



Factors Influencing Fertilizer Usage by Medium and Large Scale Coconut Farmers in Gampaha District, Sri Lanka

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Authors' contributions

This work was carried out in collaboration among all authors. Author SDNMS involved in study design, data collection, data analysis and interpretation of key results and writing the study outputs. Author AMKRB involved in survey design, questionnaire preparation, conducting interviews, quantitative data analysis and research reporting. Author AIYL involved in field level data collection (Key-person interviews and focus-group discussions), quantitative and qualitative data analysis and reporting results. All authors read and approved the final manuscript.

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ABSTRACT

Aims: This study attempts to identify the factors affecting the usage of fertilizer by medium- and large-scale coconut farmers in the Gampaha District, Sri Lanka with a view to recommend pragmatic strategies to increase coconut production in Sri Lanka.

Study Design: Multistage quota sampling with a proportion allocation method.

Place and Duration of Study: The study was conducted during the year 2017 in the Gampaha administrative district, which is a leading coconut-producing region, under the coconut triangle of Sri Lanka.

Methodology: Both primary and secondary data were utilized in the study. Descriptive analytical techniques, factor analysis, and Binary Logistic Regression techniques were used in the data analysis.

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Results: The factor analysis disclosed five-factor groups that cumulatively explain 55% of the total variation. Binary Logistic Regression revealed that the prevalence of favorable weather patterns, usage of supplementary materials, availability of credit facilities, and organic fertilizer application significantly affect the application of inorganic fertilizer for coconut cultivation. The availability of a fertilizer subsidy, practicing moisture conservation, practicing animal husbandry, and applying inorganic fertilizer significantly determined the application of organic fertilizer for coconut cultivation. Usage of supplementary materials, yield of the last coconut picking, and household size significantly affected the fertilizer application for coconut cultivation in general.

Conclusion: Prevalence of favorable weather patterns, supplementary materials, and credit usage increase the chance of applying inorganic fertilizer for coconut. Organic fertilizer application decreases the likelihood of applying inorganic fertilizer for coconut. Availability of a fertilizer subsidy, practicing moisture conservation, practicing animal husbandry increase the chance of applying organic fertilizer for coconut, whilst the inorganic fertilizer application decreases the likelihood of applying organic fertilizer for coconut.

Keywords: Coconut; soil fertility; inorganic fertilizer; organic fertilizer.

1. INTRODUCTION

Coconut cultivation plays an economically and socially important role in Sri Lanka, being one of the key sources of direct and indirect livelihoods. The leading coconut producers in the world are Indonesia, Philippines, India, and Brazil [1]. Sri Lanka is the 5th largest coconut producer in the world, with over 440,000 ha of cultivated land. Coconut accounts for nearly 12% of total agricultural production in Sri Lanka, with a total land area of 409, 244 hectares under cultivation [2]. The coconut triangle, which covers Kurunagala, Puttalam, and Gampaha districts stand for 56% of the total coconut cultivated area [3]. Smallholders own a major part of coconut holdings in Sri Lanka, whilst the rest belongs to the estate sector that is owned by both private and government companies. The medium and large-scale coconut growers coming under the non-estate sector occupy a significant position of coconut cultivation in the Gampaha District.

The salient attributes associated with this sector have been recognized by both public and other stakeholders and have largely contributed to promote cultivation and production over the years. Despite these favorable mechanisms, the national coconut productivity has declined over the years [4], making it insufficient to meet the growing demand associated with increasing population. In comparison to other regions, the Gampaha District has experienced a rapid downturn in productivity over the years. Lack of proper agronomic practices and unfavorable weather [5], the poor state of soil [6], inappropriate markets, and lack of effective extension services are among the major

causative factors identified for the low productivity of the coconut industry. Moreover, substandard fertility management of soil has been identified as a prime contributory factor for low coconut production in the short run as well as in the long run.

