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Adoption of commercial fruit farming recommendations in Anuradhapura district with special reference to fruit village programme

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Abstract

The economic benefits are highly realized in commercial fruit cultivation and it is important to adopt technology recommendations to gain potential output. The aim of this study was to determine the factors that influence the adoption of recommended practices in fruit cultivation of fruit villages established under the National Food Production Programme (NFPP) in the year 2016. This study was conducted in Anuradhapura district covering 16 fruit villages. The study used multi stage random sampling method to select 97 beneficiaries to carry out cross sectional data survey. The data analysis was carried out through descriptive statistics and econometric model of ordered logistic regression. The study constructed the Farming Practices Intensity (FPI) index considering the application of recommendations in the field. According to the FPI index, the majority of the farmers (57.7%) were categorized into the medium level adopters' category whereas the low and high adopters' are representing 25.7% and 16.6% of the total sample, respectively. The model estimated that male farmers were more likely to be in higher adopters' category compared to the female farmers. The farming experience, perception of farmers on the fruit village program and the contacts with extension officers were positively correlated with technology adoption and more influential on farmers to be practiced technological recommendations in commercial fruit cultivation. Therefore, the policy makers and the research and technology dissemination experts are needed to consider the disparity-inducing factors in their planning process to realize the expected outcome from the fruit village programme.

Keywords: Adoption, Fruit villages, Technology recommendations

Introduction

Fruit cultivation in Sri Lanka is spread over 150,000 hectares and a large share of the extent is cultivated in home gardens (CBSL, 2018). The annual fruit production is reported as 1.07 million metric tons (DCS, 2018). The country records fruit exports of 37.3 million kilograms worth Rs. 6.3 billion and 78.7 million kilograms of imports valued Rs.14.2 billion (CBSL, 2018). The food balance sheet revealed that per capita annual fruit availability is 41 kg (DCS, 2017). That is approximately fulfilling the half of the daily dietary fruit requirement (200 g) of a healthy person. Therefore, there is a necessity to increase fruit cultivation to fulfill the current requirement of the country. For the purpose of enhancing food production in Sri Lanka, the National Food Production Program (NFPP) has been launched in year 2016. The program was led by the Ministry of Agriculture and other agriculture related institutes in the country. The food production program has focused to enhance the availability of food encouraging the production of paddy, other field crops, vegetables and fruits. The NFPP has launched fruit village program to popularize commercial fruit cultivation at village level. This program has aimed to increase the fruit availability for consumption and exports while reducing the imports. In this program, the fruit village is defined within the *Grama Niladari* Division (GND). The Department of Agriculture (DOA) has distributed 900 plants in same variety of fruit for each fruit village and that should not be exceeded among 20 beneficiaries in the GND. In addition, DOA has been responsible to provide extension and trainings for beneficiaries regarding the recommendations on commercial fruit farming practices.

The success of an agriculture program is mainly affected by the farmer's decision to implement technology recommendations in field level. Moreover, the reasons behind why some farmers are low adopters while others are medium and high adopters of commercial fruit farming recommendations in fruit villages have not been sufficiently examined yet. Additionally, in an effort to address the policy variables that influence the adoption of commercial fruit farming, it is important to explicate determinants that cause the disparity in adoption. Identification of the adoption disparity factors is vital to affirm effectiveness of the policy actions to enhance production and productivity of the fruit villages. This study was designed to identify the factors that influence the disparity in adoption of recommendations for commercial fruit farming with special reference to the fruit villages established in Anuradhapura district.

Materials and Methods

The study followed multi stage random sampling techniques to draw a sample. In the first stage, Anuradhapura districts was selected purposively where 160 fruit villages established in the Anuradhapura Inter Province (AIP) area in year 2016. In the second stage, 16 fruits villages were selected randomly and finally, from each fruit village, beneficiaries were selected using simple random sampling technique. The total sample consisted with 97 beneficiaries. The sample was represented by eight types of fruit villages i.e., mango, papaya, sour-sop, guava, passion fruit, pomegranate, lime and sweet orange. The data were collected from December 2018 to March 2019.

