globe. Among those, vegetables have become a vital nutritious meal and a dietary habit in most Asian countries, including Sri Lanka. In recent years more and more farmers have shifted towards vegetable farming from other agricultural activities. Farmers cultivate a wide array of vegetables even without assessing the suitability of those crops, creating sustainability issues in the long run. Investigating reasons for such practices is vital to recognize possible root causes of these crop choices. Hence, the current study was conducted to identify key socio-economic determinants of farmers, which affect the choice of vegetable crops.

Methods: Study adopted exploratory research methods. A sample of 130 vegetable farmers in Kalpitiya Divisional Secretariat were selected randomly for the study. A pre-tested structured questionnaire and focus group discussions were deployed to gather data. Multinomial Logistic Regression (MLR) was employed to elicit the relationship between the choice of crop and selected socio-economic variables.

Results: Farmers tend to select Pumpkin aiming a higher selling price per unit over Beet ($P<0.05$) and Cabbage ($P<0.01$). However, farmers tend to select Beet ($P<0.05$) and Cabbage ($P<0.01$) aiming a higher yield prospect over Pumpkin. Interestingly, female farmers ($P<0.01$) tend to select Pumpkin over Beet due to easiness in harvesting. Farm gate prices and the average yield are the main deciding factors to select a particular vegetable crop by a farmer. Also, short harvesting cycles in these crops mitigate market and production risk to a certain degree.

Conclusions: Creating better market linkages with sufficient information could be a possible solution to introduce alternative agricultural activities among farmers in order to create sustainable farming practices within the agrarian community in Kalpitiya.

Keywords: Kalpitiya, Production Choice, Socio-Economic Drivers, Vegetable Cultivation

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INTRODUCTION

Agriculture is a predominant socio-economic practice in almost every South Asian country including Sri Lanka. It contributes immensely to the Gross Domestic Product (GDP). Thus, the foundation of many agribusinesses in developing countries lie with the primary production of the agriculture sector. Rice is considered as the staple food commodity in Sri Lanka. In addition, vegetables, fruits, cereals, pulses, root and tuber crop cultivation is done in the country. Amongst those, vegetables are a popular agro commodity and local community consume vegetables in raw, cooked or partially processed forms. Over the years, vegetables have become a vital side dish in the main meal, in the routine dietary habit in Sri Lanka [1]. A wide array of vegetable varieties are being cultivated around different geographical areas in the island. Farmers cultivate around 80 different varieties of fruits and vegetables domestically and produces approximately around 3,000 million kg of vegetables annually [2]. Thus, vegetable subsector is an important component in the Sri Lankan agricultural sector [3-4].

Kalpitiya Divisional Secretariat (DSD) located in the Puttlam District is a key area for vegetable production. It is considered as one of the highly productive agricultural areas in the country. Kalpitiya contributes to a high percentage of vegetables (40% of the local vegetable demand) and fruit production of the country while creating a high number of job opportunities for the residents [5]. Approximately 62% of the agricultural extent in Kalpitiya is employed by intense agricultural fields with shallow-rooted crops and the remaining (38%) accounts for coconut cultivation lands [5]. Crop cultivation in the area is done throughout the year without implementing any seasonal cultivation practices. The dominant crop species in the Kalpitiya area are chilli, onion, okra and beetroot. Even though the Department of Agriculture has indicated suitable varieties for cultivation, farmers in the area mainly tend to cultivate imported varieties with a relatively higher demand.

In recent years more and more farmers have shifted towards vegetable farming from other agricultural activities. Their patterns of cultivation, including crop selection and timing, have also changed due to the dynamic nature of the sector [6]. One such reason for this is the short harvesting cycles in many vegetable crops. This yields, faster cash inflow cycles and also mitigates climatic risk in agriculture, compared to many other perennial agricultural crops. Further, according to Perera *et al.* [7], the international trade in fruits and vegetables has increased rapidly during the last two decades. This could be another reason why many farmers tend to shift towards the vegetable subsector. Apart from those reasons there may be various socio-economic factors at micro level, which influence this behaviour [8]. At the same time, it is important to investigate, whether this increasing tendency of farmers shifting to vegetable subsector is sustainable in the long run, since it could create market instability, through imbalance supply and demand in domestic markets. Therefore, proper investigation is required to identify micro level factors, which determine the farmers' choice of crop. This aids to understand the nature and patterns of the farmer choice, along with alternative strategies, to maintain the sustainability of the vegetable subsector in Sri Lanka.

