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Technology adoption in groundnut cultivation in Sri Lanka

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Abstract

Any technology generated will be viable only if it is adopted by the growers. Although cultivated extent and production of groundnut have shown increasing trends during last two decade in Sri Lanka, there is no enough evidence on level of adoption of improved varieties and agronomic practices by ground nut growers. This study has aimed to estimate the adoption rates of technology and identify factors affecting technology adoption and farmers preferences. Quantitative and qualitative data were used to answer the research questions through a structured questionnaire by 255 farmers. Adoption rate was measured using descriptive statistics while developing an adoption score for key agronomic practices. Logistic regression analysis and stepwise multiple linear regression were, respectively assigned to measure factors affecting adoption of improved varieties and agronomic practices. Result indicated that adoption of an improved variety is 85% and out of this 81% adopted only *Tissa* variety. Agronomic practices were adopted only by 36% of the farmers. The study also found that seeds produced by the Department of Agriculture and good extension service had a strong influence on variety adoption where coefficient was 2.72 ($p<0.001$) and 1.27 ($p<0.05$) with odd ratio OR: of 15.2 and of 3.6, respectively. Linear regression verified that extension service and trainings have positively influenced on the adoption of agronomic practices. Poor socio-economic background indirectly caused stagnancy of knowledge and negative attitudes, non-exposure to new technologies, and limited access to credit. This study suggests that exposing farmers towards the technology through efficient communication mechanism and increase availability of inputs and marketing facilities should be in place to increase the ground nut production in Sri Lanka

Keywords: Factors affecting adoption, Groundnut farmers, Sri Lanka, Survey

Introduction

Groundnut is one of the popular legumes and oil crops with high contain of edible oil, protein, fats, energy, minerals and vitamins. Therefore, groundnut is used to produce large range of confectionaries and oils, and help to increase food security, reduce hunger and poverty, secure livestock feed, and fixes atmospheric nitrogen in soil. Thus, the crop provides several benefits to small-scale farmers in developing countries (Simtowe *et al*., 2010).

The technology generated is viable only if it is adopted by the growers. The benefits from adopting new technologies and innovations are viewed directly through productivity increment that can translate into higher farm incomes and food security. Indirect benefits can ensure other farmers and consumers through lower food prices, increase food availability, accessibility, consumption and potentially non-farm employment (Ndjeunga *et al*., 2013).

Department of Agriculture (DOA), Sri Lanka has released 6 improved groundnut varieties during the last few decades as shown in Table 1.

Table 1. Improved varieties released by Department of Agriculture

Variety	Released year	Potential yield (kg ha^{-1})
Tissa	1993	3775
Walawa	1993	3500
Indi	1994	3864
Tikiri	2004	3000
ANKG1	2012	3000
Lanka Jambo	2015	4400

Source: Groundnut breeding division, Grain Legume and Oil crops Resreach and Development Center, Angunakolapelessa

There is no adequate information on adoption level of those improved varieties by the farmers. However, at the farmers' field, average yield is far behind the potential yield. For example, during last decade, an increasing trend in groundnut production and productivity was recorded in Sri Lanka. Accordingly, year 2016 recorded the highest cultivated extent of 19,975 hectares followed by productivity of 1.2 mt ha^{-1}. Productivity of 1.78 and 1.75 mt ha^{-1} was reported in 2017 and 2018, respectively from cultivated extent of 12,639 and 15,752 hectares, (Agstat 2010-2018). Although the productivity has considerably increased during last decades the gap between actual and potential yield is still wider and the failures in technology adoption are not known. Therefore, the study

attempted to find out the adoption level of groundnut technologies and factors affecting technology adoption in major groundnut growing areas with special attention on farmers' preferences for improved varieties and agronomic practices.