Conceptual framework

The intensity of practicing farming recommendations in the fields are influenced by different factors such as personal, socio-economic, institutional and psychological. Kebedom (2012) and Akudugu *et al*. (2012) grouped the determinants of agricultural technology adoption into three categories; economic, social and institutional factors. McNamara *et al*. (1991) categorized the adoption influenced determinants into, farmer characteristics, farm structure, institutional characteristics and managerial structure. Following Adesina and Seidi (1995), Kebedom (2012) and Akudugu *et al*. (2012), this study has focused on the effect of underlying factors on adopting recommendations for commercial fruit farming in fruit village program. The study mainly focused on the effect of socio economic background of the respondents (e.g., gender, main income source), farm characteristics (e.g., farming experience, fruit growing land area, active participation of family members for farming), and institutional factors (e.g., market accessibility, number of meetings with agricultural instructors annually). Further, the study required to identify the influence of project beneficiary's perception over fruit village program on their decision to practice recommended technologies in the fields.

Adesina and Baidu-Forson (1995), Herath and Hiroyaki (2003) and Rahman (2003) have considered that the decision of a farmer to adopt a technology is seen as single unit of package whether to adopt or not. The dichotomous nature of such decisions usually implies that the empirical model be specified as a binary dependent variable model. However, this study was designed to identify the factors that influencing the different adoption levels of the technology recommendations for fruit cultivation in the fruit villages. Following Kebede *et al*. (2017) it is needed to find the reasons behind why some farmers are low adopters while others are medium or high adopters of the same recommended package. In an attempt to address the policy variables, it is important to

elucidate the factors that cause the disparity in adoption of technology packages.

The fruit cultivation involves different farming practices recommended by the research system and promoted by extension services. The study has developed a Farming Practices Intensity Index (FPI index) to capture the intensity of practicing the recommendations by the fruit village beneficiaries. The adoption indices for commercial fruit farming recommendation package were initially computed from seven technology components consisted with 22 sub activities i.e., (1) planting (planting depth, spacing, other practices) (2) compost/organic matter application (application at planting pit preparation, application after planting, number of times applied annually) (3) inorganic fertilizer application (basal application, 6 top dressing applications), (4) weeding (methods of weeding, number of times of weeding annually), (5) pest and disease control (field sanitation and chemical control), (6) water management (watering/irrigation, water conservation activities) and (7) fruit plant training and pruning practices (removing water shoots/shady branches, balance distribution of the fruit bearing parts, other related activities). The each sub activity was introduced Likert scale with three points such as 0, 1 and 2 for "no recommendation", "close to recommendation" and "recommendation", respectively. The FPI index was calculated by taking the ratio of total score earned by an individual farmer to the maximum score allocated for the recommended package (see Equation 1). It indicates the extent to which an individual farmer has adopted the practices in the recommendation package.

$$\text{FPI Index} = \frac{\text{Total score earned by } i^{th} \text{ farmer}}{\text{Maximum score of the total package}} \quad \ldots\ldots\ldots(1)$$

A farmer who adopted all practices at recommended level would earn maximum score 44 and the FPI index will be one. If a farmer has not adopted any attributes in recommendation package, he/she will earn zero for FPI index. Therefore, FPI index can be varied from 0 to 1 and farmer who has practiced higher number of farming recommendations would gain higher score for FPI index. For the purpose of identification of the determinants that influence different adoption level, the respondents were categorized into low, medium and high adopters with respective ranges of FPI index such as 0.0–0.33, 0.34–0.66, and 0.67–1.00.