In addition, understanding the nature of vegetable production in the country is important for the generation of long-term strategies in the agriculture sector. It addresses specific issues in the vegetable supply chain around the country. This may overcome possible price volatilities and adverse structural changes in the agricultural markets in the country. Otherwise, over supply and shortage may disturbs the natural market behaviour creating various lapses. Investigating micro economic factors of farmers is an ideal way to initiate such work. In light of this, the main objective of the study is to identify key socio-economic

determinants of farmers which affect the choice of vegetable crop.

METHODOLOGY

Conceptual Framework

The context of vegetable farming in Sri Lanka is complex. Therefore, the current study adopted exploratory research methods. Both qualitative and quantitative approaches were used in the study. Study inquired the factors, which affect farmers' choice of crops. Accordingly, figure 1 illustrates the conceptual framework of the study. It is assumed that the farmer's choice of crop is dependent on selected socio-economic variables. These variables represent micro level aspects of the farmer. Set of macro-economic factors are also moderating the relationship between dependent and independent variables.

Gender, age (years), education of the farmer, extent (acre), average yield (kg $acre^{-1}$), unit selling price (LKR kg^{-1}), average fertilizer usage (kg $acre^{-1}$), number of family and hired labour for the selected crop and organic fertilizer usage are the selected independent variables, which influenced the choice of crop. Broad macro-economic factors such as government policy frameworks, developments in market and other infrastructure, technological advancement and research and development are considered as the mediating variables [9-11].

Study Area

Study was conducted in Kalpitiya Divisional Secretariat (DSD) which is located in the Puttalam District, North-Western Province in Sri Lanka. Kalpitiya DSD belongs to the DL_3 (North Western Dry Zone) agro-ecological zone, which has unique features due to sandy soil and semi-arid environment [12].

Data Collection

A sample of 130 vegetable farmers were selected randomly for the study. Grama Niladhari (GN) divisions, which had the highest number of vegetable farmers were selected with the aid of Agrarian Services Centre (ASC) in the area. Both primary and secondary data were used to interpret the results. Primary data collection was done using a pre-tested structured questionnaire survey, along with focus group discussions. Secondary data were gathered from various secondary sources. Questionnaire covered socio-economic status of the respondents, crop production practices, status, patterns and behaviours.

Statistical Analysis

Both descriptive and inferential statistics were used to analyse data. Multinomial Logistic Regression (MLR) was employed to elicit the relationship between dependent and independent variables. Dependent variable, which is choice of crops is a discrete and non-ordered categorical variable and hence the MLR was used.

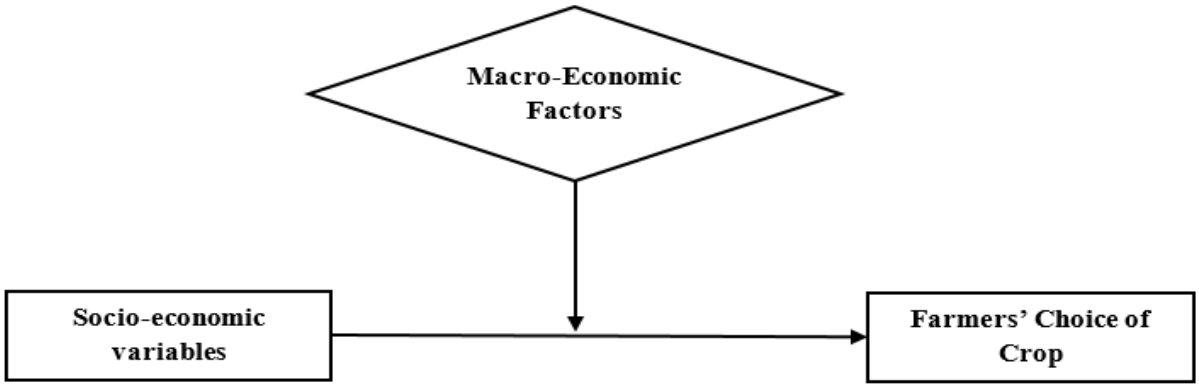

Figure 1: Conceptual Framework of the Study

MLR model considers, more than two discrete and non-ordered categorical variables as the dependent variable.

Equation 1 illustrates the probability of a dependent variable to be in the n^{th} category in the MLR model. Baseline category is denoted by *j*. MLR with a dependent variable that has a single category must have "*J-1*" logistic regression models [13-15].

$$\pi_j = \frac{\exp \sum_{k=1}^{K} \beta_{jk}\, x_k}{1 + \sum_{j=1}^{J-1} \left(\sum_{k=1}^{K} \beta_{jk}\, x_k \right)} \quad (1)$$

The MLR, which has 3 categories takes the sum of probabilities of each category, which is equal to "1"

$$P(D = 1|x) + P(D = 2|x) + P(D = 3|x) = 1 \quad (2)$$

Hence, only two odds ratios are calculated and each category is compared with these ratios. The model is linearized by taking the natural logarithms of these odds ratios to obtain logistic models.