This situation was aggravated because of the prolonged drought condition occurred in 2016. However, previous studies have identified some steps capable of uplifting productivity in coconut cultivation, especially under poor soil conditions with a lack of field care. Some authors reported that the yield of coconut could be significantly improved with fertilizer application [7]. Moreover, it was evident that applying fertilizer at the initial two years of the crop does not significantly improve the coconut yield, however afterwards coconut yield significantly improves with fertilizer application. For instance, the annual production of a coconut tree can be increased by 32 to 34 nuts with fertilizer application [8] and [9]. Thus, this study attempts to identify the factors affecting the use of fertilizer by medium- and large-scale coconut farmers in the Gampaha District in order to recommend pragmatic strategies to increase coconut production in Sri Lanka.

2. METHODOLOGY

2.1 Study Area and Sampling

The study was conducted in the *Gampaha* administrative district, which is a leading coconut-producing region that falls under the coconut triangle of Sri Lanka. Multistage quota sampling with a proportion allocation method was adopted to select coconut growing regions,

agrarian service divisions (ASDs), and coconut growers. At the first stage, three divisional secretariat divisions (DSDs), namely Divlapitiya, Mirigama, and Minuwangoda, cover more than half of the total coconut growers, were purposely selected as the principal coconut growing regions within the district.

In the second stage, a sample of 227 coconut growers (95% confidence level and 10% margin of error), which consists of 81 medium-scale (2.0-4.1 hectares) and 146 large-scale (4.1-20.2 hectares) coconut growers, were selected from all the ASDs within the selected DSDs using proportion allocation method.

2.2 Data Collection

Both primary and secondary data were utilized in the study. Primary data were collected mainly from a field survey using a pre-tested and structured questionnaire. Moreover, Key personnel interviews and focus group discussions were performed to acquire detailed information on measured aspects. Secondary data required for the study were extracted from both related published and unpublished sources.

2.3 Data Analysis

Descriptive analytical techniques, factor analysis, and Binary Logistic Regression techniques were used in the data analysis. Factor analysis was adopted to realize the major factors or group the variables affecting the fertilizer application decision by the coconut growers. Factor analysis [10,11] is an analytical technique used to disclose the underlying relations behind a large set of variables. It allows the grouping of variables that correlate into a small set of factors and thereby reduces the dimensionality of the variable's space. Each factor is created as a linear combination of the original variables. The present study satisfies the basic criterion for using the factor analysis as the ratio of the initial variables (14 variables) to the number of observations (227 observations) in the sample. Age, gender and education level of the grower, available family labor, land ownership status, coconut cultivated extent, coconut production and revenue from unit land, adopted cropping pattern, the existence of alternative income sources, credit usage, availability of advisory services, holding memberships in coconut related organizations, and consideration on favorable weather pattern in applying fertilizer were the variables in this study.

Binary logistic regression was employed to identify the variables affecting the fertilizer application decision of the coconut growers'. Statistical analysis was performed using both SPSS and SAS software. Many studies [12,13,14] have utilized binary logistic regression to find the relationship between binary response with predictor variables [15]. The response variable, fertilizer application status, consisted of two categories as "applying fertilizer" and "not applying fertilizer" denoted by $Y = 1$ (applying) and $Y = 0$ (not applying). Here, the variable "fertilizer application status" followed the Bernoulli distribution for every single observation. The following model describes the status of fertilizer application.

$$\text{logit}Y = \beta_0 + \beta_1X_1 + \beta_2X_2 + \dots + \beta_nX_n(1)$$

Where;

$\text{logit}Y$ = Dependent variable (Fertilizer application status)

1 represented the farmers, those who were applying fertilizer

0 represented the farmers, those who were not applying fertilizer

β_0 = Intercept

β_1, β_2 to β_n = Estimated coefficients

X_1, X_2 to X_n = Independent variables

3. RESULTS AND DISCUSSION

3.1 Results of the Factor Analysis

The factor analysis disclosed five-factor groups that cumulatively explain 55% of the total variation. Factor 01 represents technical variables such as availability of advisory services (Factor loading = 0.73), land size (0.66), and availability of credit facilities (0.65). Factor 02 represents the monetary aspects such as income per acre and coconut yield. Both factors 03 and 04 collectively represent variables related to demographic characteristics where farmer's age and gender represent the highest loadings of each factor, respectively. Factor 05 mainly represents crop-based community engagements, such as membership of any coconut related organizations (Table 1). The results of the factor analysis revealed the necessity to focus more on related technical variables compared to other categories of variables. The highest loading suggests that more attention is necessary to motivate the people and provide guidance in the decision-making process of applying fertilizer.