Analytical framework

The nature of dependent variables is a directive for the selection of appropriate econometric model. The dependent variable in this study is ordinal with three adopters'

categories i.e., low, medium, and high. Hence, the ordered logit model was used to estimate the relationships between the dependent variable and the set of predictor variables. Following Long and Freese (2014), in ordered logit, an underlying score was estimated as a linear function of the predictor variables and a set of cut points. The probability of observing outcome i corresponds to the probability that the estimated linear function, plus random error, is within the range of the cut points estimated for the outcome (see Equation 2).

$$P_{ij} = \Pr(y_i=i) = \Pr(k_{i-1} < x_j\beta + u \leq k_i) = 1/(1+\exp(-k_i + x_j\beta) - 1/(1+ \exp(-k_i + x_j\beta) \quad .....(2)$$

Where, u is assumed to be logistically distributed in ordered logit and the coefficients of β ($\beta_{1,2}$, ,…, β_k,) along with the cut points k_1, k_2…, k_k-1, where k is the number of possible outcomes. The value of k_0 is defined as -∞, and k_k as +∞. Because of the fact that the coefficients of the estimates are in log-odds units, they are often difficult to interpret, so converted them into odds ratios.

The empirical model for the adoption of recommendations for commercial fruit farming is specified as follows (see Equation 3):

$$FPI\ index_i = \beta_0 + \beta_1 GEND_i + \beta_2 INCOMSD_i + \beta_3 FL_i + \beta_4 FEXP_i + \beta_5 FRUACR_i + \beta_6 PECPN\_i + \beta_7 MEET_i + \beta_8 MKTACCD_i + \varepsilon_i \quad .....(3)$$

GEND is a dummy variable for gender expression that is one for male and zero for female farmer. Asare *et al*. (2013) and Adekemi (2014) explained that adoption level was higher among male adopters compared to the female farmers. Variable *INCOMSD* is a dummy variable and refers to the main income source of the respondent. If farming is the main income source, variable equal to one and otherwise zero. Following Sunny *et al*. (2018) farmers are engaging with agriculture for living, hypothesized to positive effect on adopting the commercial fruit farming recommendations. *FL* refers to the number of actively participating family members for agricultural activities in the farm. Since the number of actively participating family members is increasing, farmers are expected to be courageous to practice commercial fruit farming because of expectation to reduce labor cost (Udimal *et al*., 2017). *FEXP* refers to the number of years of farming experience. With increasing experience, farmer may be able to make critical decision on technology adoption. Ainembabazi and Mugisha (2014) revealed that existence of inverted U shape relationship between farming experience and technology adoption. This study hypothesize farming experience is to be positively correlated with FPI index. Land

extent of fruit farming referred to *FRUACR* and it measures the land area under new fruit cultivation. Many studies have reported a positive relationship between farm size and the adoption of agricultural technology (Ahmed, 2004; Uaiene *et al*., 2009). As the land size is large it's more likely to adopt inputs intensive farming. Secondly, large farm size would facilitate easy realization of the benefits due economy of scale. Thus, farm size is hypothesized to be positively related to the adoption of recommendations.

The perception of the farmers on fruit village program was introduced to the model as a score that has been constructed using four key aspects. The score has been built with respect to the perception on the quantity and quality of plants received, whether the fruit plants were being affected by the dry spell prevailed at plant distribution and the beneficiary's evaluation on training and extension services provided regarding the fruit cultivation practices before the plants distribution. The respondents were asked to choose preferable Likert scale that varies from 1 to 5 and depicted, 1 = strongly disagree, 2 = disagreed, 3 = neutral, 4 = agreed and 5 = strongly agreed. If a farmer strongly agreed with four aspects of the perception score, he/she would earn the maximum perception score of 20. The minimum score will be four and it occurs when beneficiary is strongly disagreed with all elements of the perception score. The perception score (*PECPN*) is hypothesized to have a positive correlation with FPI index of fruit farming. The number of meets with extension personal during a year referred by *MEET* and hypothesized to have a positive relationship with FPI index (Genius *et al*., 2014; Uaiene *et al*., 2009). Possibility of marketing fruits by any mean (collector, whole seller, retailer, exporter or processor) is referred by *MKTACCD* and it is a dummy variable. Aryal *et al*. (2018) found that farmers tend to adopt new recommendations if market access is assured. Therefore, ability to access the market is hypothesized to have a positive relationship with FPI index.