RESULTS AND DISCUSSION

Majority (91%) of farmers, who participated for the study were males. Age of the sample was ranging from 19 years to 79 years with an average age of 42 years. Age distribution indicated a relatively higher presence of younger farmers in the vegetable cultivation. In general, younger farmers were more interested on vegetable cultivation in the area, due to speed of cash recovery between cultivation cycles. A crop cycle ranged between 45 to 60 days on the average.

Adjacent famers cultivated different vegetable varieties in order to avoid competition between them. From the total sample, half of the farmers represented grade six to grade 10 education categories, while only few (18%) had an education level below grade five (Table 1). This indicates majority of the sample was having a reasonable education.

The average vegetable land extent was 6879.65 m^2 (1.7 acre) and more than 95% of farmers held land less than 20234.30 m^2 (5 acre) of land. Hence, vegetable cultivation was practiced in small land plots within the area. Average farm gate prices of Pumpkin, Beet and Cabbage were 74.43 LKR kg^{-1}, 45.82 LKR kg^{-1}, and 33.00 LKR kg^{-1} respectively (Table 1). Farm gate prices ranged between 10 LKR kg^{-1} to 180 LKR kg^{-1} for all three vegetable varieties. Farmers obtained an average yield of 0.92 kg m^{-2} (3734 kg $acre^{-1}$) for pumpkin, 1.54 kg m^{-2} (6233 kg $acre^{-1}$) for Beet and 2.78 kg m^{-2} (11242 kg $acre^{-1}$) for Cabbage.

They also applied 0.10 kg m^{-2} (354 kg $acre^{-1}$) of solid form of inorganic fertilizer, separately for both Pumpkin and Beet and 0.08 kg m^{-2} (349 kg $acre^{-1}$) for Cabbage. Interestingly, majority (80%) mixed various types of organic matter (poultry manure, cow dung, paddy husk and other crop and animal residue) with inorganics. Average monthly household income of only 28% of farmers were below LKR 100,000. This implies earnings of the farmer families were at a satisfactory level, compared to other crop cultivators around the country.

Farmers tend to select Pumpkin aiming at a higher selling price per unit over Beet ($P<0.05$) and Cabbage ($P<0.01$) when everything else was held constant (table 2). This was mainly due to the varietal selection and frequent cultivation of *batana* variety in the area. Hence, they obtain better farm gate prices for *batana* pumpkin variety compared to normal variety (Table 2). However, there was a considerable yield difference between these two varieties. In general, farmers obtained a relatively lower yield from *batana* variety. On the other hand, this is one of the highly demanded vegetable commodities in the local consumer markets.

Farmers tend to select Beet ($P<0.05$) and Cabbage ($P<0.01$) aiming higher yield prospects over Pumpkin when other factors are not changing. Both Beet and Cabbage are originally cultivated in the upcountry region

Table 1: Socio-Economic Characteristics of the Sample

Demographic Character	N = 130	Percentage
Gender		
Male	119	91
Female	11	9
Education level		
Grade 5 or below	18	14
Grade 6 – 10	65	50
Up to O/L	35	27
Up to A/L	12	9
Higher education	-	-
Average monthly household income*		
< 50,000	13	10
51,000 -100,000	22	18
101,000-150,000	19	15
151,000-200,000	15	12
201,000-250,000	19	15
251,000-300,000	8	6
301,000-350,000	4	3
351,000-400,000	5	4
401,000-450,000	2	2
451,000-500,000	5	4
501,000-550,000	2	2
551,000-600,000	3	2
601,000-650,000	2	2
651,000-700,000	-	-
>700,001	5	4

	Crop		
	Pumpkin	**Beet**	**Cabbage**
Average Land extent (acre)	1.50	1.74	1.62
Average Yield (kg acre^{-1})	3734	6233	11242
Average Farm gate price (LKR kg^{-1})	74.43	45.82	33.00
Average Inorganic fertilizer usage (kg acre^{-1})	354	354	349

*Note: * Only 124 farmers were disclosed the average monthly household income*

of Sri Lanka.

