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Nexus between Awareness, Perception and Adoption of Recommended Technologies: Evidences from Smallholder Rubber Cultivation

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ABSTRACT

The adoption of recommended practices in agriculture boosts production and thereby increases farmer income. It ensures that scarce resources are optimally utilized. Awareness and perception of recommendations are precursors to adoption in the rubber smallholder sector. This research tested the causal links between awareness, perception and adoption. Data were collected using a pretested questionnaire covering four rubber growing districts. Three indices were developed for awareness, perception and adoption. Three behavioral equations were developed to estimate the relationship between awareness, perception and adoption and they were simultaneously estimated using a three stage least square technique. Results revealed that awareness of recommendations significantly influences perception and the perception in turn significantly influences adoption and therefore, the link between these was clear. The role of extension effort is significant in creating awareness while peer effect and human capital significantly assist in formation of favorable perception on technologies.

Keywords: Adoption, Awareness, Perception, Rubber smallholders, Three stage least square

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Introduction

Adoption of recommendations assures sustainable cultivation while minimizing the effects of other critical issues such as sudden disease outbreaks and adverse climatic conditions. The thorough reviews first by Feder *et al.* (1985) and Besley and Case (1993), Sunding and Zilberman (2001) and more recently by Prokopy *et al*. (2019) was evidence of the interest and importance of this aspect in agriculture. Therefore, encouraging farmers to adopt the recommendations is vital to enhance production and the productivity of scarce land resources. Research findings in this regard will help in setting up policy decisions for the betterment of the agriculture sector in general. The adoption process is not a simple phenomenon, and scientists have developed various theories and definitions to explain it. They have discussed that the adoption process is affected by many factors, which have been categorized in diverse ways. Melesse (2018) has categorized these factors into three: institutional, demographic, and socio-economic. Further, Pradhan and Gupta (2020) have categorized them as intrinsic and extrinsic factors. Farmer awareness and perceptions on recommendations are two important intrinsic factors that determine the level of adoption of recommendations.

Awareness, in other words, is the knowledge and the primary need for the adoption process, and it is the first requirement to start the adoption process (Rogers, 2003). Thus, knowledge is one of the five steps described in the innovation-decision process (Taherdoost, 2018). Acheampong *et al.* (2018) stated that awareness significantly affects adoption, and it can be increased through organizing field days and demonstrations. Farmer perception was highlighted since the perception-adoption paradigm, and its significant impact on adoption was discussed by many scientists. Perception significantly affects the adoption of new crop varieties (Negatu and Parikh, 1999). In the theory of 'reasoned action,' attitude was explained as one of the factors affecting adoption. Attitude and perceived behavioral control were discussed as the factors affecting adoption by Gant in his Theory of Planned Behavior (Taherdoost, 2018). Further, Rogers (2003) explained that persuasion is the second step in his Diffusion of Innovation Theory. Meanwhile, both awareness and perception were affected by several factors. Joshi *et al*. (2019) explained that awareness was significantly affected by training programs and education levels. Thus, awareness, perception, and adoption are sequentially related factors, and they are influenced by several other socio-economic and institutional aspects. Through the identification of the factors affecting

awareness, perception and adoption, approaches can be identified to enhance them. Further, it will help to make correct policy decisions to improve productivity, converting rubber cultivation into a profitable venture.

Natural Rubber (NR) plantation covers 14,321,300 ha of the terrestrial lands in the world, 90% of which are in the Asian region (Anon, 2018). Sri Lanka has been cultivating rubber for more than a hundred years, and currently, rubber is cultivated in 126,685ha of land in both estate and smallholder sectors (Anon, 2018), giving a livelihood for more than 300,000 people. A considerable proportion of the land extent and production is contributed by the smallholder sector, which was 64% and 60% respectively during the year 2018. Meanwhile, there was a high production variability in the sector, which eventually led to income variability among them. Improving the smallholder sector not only helps to enhance their livelihood but also to increase total rubber production.