Materials and Methods

Quantitative and qualitative methods were used to collect data. For the quantitative part of the study, a household survey research was conducted during June-September 2018 using a well-structured questionnaire, administrated by well-trained enumerators with solid criteria of cross-check for reliability of every part of the questionnaire. Under qualitative part of the study, four focus group discussions (FGD), each consisted eight farmers were held to understand farmers' preferences for improved varieties and barriers hindering the adoption possibility of groundnut technology. Agriculture Instructor's (AI) ranges of Pudukuduirippu, Thelulla, Mahananeriya and Anamaduwa, respectively from Mullaitivu, Monaragala, Kurunegala and Puttlam districts were the selected areas for FGD. The sample size was decided using Raosoft web-based sampling calculator (http://www.raosoft.com/samplesize.html). Accordingly, 255 groundnut farmers were included into the sample assigning the multi-stage sampling procedure at 95% confidence interval. Two hundred and fifty five farmers were proportionately drawn from different districts (Mullaitivu-88, Monaragala-82, Kurunegala-40, Puttlam-35, Hambantota-10) with special attention on major growing ranges to select well represented sample. Though the initial sample size was 255, for strengthening more reliability and validity of the data analysis, only 235 respondents who had cultivated groundnut consecutively more than five years were considered for the regression analysis. Adoption rate was estimated using descriptive statistics. The computer software of Statistical Package for Social Science (SPSS-2019) was used to analyze the data.

Based on the nature of the data, two regression analyses methods were assigned where multiple logistic regression for measuring the association between improved varieties adoption and its associated factors, and stepwise multiple linear regression for measuring the relationship between adoption of agronomic practices and its associated factors. Further, for measuring adoption level of agronomic practices, only five major agronomic practices which are critically influencing on yield were considered and adoption level was measured based on the adoption score. Adoption score was developed based on the questionnaire survey and expert opinion (researchers of breeding and agronomic) and careful consideration was given to select most decisive agronomic practices. Thus, land preparation, fertilizer application, sowing method (with recommended spacing), weed

control, and pest and disease control were assumed as the most important factors affecting yield. Subsequently, each agronomic practice was given one score and total score was summed up as five. Thus, if a respondent practiced all these agronomic practices, his total score should equal to five and zero score for vice versa. Ultimately, descriptive statistics of mean, median, maximum and minimum were used to measure adoption level of agronomic practices and adoption score was used as the dependent variable for stepwise regression analysis. Among the independent variables, knowledge and attitudes were also measured using score given to the respondents based on the related questions raised. Based on the given score, respondents were categorized into three groups as good, moderate and poor knowledge and attitudes bearers.

Selected models and variables included into the two models are shown in the Table 2.

Table 2.Variables in the regression models

Model 1	$\log(odds) = a + b_1 x_1 + b_2 x_2 + \ldots\ldots + b_n x_n$	
Model 2	$(\hat{Y}i) = a + b_1 x_1 + b_2 x_2 + b_i x_i$	
Variables	**Symbol**	**Label and measurement levels**
Dependent variable for model 1	Log(odds) of z	Improved variety adoption 1, 0 otherwise (dichotomous)
Dependent variable for model 2	Ŷi	Adoption score, (continuous)
Independent variables		
Age of the respondent	Age	Age, (continues)
Family labour	FL	No of people in 18-55 age,(continuous)
Position in the family	PoF	Respondent is house hold head 1, 0 otherwise (dichotomous)
Education level	EdL	1- up to grade 5, 2- up to O/L, 3-Up to A/L (categorical)
Income	Inc	Annual income, (continuous)
Interaction with extension officer	ExtIn	1-good, 2-moderate, 3-poor, (continuous)
knowledge and attitude	KnoAtt	1-good, 2-moderate, 3-poor (continuous)
Seed source	Seeds	1-DOA, 2- own multiplied, 3- other (continuous)
Access to credit	Credit	1-good, 2-moderate, 3-poor (continuous)
Training	Trai	Number of training attended (continuous)

Results and Discussion

Socio demographic profile

Table 3 presents socio economic and demographic profile of the surveyed households. On average, 76% of the respondents were male. About 96% of the respondents were married while rest was single, widower or divorced. Seventy one percent of the respondents were household head and 29% were spouse, children or other relatives. Thus, female headed household were estimated as 16%. Generally sampled farmers were middle aged (mean-49.5 years) with low-level of education (mean - up to O/L), low annual income (mean- Rs. 122,895.00), small-scale farmers (mean- 0.82 hectare of land holding), almost depend on farming (mean 0.97) with long time experience on groundnut farming (mean- 24 years).