Results and Discussion

Descriptive statistics of the research variables are presented in Table 1. The study found that the participation of male farmers in fruit village program was 56% of the total sample and there is reasonably higher participation of female farmers' (44%) too. It is important to highlight that 39% of beneficiaries whose main livelihood was not the farming. This is a positive indication of attracting new followers for agricultural activities in the study area. Further, the study found that the average number of actively participating family members for farming activities was 2. It was noticed that the farming experience of beneficiaries ranged from 2 to 37 years with the mean value of 10.2 years.

Table 1. Description of summary statistics of explanatory variables (n=97).

Variable	Measure	%	Minimum	Maximum	Mean	Standard Error
Gender (*GEND*)	Male = 1 Female = 0	56 44	0	1	0.56	0.05
Main income source (INCOMSD)	Farming =1 Other = 0	61 39	0	1	0.61	0.05
No. of actively participating family members (FL)	Number		0	4	2	0.07
Farming experience (FEXP)	Years		2	37	10.2	0.82
Fruit growing area(FRUACR)	Acre		0.04	0.60	0.16	0.03
Perception Score (PECPN)	Score		4	14	10.58	0.21
Number of contacts per year (MEET)	Number		1	12	4.12	0.30
Market access (MKTACCD)	Yes = 1 No = 0	68 32	0	1	0.69	0.05

Source: Authors' prepared based on study information

The descriptive results depicted the average fruit growing land area as 0.16 acres. The perception score ranged from 4 to 14 while portraying mean was 10.58. The average number of meets with extension officer was found as 4 times per year. The percentage of respondents who has found a market to sell their fruits was 68% of the sample.

The distribution of respondents according to their adoption level of each attribute of the recommendation package was presented in Table 2. The respondents were categorized in to 3 groups *i.e.*, who have followed the recommended practice (Recommendation), close to recommendation but not the recommendation or zero practice of technological attributes. The study found that all three attributes (planting depth, spacing and other related practices) come under the fruit tree planting showed relatively higher rate of adoption. The respondents (represents both groups: recommendation and close to recommendation) concerned on applying organic matter during planting and after planting on a regular basis. However, farmers have not followed the recommended quantity and the number of applications of inorganic fertilizer that should be done annually. It showed majority of the farmers who has practiced weeding and chemical control in pest and disease as per the recommendation or close to recommended level.

Table 2. Distribution of respondents in accordance with adopting the recommended operations for fruit cultivation.

Operations		No recommendation	Close to recommendation	Recommendation
Planting	Planting depth	10%	23%	67%
	Spacing	10%	18%	72%
	Other practices	21%	25%	55%
Organic fertilizer application	Before planting - quantity kg per pit	31%	31%	38%
	After planting - quantity kg per application	45%	30%	25%
	No. of times per year	58%	38%	4%
Inorganic fertilizer application	Basal application	70%	12%	18%
	1st top dressing	54%	21%	26%
	2nd top dressing	54%	21%	26%
	3rd top dressing	58%	21%	21%
	4th top dressing	66%	13%	21%
	5th top dressing	80%	2%	18%
	6th top dressing	95%	1%	4%
Weed control	Methods of weeding	11%	31%	58%
	No. of times of weeding per year	13%	63%	24%
Pest and disease control	Field sanitation	71%	8%	21%
	Chemical application (n=17)	-	41%	59%
Water management	Irrigation/ watering frequency	5%	8%	87%
	Water conservation activities	46%	36%	18%
Fruit plant training and pruning	Removing water shoots ,shady branches	50%	31%	19%
	Balance distribution of the fruit bearing parts	62%	26%	12%
	Other practices	65%	23%	12%

Source: Authors' prepared based on study information

It was evidenced that higher percentages (87%) of beneficiaries have irrigated their fields whereas they paid less attention on water conservation activities. The findings revealed that farmers have paid less attention on fruit plant training and pruning.