Table 1. Rotated component matrix

Variable	1	2	3	4	5
Availability of advisory services	.731				
Cultivated extent	.663	-.348			
Credit usage	.649				
Prevalence of favorable weather	.460				-.339
Revenue from unit land		.792			
Coconut Yield		.751			
Household size		.334	.670		
Age of the farmer			.676		
Educational level of farmer			-.635		
Gender of farmer				.752	
Land ownership				.751	
Membership in related organization					.807
Cropping pattern					.316

3.2 Factors Affecting Applying Inorganic Fertilizer

Results of the Binary Logistic Regression revealed that the prevalence of favorable weather patterns, usage of supplementary materials, availability of credit facilities, and organic fertilizer application are statistically significant ($P < 0.05$) in determining the application of inorganic fertilizer for coconut cultivation (Table 2). Urea, Eppawala Rock Phosphate, and Muriate of Potash are the inorganic fertilizer mixture normally used by the farmers in the study area.

The prevalence of favorable weather conditions is the most important factor determining inorganic fertilizer application. A favorable weather pattern has increased the possibility of applying inorganic fertilizer by 258 times compared to an unfavorable weather pattern. Generally, coconut growers consider well on the prevailing weather, and this finding suggests that the consistency of favorable weather pattern increases fertilizer usage [4,16]. Coconut growers fear to invest in fertilizer owing to the uncertainty of weather conditions and the time lag between fertilizer application and yield. Some scholars pointed out that the coconut harvest in a given year is influenced by rainfall distribution of a previous year, and the absolute response to fertilizer by coconut reaches a peak under a favorable rainfall [4].

The usage of supplementary materials has improved the likelihood of applying inorganic fertilizer 30 times compared to the non-usage of supplementary materials. Well-managed coconut cultivations are usually treated with supplementary materials in addition to the typical

inorganic fertilizer mixture. The majority (85.90%) of farmers added supplementary materials such as salt, zinc sulfate, boron, kieserite, and ash to the coconut lands to improve soil fertility.

The credit usage has improved the chance of applying inorganic fertilizer [6] by 6.3 odds value. The growers who used credits for purchasing fertilizer tend to apply inorganic fertilizer for coconut compared to none-credit users. In general, any financial assistance would expand the potential expenses and consequently, growers are getting a higher chance of purchasing more inorganic fertilizer. Though the Sri Lankan Coconut Cultivation Board does not offer fertilizer subsidy for coconut cultivations above 2.03 hectares or 05 acres, such individual growers, as well as Co-operative Coconut Grower Societies, are entitled to credit schemes. This credit arrangement encourages the usage of inorganic fertilizer by coconut growers. A study on socio-economic conditions of the coconut small-holding sector in Sri Lanka (1986) pointed out that inadequate credit facilities for purchasing fertilizer have resulted in fertilizer applications below the recommended levels. Studies [17,6] have found that richer households, especially having off-farm income sources, often have access to farm inputs and thereby obtain better harvests.

The application of organic fertilizer has negatively affected (- 2.002) the event of inorganic fertilizer application. The possibility of applying inorganic fertilizer is decreased by 98% when a farmer is applying organic fertilizer to the field. In other words, farmers who are applying organic fertilizer tend to apply a lesser amount of inorganic fertilizer [18]. A plausible explanation

for this is that the cost increased when applying organic and inorganic fertilizer together. In such systems, organic fertilizer usage is limited as growers would expect the inorganic fertilizers to boost yields adequately [18]. Some studies also have identified that the main reason for not applying fertilizer is either high prices or lack of funds [19] and [20]. Therefore, take into account the risk of droughts and the time lag between the application and obtaining a higher yield, many growers were not interested in the use of organic and inorganic fertilizer together.

3.3 Factors Affecting the Use of Organic Fertilizer

Results of Binary Logistic Regression revealed that the availability of fertilizer subsidy, practicing moisture conservation, practicing animal husbandry, and applying inorganic fertilizer significantly ($P=0.05$) determined the application of organic fertilizer for coconut cultivation (Table 3). Cattle manure, Goat manure, and poultry manure are the most frequently used organic fertilizer in the study area.