Table 3. Socio demographic profile of the groundnut farmers

Variable	Basic statistics				
	Mean	Std.dev.	Min.	Max.	Median
Gender of the respondent (0=female, 1=male)	0.76	0.64	0	1	1
Age of the respondent	49.47	12.43	23	82	49
Marital status (1=married, 0=otherwise)	0.96	0.19	0	1	1
Household (HH) size	3.84	1.30	1	7	4
Position in the family (1= head of the HH, 0=otherwise)	0.71	0.45	0	1	1
Literacy (0=illiterate, 1=literate)	0.94	0.23	0	1	1
Education (1=primary, 2= up to O/L, 3= p to A/L)	2.45	0.64	1	3	2
Occupation (1=farming, 0=other)	0.97	0.16	0	1	1
Annual groundnut income (Rs'000	122.89	12.41	12.00	800.00	93.75
Proportionate groundnut income (%.)	61.46	29.37	12.00	100.00	60.24
Land holding size (ha)	0.82	0.71	0.10	3.22	0.71
Groundnut farming experience (years)	24.00	31.29	3.00	54.00	26.00

Groundnut cultivation, technology adoption, extension service and training

The study found that adoption of either varieties or agronomic practices were not dependent on the season. Almost every season, farmers cultivated same varieties and followed the similar agronomic practices. Therefore, after generalizing the situation, only the latest season that farmers cultivated groundnut was illustrated to simplify data interpretation. Majority of the farmers who cultivated in 2017 *Yala* were from Mullaitivu district due to the availability of irrigation facility in dry period which was unavailable for majority of the Monaragala farmers.

Table 4 shows that improved variety *Tissa* has adopted by vast majority in both the seasons (95% and 76% for *Yala* and *Maha*, respectively) although majority of them did not know other improved varieties. This adoption level is much higher compared to the findings of Simtowe *et al*. (2010) who stated that only 26% of the sampled farmers grew at least one of the improved groundnut varieties in Malawi. The potential adoption rate of improved groundnut for the population was estimated at 37% in Malawi. Further, the adoption gap resulting from the incomplete exposure of the population to the improved groundnut is 12% in Malawi. This result further consistent with the findings of Shiferaw *et al*. (2010) that stated almost 60% of the households indicated that they have grown at least one improved groundnut variety during the previous cropping season in Uganda.

Even though some farmers who cultivated variety *Tissa* were aware of a few of other improved varieties, they still prefer to cultivate *Tissa* continuously due to its tolerability of extreme weather condition and good demand at the market. Number of farmers who adopted improved varieties such as *Tikiri, ANKG1* or *Lanka jumbo* were very less as 14% (all together) in 2016/17 *Maha* season and they met from the area where technology was disseminated and seed were made available. this result is consisted with the findings of Deb *et al*. (2005) concluded that adoption of improved varieties that jointly developed by the NARS and ICRISAT were adopted in specific locations where technology was disseminated and seeds were made available in India,. Minor proportion of the farmers (10%) has cultivated mixed varieties (unclassified) that they called in different local names such as White, Red or Rose. However this category also included improved varieties although farmers do not know name of the variety. If the study could explain productivity statistics for each variety adopted by the farmers, it could be more useful. However, generalizing average figures using small proportion of the sample would be less representative as the improved varieties other than *Tissa* were reported by a very low number of farmers (e.g.*Lanka Jambo* 7% in *Maha* season).

Upland cultivation was the most prominent in every district which was reported by 86% of the farmers, and 66% of their soils were sandy. Eighty nine percent (89%) of the farmers did plough the land. Bed or ridge preparation was dependent on the land or soil type.