Table 3 presents the distribution of respondents by FPI index categories. Out of the total sample, 25.7% of respondents were categorized in to low FPI index score category. The majority (57.7%) of the respondents recorded in the medium level category whereas 16.6% of respondents were found in high FPI index score range.

Table 3. Distribution of respondents by FPI index categories (n=97).

Adoption category	N	%	FPI index score range	Mean	Standard deviation
Low	25	25.7	0.00 - 0.33	0.29	0.05
Medium	56	57.7	0.34 - 0.66	0.52	0.06
High	16	16.6	0.67 - 1.00	0.69	0.01

Source: Authors' prepared based on study information

Table 4 presents the farmer perceptions on fruit village program which has been studied using four criteria. Farmers were satisfied with the total number of plants and the quality of the fruit plants received by them.

Table 4. Farmer perceptions on fruit village program.

Perception statement	Strongly disagreed = 1 (%)	Disagreed= 2 (%)	Neutral =3 (%)	Agreed =4 (%)	Strongly agreed = 5(%)	Mean score
1. Overall agreement with number of plants received	0%	14%	21%	59%	6%	3.57
2. Overall agreement with quality of the plants received	2%	15%	19%	57%	7%	3.52
3. Fruit plants were being affected during the dry period (a)	10%	36%	21%	33%	0%	2.77
4. Training on fruit cultivation before plant distribution	20%	36%	15%	29%	0%	2.53

Source: Authors' prepared based on study information

Note: (a) Likert scale was introduced in opposite direction; strongly disagreed = 5, disagreed = 4, neutral = 3, agreed = 2 and strongly agreed = 1

The mean scores of perception on whether the fruit plants being affected during dry period, and the extension and training given on fruit trees before the distribution of plants have depicted neutral perception.

Results of econometric model

In this section, the ordered-logit model was employed to see the relative influence of different socio-economic and institutional variables on the intensity of practicing fruit farming recommendations in the fruit villages VIF (Variance Inflation Factor) test has resulted mean VIF as 1.52 which indicated the absence of multicollinearity between the hypothesized variables in the study. Further, Breusch-Pagan/Cook-Weisberg test read the non-existence of heteroskedasticity ($\chi^2 = 0.22$, prob > $\chi^2 = 0.5651$) in sample data.

The likelihood ratio χ^2 of 62.47 with a p-value of 0.000 indicated at the model as a whole is statistically significant compared to the null model with no predictors (see Table 5). The cutoff points shown at the bottom of the output indicate where the latent variables are cut to make the three groups that observed in data.

Table 5. Parameter estimates of ordered-logistic regression model.

Variable	Coefficient	Standard Error	z -statistics	Odd ratios	Standard Error
GEND	0.177**	0.060	2.49	1.194**	0.128
INCOMSD	0.743	0.769	0.97	2.103	1.616
FL	-0.124	0.404	-0.31	0.883	0.357
FEXP	0.152***	0.045	3.41	1.164***	0.052
FRUACR	0.696	0.844	0.83	2.006	1.693
PECPN	0.604***	0.187	3.24	1.830***	0.342
MEET	0.194**	0.099	1.95	1.214**	0.121
MKTACCD	1.177	0.899	1.31	3.243	2.917
/cut1	4.692	1.748		4.692	1.748
/cut2	12.145	2.451		12.145	2.451

*Log likelihood = -40.45312, LR chi2 (8) = 62.47***; Pseudo R2= 0.4357. Note: ***, ** and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.*

The study results found that being a male famer, farming experience, beneficiary's perception score and the number of meets with extension officer annually were statistically significant with positive influence on adopting the recommended technologies in the fruit villages.