In recent years, low-country farmers also initiated cultivation of some of those vegetable varieties. This resulted competition between primary vegetable production groups in the country. This transformation is prominently evident in the Kalpitiya area. In the early years, Kalpitiya area was popular for the cultivation of cash crops like other field crops (OFC). However, at present more farmers have adopted vegetable cultivation. This has been further boosted with the establishment of the Norochchole Dedicated Economic Centre (DEC), which is specialized for vegetable marketing. Estimated daily vegetable trade of the centre is 100,000 kg. Interestingly, female farmers ($P<0.01$) tend to select Pumpkin over Beet. This may be due to easiness in harvesting.

Adherent topography (sandy soil and arid climatic condition) is also boosting the cultivation of vegetables in Kalpitiya. At present the area is flourished with roughly around 2500 hectares of vegetable lands [16].

Table 2: Results of the MLR Analysis

Crop[a]	Parameter	Coefficient	SE	P value
Beet	Intercept	35.09	3511.23	0.99
	Gender (Male)	-17.66***	1.34	$<1*10^{-3}$
	Age	-0.01	0.03	0.84
	Extent	0.27	0.44	0.53
	Average Yield	$<1*10^{-3}$**	$<1*10^{-3}$	0.03
	Selling Price per unit	-0.04**	0.02	0.01
	Average Fertilizer Usage	0.00	$1*10^{-3}$	0.83
	Organic Fertilizer Usage	1.00	0.80	0.21
	No. Family Labor	0.06	0.25	0.81
	No. Hired Labor	0.04	0.04	0.34
	[Education=1]	-16.46	3511.23	0.10
	[Education=2]	-16.50	3511.23	0.10
	[Education=3]	-16.49	3511.23	0.10
	[Education=4]	0[b]	-	-
Cabbage	Intercept	35.91	3511.23	0.10
	Gender	-20.22	$<1*10^{-3}$	-
	Age	-0.03	0.04	0.49
	Extent	0.39	0.50	0.43
	Average Yield	$1*10^{-3}$***	0.00	$<1*10^{-3}$
	Selling Price per unit	-0.12***	0.03	$<1*10^{-3}$
	Average Fertilizer Usage	$<1*10^{-3}$	$1*10^{-3}$	0.77
	Organic Fertilizer Usage	-0.58	1.14	0.61
	No. Family Labor	-0.37	0.39	0.34
	No. Hired Labor	0.06	0.05	0.31
	[Education=1]	-32.14	4271.77	0.99
	[Education=2]	-14.42	3511.23	0.10
	[Education=3]	-14.51	3511.23	0.10
	[Education=4]	0[b]	-	-

a. The reference category is: Pumpkin.
b. This parameter is set to zero because it is redundant.
***Significant at 1% level, **Significant at 5% level, * Significant at 10% level.

Agriculture itself has created nearly 30,000 jobs in the area. Inter-monsoon starting from October to December and North-East monsoon starting from December to February are the two major rainy seasons. Farmers tend to cultivate more on these seasons. The presence of fresh water reserves in the soil at easily accessible depths is another factor, which encourages cultivation in the area. This favours crops, which have short life span such as vegetables. Sequential vegetable cropping pattern (three to four crops are planted one after another) was visible in the area [16]. Crop diversity within the farm and natural fallowing was at a minimum level. Maintaining an optimum level of water supply for plants is vital, in order to provide moisture as well as to reduce heat. Therefore, most farmers use irrigation systems like, sprinklers and drips. Extraction of too much of groundwater may result salt water intrusions in the area. Hence, establishment of agro-wells should be done with care.

In overall, development of farming activities in Kalpitiya area have been intensified over the years according to the respondents. Interestingly, more and more farmers have gradually opted for vegetable cultivation. This practice was prominent

among younger farmers. Usage of high amounts of agrochemicals is one of the major issues identified in the vegetable cultivation. Poor soil fertility and high nutrient leaching potential in the area, have induced farmers to apply high amounts of agrichemicals. Excess chemicals, which leach into groundwater could lead to long term health issues among the community. This could be reduced by applying sufficient organic manure in to the soil layers. Water efficiency could be improved by applying mulches and planting cover crops [17].

Farmers rarely exhibit such practices in their cultivation. In addition, Kalpitiya area is highly vulnerable to climatic changes. Even minor changes in climate could have a significant impact on the cultivation. Hence, farmers should be properly aware on alternative crop cultivations like fruit crops and plantation crops to mitigate climatic risk in agriculture to a certain extent. At the same time promotion of protected house cultivation among the community is another suitable option [18]. Also, information flow of the supply chain is less efficient. Most of the time, both producers as well as consumers make incorrect selling and purchasing decisions based on false signals.