Table 4. Level of technology adoption, extension service and training

Variable	Category 1(%)	Category 2 (%)	Category 3 (%)
Variety *Yala*(n=147)	*Tissa* (95)*	*ANKG1*(1) *Tikiry* (2)	Unclassified (2)
Variety *Maha*(n=208)	*Tissa* (76)	*ANKG1*(5) *Tikiry* (2)	*Lanka jambo* (7) unclassified (10)
Seed source	DOA (39)	Own (24)	Other (37)
Land type	upland (86)	Lowland (14)	-
Soil type	Sandy (66)	Clay (10)	unclassified (24)
Land preparation	Plough (89)	Bed preparation (47)	Ridge & furrow (6)
Earthing up	(100)	-	-
Spacing	Recommended (26)	Narrower than (46)	Wider than (28)
Sowing method	Row (92)	Ridge and furrow (6)	No proper order (2)
Water supply *Yala*	Irrigated (81)	Rainfed (19)	-
Water supply *Maha*	Rainfed (76)	Irrigated + rainfed (24)	-
Weeding	Manual (72)	Chemical (5)	Both (23)
P & D control	IPM (1)	Chemical (38)	No P & D (61)
Fertilizer application	Only organic (3)	Only chemical fertilizer (29)	Use both (22), not used (46)
Crop rotation	(92)	-	-
Machinery use	(3)	-	-
Interaction with extension officer	Good (66)	Moderate (11)	Poor (23)
Training	Not attended (85)	1-3 training (13)	More than 3 training (2)

**- the numbers in parenthesis are row percentages*

Earthing up followed by weeding was done by everyone. Although recommended spacing was followed by 26% of farmers, only 22% followed recommended sowing method which should be compatible with spacing. In *Yala* season, majority of the farmers cultivated under irrigated (81%) and rainfed (76%) cultivation was prominent in *Maha* season. Weeding was done by everyone manually (72%) or by chemical methods (5%). Pest or disease incidents were reported only by 39% of the farmers and almost everyone used minimum chemical application for pest or disease control. More than half of the respondents (54%) concerned on the soil fertility management. However, the use of organic fertilizer was minimum and all the farmers who used fertilizers applied less than the recommended amount due to their traditional belief that groundnut crop does not need fertilizer to gain good yield. Crop rotation was satisfactorily done by farmers (92%). Machinery use in harvesting and processing was also very rare in every district. Only three percent of the respondents (from Mullaitivu district) used machines for pod separation,

but none of them used machines for uprooting. Maintaining a good relationship with the extension officers (66%) was not similarly displayed by the respondents. Vast majority (85%) had not attended any of the training programs.

Knowledge, attitudes and farmers' preferences on technology adoption

By scrutinizing the knowledge and attitude through questionnaire and focus group discussion, it was found that 42% had poor knowledge and negative attitudes while only 27% had good knowledge and positive attitudes on groundnut technology adoption. Rest of the farmers was at the moderate level. As per the questionnaire survey, vast majority of the farmers had adopted and still like to adopt *Tissa* variety. Focus group discussion revealed that main reason behind the adoption of *Tissa* variety was, that was the only variety available in every district and farmers had exposed to that. Majority did not have access to buy or they did not know about other varieties. Further, many of the respondents expressed that the *Tissa* variety can be successfully grown in any soil type without severe losses in yield, encountered fewer diseases and not much harsh in uprooting during drought period. Some of the Monaragala farmers introduced *Tissa* in different local names such as White, Rose, or small groundnut. They said "We know only *White* (*Tissa*) variety. *Rose* (*Tissa*) is good variety which gives good yield with no pest and diseases. It has good demand at the market. However if other high yielding varieties are variety available, I will try it". One of other farmer said "I have cultivated *Jambo peanut* (local name farmer use) last season. But I like *Tissa*". Similar responses were received during the focus group discussions held in Mullaitivu, Puttlam, and Kurunegala districts. However slight differences were found in Mullaitivu districts where groundnut is cultivated more successfully than other districts. Members in the focus group collectively expressed that *Tissa* is a good variety which gives good yield. Earlier we have cultivated *Walawa* variety. But still like to cultivate *Tissa* as the *Tissa* variety is much favorable for extreme climatic condition and pest disease incidents. A few of the respondents from Mullaitivu and Monaragala districts have cultivated *ANKG1* and Lanka Jumbo varieties. But none of them has continuously cultivated those varieties due to either no longer existence of their own multiplied seeds or they have no access to buy these new varieties. One of the members said "I have heard about Lanka Jumbo. But I have not seen. If it is high yielding variety, I would like to cultivate". Another person from the same group said "Last *Maha* season I cultivated Lanka Jumbo. But when selling I faced some difficulties. As this variety was not much spread in the area, groundnut collectors displayed backward interest to buy small stock I had".