It has found that variable gender was statistically significant at 5% level of significance on adopting the recommended technologies. According to the model estimates, keeping other factors constant, for males, the odds of being in a high adopter technology category versus the combined medium and low adopter categories was 1.19 times greater than that for females while adopting the recommended technologies in the

study area. Similarly, the odds of the combined categories of high and medium adopter's of the recommendation package versus low adopters category was 1.19 times greater for male farmers compared to females, keeping other factors constant. This finding is consistent with Asare *et al*. (2013) and Adekemi (2014) who found that male farmers are early adopters of agricultural technologies compared to female growers.

The study revealed that, when the experience of a beneficiary increased by a year the odds of being in a higher adopter's category was 1.16 times greater while keeping other factors constant. In the same way, for a one year increase in farming experience, the odds of the combined high and medium adopter's category versus low adopter's category of the technology package were about 1.16 times greater, keeping the other predictor variables constant. This could be associated with the fact that farmers are getting experience in cultivation; there could be an accumulation of information and knowledge about the technology packages. Further, Nkamleu *et al*. (1998) expressed that experienced farmers have been witnessing the benefits of various government interventions in agriculture sectors. Farmer perception (*PECPN*) over fruit village program was statistically significant at 1% level of significance. Findings expressed that as the perception score of the farmer increased by one unit; the odds of being in a higher adopter's category versus the combined middle and low adopter's categories were 1.83 times greater, given the other variables were held constant in the model. In the same way, for a one unit increase in the perception score, the odds of the combined high and medium adopter's category versus low adopter's category were about 1.83 times greater, when keep other variable constant. This was as evidence for expressing attitudinal change that could be made the choice of novel practices for farming. Frequencies of contacts (*MEET*) with extension officers were found to be positively significant at 5% significant level. The model result depicts that contacts with extension personal increase by one time, the odds of being in high adopter's technology package category versus the combined medium and low adopters of the package were 1.21 times greater keeping other factors constant. Similarly, the odds of the combined categories of high and medium adopter's category of the technology recommendation package versus low adopters category was 1.21 times greater for farmers who had contacted extension personnel frequently when compared to farmers who had less number of meets. The farmers who met extension officers often have an opportunity to share the information about the recommendations and that would be supportive for the technology adoption.

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Conclusion

The purpose of this study was to examine the effect of socioeconomic and institutional factors that govern the differences among farmers in relation to the adopting recommendations for fruit farming in Anuradhapura districts. The study was designed to examine three categories of recommendation adopting groups *i.e*. low, medium and high. The study found that male farmers were higher adopters of recommendations in fruit farming compared to female farmers. The experienced farmers were more likely to adopt new recommendations and it might be as they have acquired information and knowledge through the farming practices over the time. The farmer perception on fruit village program had played important role to extended use of technical recommendations in fruit cultivation. Further, the frequent extension visits contributed towards higher level of adoption of crop recommendations in the field. Therefore, the study recommends the enhancement of capacity of the extension programs to upkeep the commercial farming in the fruit villages to achieve expected economic benefits. Further, policy makers, research and technology dissemination experts, development practitioners, and planners should consider the disparity-inducing factors are revealed for their program planning process.

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References

Adekemi, O. 2014. Gender differences in technology adoption and welfare impact among Nigerian farming households, Department of Agricultural Economics, M.Sc. Thesis. University of Ibadan, Nigeria.

Adesina, A.A. and J. Baidu-Forson. 1995. Farmers' perceptions and adoption of new agricultural technology: evidence from analysis in Burkina Faso and Guinea, West Africa. Agricultural Economics 13:1-9.

Adesina, A. A. and S. Seidi. 1995. Farmers' perceptions and adoption of new agricultural technology: analysis of modern mangrove rice varieties in Guinea-Bissau. Quarterly. Journal of international Agriculture 34(4):358–71.