Due to the land scarcity, limited possibilities are available to expand rubber cultivation in the traditional rubber growing areas; authorities have been focusing on non-traditional areas for the last two decades. Increasing the productivity of the existing rubber lands is the other possible solution to increase rubber production within the country. Further, it helps to minimize the variability in productivity and consequently the income variability among rubber smallholders. Adhering to the recommendation is the key aspect to achieving this target. The level of adoption of recommended agronomic practices by rubber smallholders is low and consequently records low productivity levels in the sector (Wijesuriya *et al*., 2007; Edirisinghe *et al*., 2013). Therefore, boosting the adoption of recommendations in the smallholder sector in Sri Lanka is a timely need. Since adoption links with farmer awareness and the perception on recommendations, study on adoption, awareness and perception is critically important.

With this background, this study was conducted in the rubber smallholder sector with two objectives. The first was to assess the level of awareness, perception and adoption of recommendations in the smallholder sector, which will aid in getting a clear picture of the present situation of the smallholder sector. The second was to identify the factors affecting awareness, perception, and adoption of recommendations.

Methodology

Conceptual Framework

The conceptual framework was developed based on findings of extant literature and the theory of planned behavior. It was hypothesized that there is a causal link between awareness, perception and adoption of recommended practices. Many researchers have reported that awareness is a precursor to adoption. If the awareness of the technology is low, farmers are slow to adopt it (Fisher *et al*., 2018; Ullah *et al*., 2022). However, research on farmer perception of agricultural innovation and its role in adoption is scarce (Meshesha *et al*., 2022). Examining farmers' perceptions of new agricultural technology was critically important to ensure the adoption and scaling up of the technologies. This is important to ensure sustainable growth and the development of the agricultural sector (Mottaleb, 2018). Sinja *et al*. (2004), Adesina and Baidu-Forson (1995) reported that there was a significant impact of perception on adopting recommendations. Further, Gant has explained that attitude and perceived behavioral control create the intention to adopt the recommendations in his Theory of Planned Behavior (Taherdoost, 2018). Therefore, this research proposes that taking up of technological innovation and practices takes place sequentially as awareness-perception-adoption. Once a farmer is aware of the technology, he/she creates a perception in his/her mind about the technology and if the perception is favorable towards the technology, he/she will adopt it (Figure 1). Following existing literature, it was hypothesized that extension effort is the key facet in awareness creation (Fisher *et al*., 2018; Ullah *et al*., 2022). Perception is hypothesized to be influenced by peers and the level of the human capital farmer has apart from the awareness of the technology. The influences of peers on the adoption of technologies have been documented by many (Bell *et al*., 2018; Sampson and Perry, 2019). In addition, the farmer perceives the relevance and suitability of new technology for a specific farm based on the farmer's human capital situation (Chavas *et al*., 2020). Adoption, in turn, was influenced by perception, but its level was moderated by farm characteristics which determine whether actual adaptation would take place or not.