The focus group discussion further emphasized that adoption of many of the agronomic practices were affected by poor interaction with extension officer less training on groundnut cultivation, poor knowledge and negative attitudes. For example, one group in Monaragala district, all of whom did not apply fertilizer displayed poor connection with extension officers and one of them who agreed with the group said "no need to apply fertilizer for groundnut cultivation. Without fertilizer a good yield can be harvested. In terms of spacing, another participant said "we keep much larger spacing. It helps easy earthing up and weeding. Otherwise weeding is difficult and consumes higher labour units". A member in the same group (59 years old) who agreed with the other members said "I know the extension worker in the area. But I do not go to him regarding the questions arise about my crop cultivation. We need only quality seed. We know how to cultivate". Knowledge on machinery use also very poor for the farmers in every districts except Mullaitivu. one of the group member said "we do not know about machines and how to use it. We like to use machines if the machines are available at least to hire".

Factors affecting adoption of improved groundnut varieties

Table 5, model one included only the socio economic factors that had significant effect on the dependent variable in univariable analysis. Accordingly, only position in the family and education level had statistically significance association. Thus, position in the family (respondent is the head of the household) and adoption of improved varieties where (p<0.25) OR: 0.39, indicates that respondent being the head of the household help less likely improve variety adoption. As well, compared to the illiterate, people educated up to GCE advance Level (A/L) had significant effect on variety adoption where (p<0.25) OR:1.6 shows more likely to adopt improved varieties. However, there were no statistically significant associations in age, number of family labour or income with adoption level. (For the purpose of clarity, those variables were not included to the Table 5). However socio economic status explained relatively little of the variance (22%) in the model.

Table 5. Factors affecting adoption of improved groundnuts varieties

Variables [a]	Model 1		Model 2			
	B	OR	B	OR	95% CI	
		Exp(B)		Exp(B)	Lower-Upper	P- value
Constant	0.12	1.124	3.59			
Position	0.48*	0.39	-0.43	0.48	0.16-01.43	0. 003
Education						
Up to O/L	0.66	0.7	0.75	2.12	0.56-00.80	0.942
Up to A/L	0.41*	1.6	0.04*	0.17	0.05-02.34	0.037
Ext.In						
Moderate	-	-	0.11*	0.89	0.31-02.55	0.033
Good	-	-	1.27**	3.57	1.18-10.80	0.002
knowAtti.						
moderate	-	-	0.15	1.16	0.45-03.00	0.061
good	-	-	3.02	18.23	0.00-49.21	0.956
Seeds						
DOA			2.72***	15.24	1.90- 28.76	0.000
Own	0.84**	0.43	0.18-01.02	0.004		
Access to credit						
Moderate			0.24	0.39	0.10-01.19	0.064
Good			0.31	0.56	0.12-01.60	0.060
Negelkerke pseudo r^2	22.7%		67.3%			
$\chi 2$	34.3, df=7, p<0.01		71.4, df=11, p< 0.000			

Note: The coefficients for the extension interaction are contrasts with the poor category (extIn1). The coefficients of the seed source are contrasts with the other seed (bought from market or neighbor) (seeds3).
a. Abbreviations were given in the Table 2.

In addition to the socio economic variables that had significant effect (p<0.25) on improved variety adoption in model 1, the model two in the Table 5 was added four more variables (interaction with extension officer, knowledge and attitude, seed source and access to credit). Model 2 further included 95% CI level for Odd Ratio and P value to indicate size of the effect and level of significant for strengthening more validity and clarity. Once the more variables added, model 2 increased the explanatory power of the model nearly threefold which was accounted for 67% of the variance. However, effects of socio economic factors were substantially reduced after adding more variables into the model. Position in the family was no longer significant and coefficient for education level of up to A/L reduced to 0.04 (p<0.05) in the model 2. Similar result was found by Simtowe *et al*. (2010) which stated that the probability of a farmer's awareness of at least one improved groundnut variety is higher among farmers with more years of education.