Ahmed, S. 2004. Factors and constraints for adopting new agricultural technology in Assam with special reference to Nalbari District: An Empirical Study: Journal of Contemporary Indian Policy.11; 359-376.

Ainembabazi, J. H. and J. Mugisha. 2014. Role of farming experience on the adoption of agricultural technologies: Evidence from smallholder farmers in Uganda, Journal of Development Studies 50(5): 666-679.

Akudugu, M. A., E. Guo and S. K. Dadzie. 2012. Adoption of modern agricultural production technologies by farm households in Ghana: What factors influence their decisions? Journal of Biology, Agriculture and Healthcare 2(3).

Aryal, J.P., M.L. Jat, T.B. Sapkota, A. Khatri-Chhetri, M. Kassie, D.B. Rahut, and S. Maharjan. 2018. Adoption of multiple climate-smart agricultural practices in the Gangetic plains of Bihar, India, International Journal of Climate Change Strategies and Management 10(3): 407-427.

Asare, R. B., J.A. Danquah, F. Annor-Frempong. 2013. Socioeconomic factors influencing adoption of Codapec and Cocoa High-tech Technologies among smallholder farmers in Central Region of Ghana, American Journal of Experimental Agriculture 3(2): 277-292.

CBSL Annual Report. 2018. Central Bank of Sri Lanka.

DCS. 2017. Department of Census and Statistics, Sri Lanka.

DCS. 2018. Department of Census and Statistics, Sri Lanka.

Genius, M., P. Koundouri, C. Nauges and V. Tzouvelekas. 2014. Information transmission in irrigation technology adoption and diffusion: Social Learning, Extension Services, and Spatial Effects. American Journal of Agricultural Economics 96:328-344.

Herath, P.H.M.U. and T. Hiroyaki. 2003. Factor determines intercropping by rubber smallholders in Sri Lanka: a logit analysis .Agricultural Economics 29:159-168.

Kebede, D., M. Ketema and N. Dechassa. 2017. Disparity in adoption of wheat production technology packages in eastern Ethiopia, Review of Agricultural and Applied Economics, 20(2): 22-29.

Kebedom, A. 2012. Adoption and intensity of use of coffee technology package in Yergacheffe District, Gedeo zone, Snnp Regional state, Ehiopia, M.Sc. Thesis Haramaya University.

Long, J. S. and J. Freese. 2014. Regression Models for Categorical Dependent Variables Using Stata. 3rd ed. College Station, TX: Stata Press.

McNamara, K.T., M.E. Wetzstein and G. K. Douce. 1991. Factors Affecting Peanut Producer Adoption of Integrated Pest Management, Applied Economic Perspectives and Policy 13(1):129–139.

Nkamleu, G.B., O. Coulibaly, M. Tamo and J.M. Ngeve. 1998. Adoption of storage pest control technologies by Cowpeas' Traders in Western Cameroun: Probit Model Application .Monograph. International institute of Tropical Agriculture.

Rahman, S. (2003). Environmental impact of modern agricultural technology diffusion in Bangladesh: An analysis of farmer's perceptions and their determinants. Journal of Environmental Management. 68: 183-191.

Sunny, F., H. Zuhui and T. Karimanzira. 2018. Investigating key factors influencing farming decisions based on soil testing and fertilizer recommendation facilities. A case study on rural Bangladesh. Sustainability, 10(11), https://doi.org/10.3390/su10114331. (accessed on 9 January 2019)

Uaiene, R., C. Arndt and W. Masters. 2009. Determinants of agricultural technology adoption in Mozambique. Discussion papers No. 67E. Ministry of Planning and Development.

Udimal, T. B., Z. Jincai, O. S. Mensah and A. E. Caesar. 2017. Factors influencing the agricultural technology adoption: The Case of improved rice varieties (Nerica) in the Northern Region, Ghana, Journal of Economics and Sustainable Development 8.