EXAMINING THE DETERMINANTS OF ADOPTION PREFERENCES TOWARDS INTERCROPPING AMONG RUBBER FARMERS IN KALUTARA DISTRICT

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Abstract

Intercropping is an agricultural technique where many crops are grown together on the same field, and it is becoming more widely acknowledged for its ability to improve the productivity and rural livelihoods through raising household income and capital assets. in this context, this study aims to assess the significant mean differences in demographic, economic and farming characteristics across adopting and non - adopting rubber smallholders towards intercropping and examine the impact of above characteristics on the adoption preferences towards intercropping among rubber smallholders in the study area. This research approach based on quantitative and using stratified random sampling method, 150 farmers who cultivate rubber as their major agricultural crop were selected during the period from October 2022 to March 2023. The collected data was analyzed using frequency analysis, descriptive statistics, independent samples t–test, chi- square test and probit model. Results of frequency showed that 79% of the farmers engaged in intercropping system and 21% of them were not adopted in their rubber cultivation. Independent samples t-test proved that on average age, family size, farming experience, farm income, immature rubber land size and distance to market were significantly differ across adaptors and non-adaptors. Estimated results of probit model revealed that among the demographic characteristics, age, education level, family size and membership of farm organizations were significantly impact on adoption of intercropping. Among the farming characteristics, farm experience, ownership of land, time allocation and nature of land were significant in the study. Farm income and size of immature rubber land are the major determinants among the economic related factors in determining the adoption of intercropping. Findings of the study may help the policy makers to formulate the appropriate strategies to increase the income and ensure the economic stability of rubber stallholders in the study area.

Keywords: Adoption preferences, Demographic characteristics, Economic characteristics, Farming characteristics, Intercropping, Rubber farmers.

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1. Introduction

Rubber as a major cash crop in Sri Lanka and it plays an important role in its economy, in terms of export earnings and employment generation with more than 80 000 small-scale producers within the island. (Rubber Research Institute of Sri Lanka, 2020). The rubber industry is a pillar of the economy in Sri Lanka which is accounting around 10% to the agricultural exports together with processed agricultural products (Sri Lanka export development board, 2022). In 2020, rubber cultivation represented 136 300 ha in Sri Lanka which corresponds to 2% of the total land area with an average yield of 642 kg/ha/year with more than 80 000 small-scale producers (Rubber Research Institute of Sri Lanka, 2020). In the past few years, the government has classified rubber as a major strategic resource and is therefore encouraging the development of the sector, with the help of scientific institutions and private companies.

Problem statement

Rubber provides an extremely important source of income for the poor in Sri Lanka as it can prevent those who are hovering on the poverty line as locally defined by the Samurdhi programme) from falling below it (Janowski, 1997). Several benefits can be achieved through the focus on rubber-based intercropping. Intercropping with short-term crops provides a significant additional income during the long immature period of rubber. As well as increasing the rate of crop production, with the advantage of simultaneously decreasing the risk of total crop reduction, controlling weeds, maximizing land usage, and minimizing the risk. In the natural rubber industry, smallholders, the major producers, are the most vulnerable, have low resilience, and bear the burdens of unsustainable industry costs. However, the structural environment of their rubber farms is technically viable for intercropping and agroforestry systems, which contribute to ecological and economic sustainability. Despite this, they have faced some constraints in adopting rubber-based intercropping systems and achieving the sustainability benefits of the systems. In this context, interventions with promoting intercropping schemes in supporting initial investments, transferring technologies, providing high-yield cultivars and other inputs, and creating potential markets for intercrops are important. Based on the climatological and topographical factors Kalutara is a considerable extent of rubber growing area. However, several issues substandard and problems are facing by the farmers in Kalutara district such as growth in immature rubber land, low productivity in mature lands, low quality in produced rubber, and improper marketing systems (Wijesuriya et al. 2007). Thus, the farmers who cultivates rubber in Kalutara district they should take more attention on their intercropping decision.

Objectives of the Study

a) To assess significant mean differences in demographic, economic, and farming characteristics between adopting and non-adopting rubber smallholders towards intercropping in Kalutara district.
b) To identify significant associations between selected demographic, economic, and farming characteristics and the adoption of intercropping.

c) To examine the impact of demographic, economic and farming characteristics on the adoption of intercropping among rubber smallholders.