Kassie *et al*.(2010) also found that groundnut technology adoption was influenced by farm size, market distance, education, occupation, membership in farmers' associations, and income from off-farm activities.

Seed availability and efficient extension service are already accepted as general fact for influencing adoption level. Proving the same idea, regression model revealed that good extension interaction was significant (p<0.01) and compared to poor category, people had good interaction with extension officer was around four times more likely to adopt improved varieties (OR: 3.57, 95% CI: 1.18-10.8). People had moderate interaction with extension officer had relatively low significant association with variety adoption whereas coefficient 0.11 (p<0.05) with OR: 0.89 and 95% CI: 0.31-2.55.. Similarly, Ndjeunga. *et al*. (2013) stated that exposure or awareness to modern technologies is the first step to adoption of technologies. Simtowe *et al*. (2010) also stated that improved varieties are mainly influenced by information access. Further, Freeman *et al*. (2002) found that informal farmer-to-farmer diffusion was the main distribution mechanism for disseminating seeds of the new groundnut varieties.

Seeds source was highly significant 2.72 (p<0.001) with OR: 15.24, and 95% CI:1.90- 28.76 for DOA seeds. Therefore people who bought seeds from the DOA were fifteen times more likely to adopt improved varieties. Own seeds used people were less likely to adopt improved varieties (OR:0.43, 95%CI: 0.18-1.02). Consisting this result, Karunakaran *et al*. (2013) also found that seed availability is the binding constrain in popularizing varieties. Although knowledge/attitudes and access to credit were not significant in the model 2, access to credit had nearly significant association with improved variety adoption.

Adoption level of agronomic practices

As explained in the methodology section, measured adoption score was summarized in Table 6. Accordingly, only 36% of the respondents well adopted agronomic practices which were reported more than three practices.

Table 6. Adoption level of agronomic practices

Adoption score	Categories	Adoption level	Number of farmers %
Mean 2.8 Median 3	Less than median score	Poorly adopted	41
Mode 2	Median score	Moderately adopted	33
Maximum 5 Minimum 1	More than median score	Well adopted	36

Factors affecting adoption of agronomic practices (Stepwise regression)

In addition to the independent variables entered into the model two in Table 5, number of training program attended was added to the stepwise linear regression model. However socio economic factors were not included to the stepwise linear regression as those were identified as less important to decide adoption score (dependent variable). At step two of the analysis, level of training and interaction with extension officer entered into the regression equation were significantly related to the adoption level F (2, 232)= 51.67, $p<0.000$. The multiple correlation coefficient was (R) 0.69, indicating approximately (R^2) 47.61% of the variance of the adoption score. Seed source, knowledge/ attitude and access to credit did not entered into the equation at step two of the analysis (t=1.41, -0.13 and 0.71 respectively, $p>0.05$). Thus the regression equation for predicting adoption level of agronomic practices can be written as:

Predicted adoption level ($\hat{Y}$)=2.76 + 0.243*Trai* + 0.178 *ExtIn*

It indicated that every one unit increase of training program and every one unit increase of interaction with extension officer help increase adoption of agronomic practices by 0.243 and 0.178 respectively. As mentioned in the logistic regression under Table 6, this result also proved that exposure to technology through good interaction with extension officer is significantly influence the technology adoption which was consistent with the findings of Ndjeunga *et al*. (2013) and Diagne, (2006) which was indicated above under logistic regression.

Conclusion

The study found that adoption of at least one improved variety other than *Tissa* can be increased by increasing seeds availability and exposing farmers towards technology through strong interaction with extension officer. Providing training is also a decisive factor for adoption of agronomic practices. Therefore, the study suggests maximum utilization of existing extension service and use efficient communication mechanism for dissemination of technologies into all the isolated villages to change farmers' backward trend for technology adoption. The study suggests that small scale farmers should be facilitated with inputs (fertilizer, seed, machinery and irrigation), marketing facility and access to credit for eliminating economic constrain which is indirectly affected propensity of technology adoption. Any development program prepared for helping farmers should not be confined to a certain area and should be accessible and attainable for whole farmers those who are interested and more likely to acquire.

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