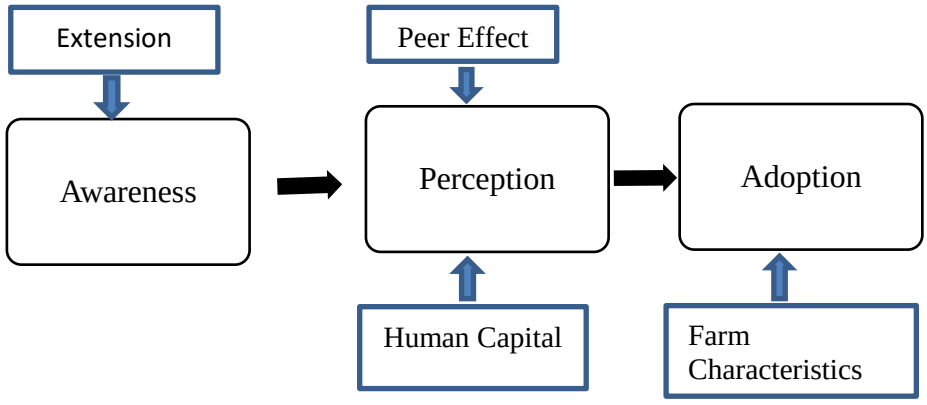

Figure 1. Conceptual Framework

Data and Data Collection

Traditional rubber growing areas are distributed in the Wet Zone (WZ) and the Intermediate Zone (IZ) of Sri Lanka. Representing both WZ and IZ, four rubber growing districts, Kegalle, Gampaha, Kurunegala and Kandy, were selected for the study to maintain diversity among the sample in terms of environmental conditions. A two-stage sampling scheme was adopted to select a representative sample from the study population. Major climatic zones (WZ and IZ) were considered the first level while the agro-ecological zone is considered the second level. All rubber cultivating agro-ecological regions in two rubber growing areas were selected in the first stage. During the second stage, rubber smallholders were chosen randomly and probability proportionately from each agro-ecological region adopting a cluster sampling procedure. A rubber smallholding is considered as the sampling unit. In this study, the sample size was set at 850 rubber smallholdings considering a margin of error of 0.05, a confidence interval of 95% and 50-50 heterogeneity and 10% non-response rate.

The data collection tool was a pretested questionnaire which included demographic details of the farmers, crop details, infrastructure facilities social relationships and the details of awareness, perception and the adoption of recommendations. Awareness, perception and the adoption data were collected on the initial establishment, immature upkeep, soil conservation, harvesting

techniques and processing techniques recommended by the Rubber Research Institute of Sri Lanka which were considered in this study.

All three variables, awareness, perception and adoption were measured as categorical variables. Awareness and adoption of technologies were on a binary scale. Adoption data were collected considering if a farmer adopted the recommendation y=1 and if not adopted and y=0. Awareness data were collected in the same manner, considering if a farmer was aware of the recommendation y = 1 & if not aware of the recommendation y=0. Measures of the perception of adoption of different techniques were obtained on an ordinal scale with four levels [no idea, not important, important, and very important].

Development of Awareness, Perception and Adoption Indices

There were 32 recommendations on which these three things were measured. Thus, to make it simple, additive indices of awareness, perception and adoption were constructed.

Awareness Index

$$\boldsymbol{AWI_i = \frac{\sum_{i=1}^{n} Awareness_i}{n}}$$

Where,
$\boldsymbol{AWI_i}$ – Awareness Index
$\boldsymbol{n}$ – Number of recommendations
$\boldsymbol{\sum_{i=1}^{n} Awareness_i}$ – Summation of farmer awareness on recommendation

Perception Index

$$\boldsymbol{PER_i = \frac{\sum_{i=1}^{n} Perception\ score_i}{n}}$$

Where,
$\boldsymbol{PER_i}$ – Perception Index
$\boldsymbol{n}$ – Number of recommendations
$\boldsymbol{\sum_{i=1}^{n} Perception\ score_i}$ – Summation of perception scores

Adoption Index

$$\boldsymbol{AdI_i = \frac{\sum_{i=1}^{n} Adoption_i}{n}}$$

$\boldsymbol{AdI_i}$ – Adoption Index
$\boldsymbol{n}$ – Number of recommendations
$\boldsymbol{\sum_{i=1}^{n} Adoption_i}$ – Summation of adoption of recommendations

Statistical Model of the Link between Awareness, Perception and Adoption

To model this phenomenon as shown in Figure 1, three behavioral equations were developed as depicted in Equations [1] to [3]. Awareness, perception and adoption indices developed were used as the dependent variables in the simultaneous awareness-perception-adoption model.