Research questions

d) Are there any significant mean differences in demographic, economic, and farming characteristics between adopters and non-adopters towards rubber intercropping in Kalutara district.

a) Are the associations between selected demographic, economic, and farming characteristics and the adoption of intercropping significant?

b) How do demographic, economic and farming characteristics influencing the adoption preferences towards intercropping among rubber smallholders?

Review of literature

This section describes the theoretical background of the intercropping and the major concepts related to intercropping as well as its empirical evidences.

Theoretical background: Meaning and importance of intercropping

Intercropping can be defined as, growing two or more crop types on one field. There are several previous studies have identified the intercropping in different ways. According to Ijoyah, 2012) intercropping which is closely associated with peasant agriculture is a practice that involves the growth of two or more crops in proximity, in the same field during a growing season to promote interactions between them. This study mentions some reasons for intercropping like that insurance against total crop failure, yield increment, weed control and high monetary returns.

According to Ananthi et al. (2017), Intercropping is a type of mixed cropping and defined as the agricultural practice of cultivating two or more crops in the same space at the same time. It increases in productivity per unit of land via better utilization of resources, minimizes the risks, reduces weed competition and stabilizes the yield. Various variables have an effect on this intercropping like maturity of crop, selection of compatible crop, planting density, time of planting as well as socio economic status of farmers and the region.

Intercropping can divide into four groups such as, row – intercropping, mixed intercropping, strip – intercropping, and relay intercropping. Row intercropping means that Growing two or more crops simultaneously where one or more crops are planted in regular rows, and crop or other crops may be grown simultaneously in row or randomly with the first crop. Second one is the mixed intercropping represents that, growing two or more crops simultaneously with no distinct row arrangement. This type of can be suitable for grass-legume intercropping in pastures. Third one is the strip – intercropping which illustrates that, growing two or more crops simultaneously in different strips wide enough to permit independent cultivation but narrow enough for the crops to interact ergonomically. Lat one is the relay intercropping is the growing two or more crops simultaneously during part of the life cycle of each. A second crop is planted after the first crop has reached its reproductive stage but before it is ready for harvest. (Vandermeer, 1992 & Ofori and Stern, 1987)

2. Empirical Reviews

This study aims to enhance the knowledge of adoption of intercropping systems that smallholder rubber farmers pursue to ensure income security in rubber immature period in the study area. As the adaption of new techniques like intercropping is less which causes to reduce income and profits that can be generated in farming activities. Thus, this study may help to farmers on the better use of their rubber lands and the possibilities to improve their productivity in future. Through this research, it is expected to give a better insight in this regard and the findings of this study are expected to help the government, non- government and development partners and policymakers in formulating effective policies aimed at rubber stallholders. There were less empirical studies based on the demographic, economic and farming characteristics related to the adoption of intercropping among rubber stallholders in Kalutara district. Hence, the current study tries to fill the gap in Sri Lankan context considering how these characteristics influencing the adoption preferences towards rubber intercropping in Kalutara district.

A study on the factors determining intercropping by rubber smallholders in Sri Lanka using logit analysis done by Hearth and Takeya (2003) indicated that extension contacts, education level, and experience with farming other crops are positively associated with the probability of adoption.

Somboonsuke et al. (2011) conducted a study regarding diversification of smallholding rubber agroforestry system (SRAS) in Thailand. The study identified the main conditions for decision-making in the rubber intercropping system are farm household labor requirement, knowledge and experience, extension and policy implication, marketing opportunity, consistent capability of local communities, and land topography and sustainability.

Romyen et al. (2018) investigate the rubber-based intercropping system in Southern Thailand to examine the differences in the socio-economic characteristics of rubber farmers who operate either a “rubber mono-cropping system” (RMCS) or a “rubber based intercropping system” (RBIS). The studies discovered that the size of the rubber tapping area, members in the household, level of RBIS knowledge, attendance at an RBIS workshop, and rubber growing experience influencing RMCS farmers toward adopting RBIS.