CONCLUSION

According to the findings, it is evident that both farm gate prices and the average yield were the main driving factors influencing the selection of a particular vegetable crop by a farmer. Farmers obtained better returns and faster cash recovery from the vegetable cultivation. Also, short harvesting cycles in these crops tend to mitigate market and production risk to a certain degree. In addition, Norochchole Dedicated Economic Centre (DEC), which is located in the Kalpitiya peninsular also promote the vegetable marketing in the area. However, farmers were inclined to cultivate only few selected vegetable varieties rather than focusing on many varieties. For the short run this might create price competition and lower producer prices. In the long run this might create major issues in sustainability in vegetable cultivation in Sri Lanka. Hence, this has to be managed by introducing alternative cultivations like fruit crops and plantation crops among these farmers and establishing market chains accordingly.

AUTHORS' CONTRIBUTIONS

VK: Designed the study, data analysis and wrote the manuscript; NDS: Data collection and reviewed the manuscript; JE: Designed the study and reviewed the manuscript, LU: Improved the manuscript; RG and IH reviewed the manuscript.

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REFERENCES

1 Weerakkody WA, Mawalagedera SM. Recent developments in vegetable production technologies in Sri Lanka. InAgricultural Research for Sustainable Food Systems in Sri Lanka 2020 (pp. 189-214). Springer, Singapore.
2 Sri Lanka Export Development Board. Industry capability report: Fresh fruits and vegetables. Colombo: Sri Lanka Export Development Board. 2019.
3 Nuskiya F. Up-country vegetable production and marketing: challenges and opportunities. SEUSL Journal of Marketing. 2019; 4(2): 21-31
4 Priyankara EA. Present Status of Vegetable Direct Marketing in Selected Districts in Sri Lanka. Hector Kobbekaduwa Agrarian Research and Training Institute. 2016.
5 Jayasekera DL, Kaluarachchi JJ, Villholth KG. Groundwater stress and vulnerability in rural coastal aquifers under competing demands: a case study from Sri Lanka. Environmental monitoring and assessment. 2011 May; 176(1):13-30.
6 Dharmasena, P. Vegetable cultivation in the Central highlands of Sri Lanka. 2017.

7 Perera S, Rambodagedara M, Wijesinghe R. Fruit and Vegetable Export Growth Instability and Diversification. Hector Kobbekaduwa Agrarian Research and Training Institute. 2015.
8 Xaba BG, Masuku MB. Factors affecting the productivity and profitability of vegetables production in Swaziland. Journal of Agricultural Studies. 2013 Jun; 1(2): 37-52.
9 Zhou Y, Yang H, Mosler HJ, Abbaspour KC. Factors affecting farmers' decisions on fertilizer use: A case study for the Chaobai watershed in Northern China. Consilience. 2010 Jan; 1(4): 80-102.
10 Greig L. An analysis of the key factors influencing farmer's choice of crop, Kibamba Ward, Tanzania. Journal of Agricultural Economics. 2009 Sep; 60(3): 699-715.
11 Briggs J. An exploratory study of farmers' choice of crops in Central Sudan. Transactions of the Institute of British Geographers. 1985 Jan; 1:170-180.
12 Urban Development Authority. Kalpitiya City Development Plan 2019-2030. Puttalam: Urban Development Authority. 2019.
13 Asampana G, Nantomah K, Tungosiamu E. Multinomial Logistic Regression Analysis of the Determinants of Students' Academic Performance in Mathematics at Basic Education Certificate Examination. Higher Education Research. 2017; 2(1): 22-26.
14 Long JS, Freese J. Regression models for categorical dependent variables using Stata. (2nd ed.). College Station, TX: Stata. 2006.
15 Liao TF. Interpreting probability models: Logit, probit, and other generalized linear models. Quantitative Applications in the Social Sciences. Sage Publications. 1994 Jun 30.
16 Hitinayake HMGSB. Kalpitiya farming system: Its characteristics and emerging challenges. Crop life: Sri Lanka plant protection industry journal. 2019; 7: 58-65.
17 Thi DP, Hang NN, Viet OT, Van LN, Viet AN, Lan PD, Van NV. Sandy Soil Reclamation Using Biochar and Clay-Rich Soil. Journal of Ecological Engineering. 2021; 22(6):26-35.
18 Kumara SK, Weerakkody R, Epasinghe S. Viability of Controlled Environmental Agriculture for Vegetable Farmers in Sri Lanka. Hector Kobbekaduwa Agrarian Research and Training Institute. 2015