$$AwI_i = \alpha_0 + \alpha_1 CwE_i + \alpha_2 EV_i + \alpha_3 TR_i + \alpha_4 NTR_i + \varepsilon_{1i} \quad [1]$$

$$PER_i = \delta_0 + \delta_1 AwI_i + \delta_1 MoRS_i + \delta_2 GoHH_i + \delta_3 EPR_i + \delta_4 EOL_i + \delta_5 EAL_i + \delta_6 EH_i + \delta_7 EinF_i + \varepsilon_{2i} \quad [2]$$

$$AdI_i = \beta_0 + \beta_1 PER_i + \beta_2 TE_i + \beta_3 ADL_i + \varepsilon_{3i} \quad [3]$$

Where;
AwI_i=Awareness Index; CwE_i= Contacts with Extension; EV=Number of extension visits; $\boldsymbol{TR_i}$=Training Received ; NTR_i=Number of trainings attended; $MoRS_i$= Member of a Rubber Society; PER_i=Perception Index; $GoHH_i$=Gender of Household Head; EPR_i=Education –Primary; EOL_i= Education – OL; EAL_i= Education – AL; EH_i= Higher education; $EinF_i$=Experience in Farming; TE_i= Total Extent; ADL_i= Average Distance to Land; ε_{1i} ε_{2i}, ε_{3i} are error terms.

Here, awareness was assumed to be created by extension effort as hypothesized. To capture the extension effort, four variables were introduced: CwE, EV, TR and NTR. For farmers to perceive technology as good or bad, he/she should first be aware of the technology. Therefore, AwI becomes the first covariate in the perception (PER) equation. Secondly, it was assumed that by being a member of a rubber society, farmers interact with peers which may change the perception of farmers towards a technology, thus, MoRS was

included in the PER model to capture the peer effect. In addition, human capital variables such as education and gender were assumed to be perception altering variables and were included in the PER model [equation 2]. Equation [3] models the adoption which is assumed to depend on the perception of the farmers on technologies. To explore the role farm characteristics, play on adoption, two important variables were included: farm size (TE) and distance to the farm (ADL). Larger farms may find it costly to adopt or larger farms may receive the benefits of economies of scale in adoption. The distance was expected to capture the costs of adoption. Long farm distance from home deters some of the recommended agricultural practices, especially in the case of owner–operator scenarios. This model carries endogenous variables on the right-hand side of the equations [AwI and PER]. Therefore, the 'Three Stage Least Square' technique was used to estimate this system of equations (Greene, 2017).

Results and Discussion

Description of the Sample

Most farmers were male, which was the usual pattern of gender distribution in the smallholder rubber sector in Sri Lanka. The average farmer in the sample was middle aged with around 20 years of farming experience. The bulk of the farmers in the sample had a moderate level of formal education. However, there were considerable number of farmers with no formal education as well. The sample constituted farmers with a diverse level of income ranging from less than LKR. 20,000 to around LKR. 100,000.

The average land size of a smallholder owned was 2 acres which were comparable to the average Sri Lankan situation. Slightly more than half of the sample were members of a village society that helps rubber farmers. These societies provide many benefits to rubber smallholders, such as conducting training programs, supplying utensils for rubber tapping, giving funds to build smokehouses, and giving funds to buy rubber rollers. 71% of the farmers have attended at least one training program conducted on rubber cultivation. Rubber extension services were provided by the Advisory Services Department of the Rubber Research Institute of Sri Lanka and the Sri Lanka Rubber Development Department. Most farmers reported that they have good contact with the extension service.