Hougni et al. (2018) done research related to the rubber intercropping with the objective to describe farming practices and to evaluate the economic performance of cropping systems during the immature period of rubber plantations in Northeast Thailand. They found that, some socioeconomic characteristics of rubber farmers like age, agriculture education level of head of household, experience in rubber farming, access to farm machinery, access to agricultural loans were significant factors in the decision of intercropping in the country.

Thennakoon, (2018) was conducted a study to examine the effect of land related factors on smallholder cropping systems in rural Sri Lanka based on three objectives such as, to identify the major smallholder cropping systems, to analyze the relationship between land size and cropping intensity, and to determine how land size, land ownership, proximity to land from the homestead influences the selection of different cropping systems. The researcher found that, income level of the household had a considerable influence on several factors including, selection of cropping

systems, size of land holding, and allocation of land to different crops. Also, he found that, variation in land ownership between villages had a significant effect on the establishment of crops while distance of the land from the homestead had a significant effect on the selection or non-selection of cropping systems.

Mesike et al. (2019) conducted a research to determine the smallholding rubber agroforestry systems (RAFS) adoption in Nigeria. Their results found that, farmers' participation in on-farm trial demonstrations, accessing agricultural knowledge through trainings, extension contact, education level, membership of farm organization and attitude of farmers toward intercropping were positively associated with increased adoption of rubber agro - forestry in Nigeria. Also, off-farm income, average distance from rubber land to farmers' residence, negatively influence adoption of rubber agro - forestry.

A study on logistic analysis of factors and perception of smallholder rubber farmers to intercrop involving rubber and plantain intercropping system in Ghana done by Tetteh et al. (2019) and they found that, gender, level of education, household size, farm size, member of association and experience in rubber farming were significant influence on the adoption of rubber intercrop.

Le Guen at el. (2022) done a study on intercropping in rubber cultivation in the Monaragala and Ampara regions of Sri Lanka and they found that the intercropping models were mainly based on agronomic data and the most common intercrops grown in Ampara are cover and food crops while in Monaragala there is a large majority of cash crops with cocoa, banana and pepper were cultivated.

There is a smaller number of studies done by the researchers related to this issue Sri Lankan context specially in Kalutara district. Thus, the present study attempts to quantify the factors influencing this vital aspect in the smallholder rubber sector focusing on demographic, economic and farming characteristics in the district.

3. Method of Data Collection

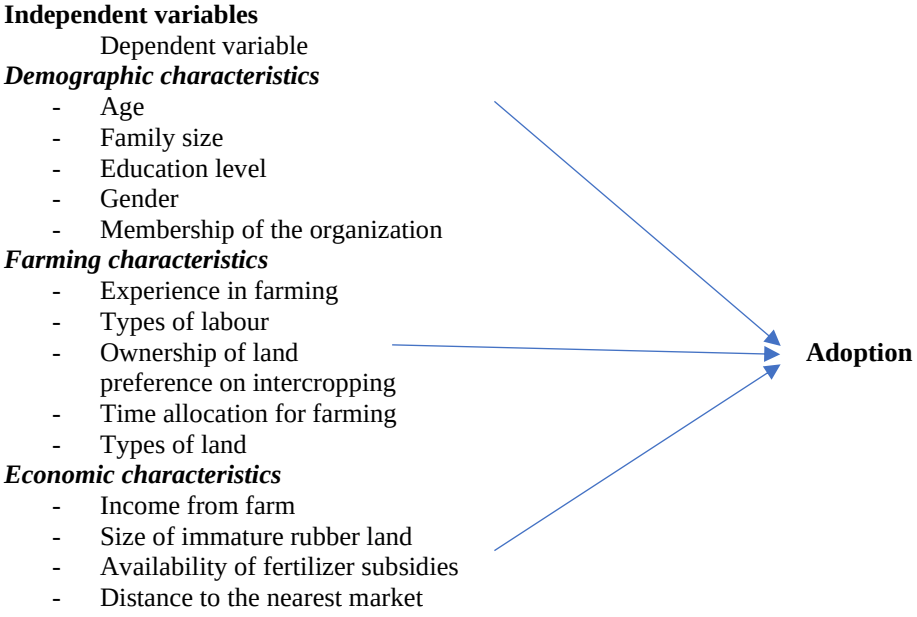
The data for the analysis were collected from October 2022 to March 2023 and the relevant data were obtained from 150 rubber farmers from Kalutara district in Sri Lanka.