The availability of a fertilizer subsidy has improved the chance of applying organic fertilizer by 3.26 odds value. The Coconut Cultivation Board, Sri Lanka, issues a subsidy scheme for organic fertilizer to promote the organic food industry. Due to the high cost of inorganic fertilizer growers, those entitled to the subsidy tend to use organic fertilizer.

The practicing of moisture conservation methods has improved the likelihood of applying organic fertilizer by about 03 times compared to none-

partitioning of moisture conservation methods. The majority of the growers (84.58%) have adopted moisture conservation methods such as mulching, drainage channels, management of cover crops, contour draining, and dip the coconut husks in pits. Organic fertilizer, which can be considered a dead mulch, is better than live mulches due to lack of competition for moisture during droughts [21] and [4].

Practicing animal husbandry parallel to coconut cultivation has improved the likelihood of applying organic fertilizer by 2.5 times compared to coconut cultivations without animal husbandry. Animal husbandry plays an important role in coconut farming to reduce the cost of fertilizer. About 43.17% of the farmers were rearing animals such as cattle, buffalo, and poultry. Most farmers were rearing cattle not for commercial purposes but only for weeding and to take the manure for plantation. Previous study found system sustainability in terms of nutrient depletion [6]. It is thus likely to become an increasingly serious issue unless there is better integration of mixed crop-ruminant livestock systems in the short run and ultimately increased fertilizer use.

The application of inorganic fertilizer has negatively affected (-0.674) the event of organic fertilizer application. The possibility of applying organic fertilizer is decreased by 76% when a grower is applying inorganic fertilizer to the field. In other words, farmers who are applying inorganic fertilizer tend to apply a lesser amount of organic fertilizer. Similar to the findings of [6], a possible reason for this could be the difficulty to find organic fertilizer.

Table 2. Binary logistic regression results for inorganic fertilizer

Paramete	Estimate	Error	Pr>ChiSq	Odds ratio
Intercept	-1.068	0.659	0.105	
Prevalence of favorable weather pattern	2.776	0.433	<.0001*	257.541*
Usage of supplementary material	1.697	0.617	0.006*	29.811*
Credit usage for buying fertilizer	0.920	0.325	0.005*	6.292*
Organic fertilizer application	-2.002	0.613	0.001*	0.018*

*significant at 5%

Table 3. Binary logistic regression results for organic fertilizer

Parameter	Estimate	Error	Pr>ChiSq	Odds ratio
Intercept	0.258	0.222	0.244	
Availability of fertilizer subsidy	0.590	0.157	0.0001*	3.257*
Practicing moisture conservation	0.507	0.222	0.022*	2.758*
Practicing animal husbandry	0.458	0.152	0.003*	2.500*
Inorganic fertilizer application	-0.674	0.202	0.001*	0.260*

*significant at 5%

Table 4. Binary logistic regression results for fertilizer

Parameter	Estimate	Pr>ChiSq	Odds ratio
Supplementary material	-1.551	<.0001*	0.045*
Yield of the last picking	0.018	<.0001*	1.018*
Household size	-0.875	0.0321*	0.417*

*significant at 5%

Further analysis revealed that the usage of supplementary materials, yield of the last coconut picking, and household size significantly ($P=0.05$) determine the fertilizer application for coconut cultivation in general (Table 4). The yield of the last coconut picking improves the likelihood of applying fertilizer, which implies that farmers tend to apply fertilizer to get more yield. This conforms with the findings of [19], which states that the fertilizer application has a greater impact on production. Both the household size and usage of supplementary materials decrease the likelihood of applying fertilizer for coconut in general.