Table 1. Summary Statistics

Variable	Description	Percentage
Gender	Male	74
	Female	26
Age	Mean Years	56
Farming experience	Mean Years	20
Education level	Not schooling	2
	Primary education	11
	Up to O/L	49
	Up to A/L	31
	Higher education	7
Income level (Sri Lankan Rupees)	< 20,000	25
	21,000 – 40,000	36
	41,000 – 60,000	26
	61,000 – 80,000	9
	81,000 – 100,000	3
	> 100,000	1
Total land extent	Acres (Mean)	2
Society membership (Rubber)	Yes	57
	No	43
Attending to training programmes	Yes	71
	No	29
Contacts with extension officers	Yes	89
	No	11

Awareness, Perception and Adoption Levels of Various Technologies

The distributions of the three indices (perception, awareness, and adoption index) were given in Figure 2. Both awareness and adoption indices move from 0 to 1 as they have been recorded as dichotomous variables. The perception index moves from 0 to 3. Awareness shows a left skewed distribution indicating that most farmers were aware of the technologies available. When considering the perception index graph, most farmers believed that most recommendations are 'important' as the distribution is slightly skewed to the right. The adoption index was symmetrically distributed showing that most of the farmers have adopted only part of the technologies considered.

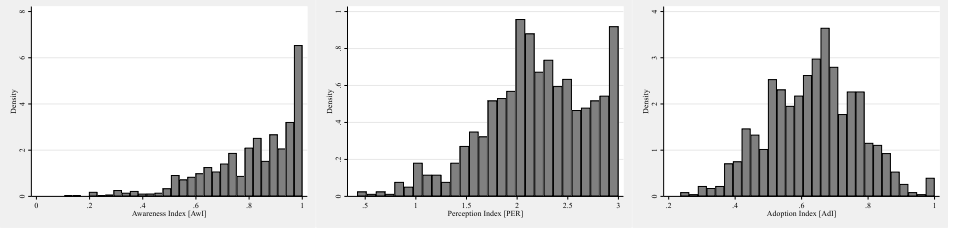

Figure 2. Distribution of Awareness, Perception and Adoption Indices

The results of the Three Stage Least Square estimation of the system of equations [1] to [3] were given in Table 2.

Table 2. Results of the Three Stage Least Square Estimation of the Adoption Model

	Coef.	Std. Err.	Z	P>z	[95% Conf. Interval]	
Awareness						
Contacts with Extension	0.054	0.024	2.270	0.023	0.007	0.102
Extension Visits	0.009	0.007	1.180	0.237	-0.006	0.023
Training Received	0.059	0.017	3.550	0.000	0.027	0.092
No. of Training	0.007	0.002	3.170	0.002	0.003	0.011
Constant	0.707	0.023	31.120	0.000	0.662	0.751
Perception						
Awareness Index	1.982	0.349	5.680	0.000	1.298	2.665
Member of Rubber Society	0.137	0.036	3.840	0.000	0.067	0.207
Gender of Household Head	0.019	0.044	0.440	0.660	-0.067	0.106
Education - Primary	-0.053	0.147	-0.360	0.718	-0.340	0.234
Education – O/L	0.042	0.139	0.300	0.763	-0.231	0.315
Education – A/L	0.149	0.144	1.040	0.300	-0.133	0.431
Higher education	0.237	0.166	1.430	0.153	-0.088	0.562
Experience in Farming	-0.002	0.001	-1.260	0.208	-0.005	0.001
Constant	0.435	0.238	1.830	0.067	-0.031	0.901
Adoption						
Perception Index	0.129	0.028	4.600	0.000	0.074	0.184
Total Extent	0.001	0.001	0.950	0.340	-0.001	0.002
Average Distance to Land	0.001	0.002	0.350	0.723	-0.003	0.004
Constant	0.344	0.062	5.590	0.000	0.224	0.465