4. CONCLUSIONS AND RECOMMENDATIONS

The study concludes that the consideration of weather patterns, supplementary materials, and credit usage significantly increase the chance of applying inorganic fertilizer for coconut. The organic fertilizer application substantially decreases the likelihood of applying inorganic fertilizer for coconut. Availability of a fertilizer subsidy, practicing moisture conservation, practicing animal husbandry significantly increase the chance of applying organic fertilizer for coconut, whilst the inorganic fertilizer application significantly decreases the likelihood of applying organic fertilizer for coconut. The study suggests developing policies aimed at improving the existing credit scheme for buying fertilizer.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

- Burton J. The world leaders in coconut production. Economics. World Atlas; 2018. Accessed 18 November 2020. Available: <https://www.worldatlas.com/articles/the-world-leaders-in-coconut-production.html>
- Sri Lanka Export Development Board, Annual Report. Colombo, Sri Lanka: Sri Lanka Export Development Board; 2018.
- Department of Census and Statistics, Annual Performance Report. Colombo, Sri Lanka: Department of Census and Statistics; 2012
- Pathiraja PMEK, Griffith GR, Farquharson RJ, Faggian R. The Sri Lankan coconut industry: Current status and future prospects in a changing climate. Australasian Agribusiness Perspectives. 2015;1-23.
- Mwachiro EC, Gakure RW. Factors affecting the coconut industry from benefitting the indigenous communities of Kilifi District, Kenya. Inter. J. Humanit. Soc. Sci. 2011;1(4).
- Waithaka MM, Thornton PK, Shepherd KD, Ndiwa NN. Factors affecting the use of fertilizers and manure by smallholders: The case of Vihiga, western Kenya. Nutrient Cycling in Agroecosystems. 2007;78(3): 211-224.
- Muyengi ZE, Msuya E, Lazaro E, Assessment of factors affecting coconut production in Tanzania. Journal of Agricultural Economics and Development. 2015;(4):83-94.
- Rosa GNGP, Novais RFD, Barros NFD, Villani EMDA. Lime and fertilizer recommendation system for coconut trees. Revista Ceres. 2011;58(1):90-99.
- Magat SS. Fertilizer recommendations for coconut based on soil and leaf analyses. Philippine Journal of Coconut Studies (Philippines); 1991.
- Chua YP. Statistik penyelidikan lanjutan: Ujianregresi, analisis factor dan analisis SEM. II. Buku 5. McGraw-Hill (M); 2009.
- Johnson RA, Wichern DW. Applied multivariate statistical analysis. Upper Saddle River, NJ: Prentice hall. 2002;5(8).
- Sadalia I, Nasution FN, Muda I. Logistic regression analysis to know the factors affecting the financial knowledge in decision of investment non riil assets at University Investment Gallery. International Journal of Management (IJM). 2020;11(2).

13. Joshi A, Kalauni D, Tiwari U. Determinants of awareness of good agricultural practices (GAP) among banana growers in Chitwan, Nepal. *Journal of Agriculture and Food Research*. 2019; 1:100010.
14. Sio J, Ismail R. Binary logistic regression analysis of instructional leadership factors affecting English language literacy in primary schools. *3L: Language, Linguistics, Literature*. 2019;25(2).
15. Hosmer DW, Lemeshow S. *Applied logistic regression*. USA: JohnWiley & Sons; 2000.
16. De Silva NTMH, Tisdell CA. Response of coconuts to fertilizer and advice to Sri Lankan growers: An aggregative approach. *Ceylon Cocon*. 1981;32:72-79.
17. Crowley EL, Soule MJ, Carter SE. Off-farm income and farming in western Kenya. Report to USAID/Kenya, Nairobi; 1996.
18. Omamo SW, Williams JC, Obare GA, Ndiwa NN. Soil fertility management on small farms in Africa: Evidence from Nakuru District, Kenya. *Food Policy*. 2002; 27(2):159-170.
19. Sepala, AC. Socio-economic conditions of coconut small-holding sector in Sri Lanka: A baseline study of the pre-project conditions of Colombo, Galle, Gampaha, Kegalle, Kalutara and Ratnapura districts. Agrarian Research and Training Institute, Sri Lanka; 1986.
20. Muyengi ZE, Msuya E, Lazaro E. Assessment of factors affecting coconut production in Tanzania; 2015.
21. Vidhanaarachchi LP. An evaluation of different mulches used in soil moisture conservation of coconut lands. *CORD, Coconut Research and Development Journal*. 1998;14(2):12-27.

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