The first hypothesis made in this research was the causal effects of awareness, perception and adoption. Table 2 showed that awareness index showed significance in the perception equation and the perception index showed

significance in the adoption equation. All except one of the variables related to extension effort were significant in the awareness regression. Earlier research also corroborates this finding (Fisher, Holden *et al*. 2018, Ullah, Saqib *et al*. 2022). One major extension tool, training programs show significance in improving awareness on recommendations. In the sample 71.4% had attended training on rubber cultivation or processing. Qi *et al*. (2021) reported that participation in technical training has played a positive role in their rubber technology adoption in central Hainan, China. Gunarathne *et al*. (2020) revealed that the training on rubber tapping caused a significant impact on farmer knowledge and adoption. Further, Esekhade *et al*. (2017) stated that the training workshop should be a continuous process to give practical knowledge on various aspects of rubber cultivation. Contacts with extension agents also returned a positive and significant sign. 89.02% of farmers said that they have contact with the Rubber Extension Officers. Comparable results have been reported in Sri Lanka on rice cultivation. Walisinghe *et al*. (2017) reported that public agricultural extension service programs were found to be significant explanatory variables of technology adoption in their study. However, extension visits in the past three months have become non-significant. 41.64% of the farmers in the sample reported that there were no visits by the extension officers to them in the last three months. Thus, organizing training programs and proper extension service proves to be fruitful in creating awareness about various technological advancements in rubber cultivation.

The perception [equation 2] was highly influenced by awareness as hypothesized. To form a perception over a technology, first, one should be aware that such a technology exists. Membership in a rubber society showed a strong significance and a positive relationship. Such memberships denoted peer effect and hence farmers who had access to it had formed a favorable perception on technologies than farmers who had no access. However, only 57% of farmers in the sample are members of society. Thus, promotion of farmer groups is fruitful in promoting technology adoption. Ainembabazi *et al*. (2017) reports that the longer the duration of the membership of a farmer group, the shorter the adoption lag in agricultural technologies. Contrary to expectations, each level of education individually did not show a significant impact on forming perception. This result implied as it there is no difference in a person educated up to advanced level with a person with no education in forming perception [as no education is the reference category]. However, considering the significance of education in adoption of technologies, a joint hypothesis test was performed on the education variable: H0: coefficients on

primary, OL, AL, and higher education are simultaneously zero. The test reported a significant effect [Prob.> chi2 = 0.0012], showing that the hypothesis of no difference between the levels of education of farmers can be strongly rejected. Thus, education [human capital] played a role in forming perceptions among farmers on technologies. Earlier studies also reported related results. Mignouna *et al*. (2011) and Namara *et al.* (2003) reported that the education level of a farmer increases his/her capability not only to obtain but also to process and use information relevant to adoption of a new technology. Rogers (2003) finds that "earlier adopters have more years of formal education than do later adopters". Further, a detailed discussion on how farmer education affects access to information has been discussed by Melesse (2018).

The estimates of the adoption equation showed that a favorable perception on technologies increases the rate of adoption of recommendations. The extent variable was included to assess whether technologies favor larger farmers over smaller ones. Although it showed a positive sign the relationship was inconclusive as it did not show significance. The distance to land was included as a proxy for transaction costs that were present in technology adoption. Although non-significant, it showed a negative sign and hence higher transaction costs may reduce adoption. Thus, results indicate that perception of the technologies is far more important than farm characteristics that determine incentives or restraints to adoption.

Conclusions and Recommendations

This research analyzed the levels of awareness, perception and adoption of recommended technologies and the factors affecting adoption. The underlying hypothesis of the study was the relationship between awareness, perception and adoption. In the case of smallholder rubber farmers, awareness leads to the formation of perceptions about technologies which in turn encourages farmers in to adoption. Awareness was found to be influenced by extension efforts while perception was found to be influenced by peer effect and level of human capital. Hence, the adoption of recommendations should be promoted by strengthening the extension service. Tried and tested tools such as farmer training were important in creating awareness. Apart from awareness, social capital and the peer effect obtained from networking among farmers form a favorable perception on available technologies. Therefore, the formation of

farmer groups, which not only improves the bargaining power of small farmers in market transactions, is found to be increasing the propensity to adopt as well. With the available information, it is recommended to organize systematic training programmes to cover all the aspects of rubber cultivation. Further, rubber societies should be established in the areas where rubber-related societies have not been established.

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