A stratified random sampling technique was employed in the selection of the 150 rubber farmers interviewed for the study. In the first stage, Kalutara district was purposively selected because it is the main rubber production region in Sri Lanka. The district locates in Western province in Sri Lanka which has14 DS divisions and out of them Horana division which has more rubber cultivators was selected in the second stage. Horana division has 89 GS divisions and among these GS divisions, only 05 villages Millewa, Pannila, Batuwita, Olaboduwa, Mahena were considered to select the rubber cultivators. In the third stage, from the above five villages 150 rubber cultivators were selected randomly to analyze the data in the study

Conceptual Framework

The preferences to adopt on intercropping by rubber farmers are influenced by several factors such as government policies, technological change, market forces, environmental concerns, demographic factors, institutional factors and delivery mechanisms. This study considered the probit regression model which is a special

case of a generalized linear model and analyzes models where the outcome is a nominal variable. The probit regression model which was used adoption preference on intercropping as the dependent variable with demographic, farming, and economic characteristics were the independent variables in the study. The following conceptual model represents the relationship between the independent and dependent variables which are used in the study.



Description of the above variables are summarized in Table 1.

Table 1: Definitions and Measurements of the variables

Definition of the Variables	Measurement of the variables
Dependent Variable	
Adoption preferences on intercropping	Coded as 1 for adopters 0 for non-adopters.
Independent Variables	
Demographic Characteristics	
Age of the farmers	Years
Family Size	Numerical numbers
Education Level	Coded as 1 for primary, 0 for secondary
Gender	Coded as 1 for male and 0 for female.
Membership of farmers organizations	Coded as 1 for yes and 0 for not.
Farming Characteristics	
Farming experience	In years
Types of labor	Coded as 1 for family labor and 0 for hired.
Ownership of land	Coded as 1 for own land and 0 for tenant.
Nature of the time allocation for farming	Coded as 1 for full-time and 0 for part-time.
Nature of the land	Coded as 1 for flat, 0 for sloped.

Economics Characteristics	
Income from farm	Continuous variable measured in Rs.
Size of immature rubber land	Acres/ perches.
Availability of Fertilizer subsidies	Coded as 1 for yes and 0 for no.
Distance to the nearest market	In Kilometer.

Source: Compiled by authors

Methods of data analysis

The study used different analytical tools such as frequency, descriptive statistics, independent samples t – test, chi - square test and probit regression model.

Frequency Analysis

Frequency analysis is used to describe the basic features of the data in the study in the terms of charts. frequency or percentage.

Descriptive Statistics

Descriptive statistics are used to examine the demographic, economic, farming characteristics of the respondents in terms of mean and standard deviation.

Independent samples t- test

The study used independent sample t- test to investigate whether an average value for selected demographic, economic and farming characteristics differ across adopters and non- adopters towards intercropping.

Chi - square test

The chi-square test is a statistical procedure used by the researchers to examine the association between categorical variables used in the study.

Probit regression model

In order to examine the impact of demographic, economic and farming characteristics on the adoption preferences on intercropping among rubber smallholders, probit model is employed in the study. Adoption preferences was measured by binary variable where the farmer is growing only rubber coded by 0 for non- adopter and coded by 1 for adopters where they are growing rubber with other crops. Thus, probit model is taken to estimate the adoption preferences on intercropping as binary dependent variable and demographic, economic and farming and characteristics as explanatory variables in the model as given below:

For demographic characteristics …….model (1)

$$Y_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \varepsilon_I$$

Where,

Y = Adoption preferences on intercropping coded as 1 for adopters and 0 for non-adopters

X_1 - Age of the farmer

X_2 - Family size

X_3 -Education level coded as 1 for primary, 0 for secondary
X_4 -Gender coded as 1 for male, 0 for female
X_5 -Membership of farm organization coded as 1 for having membership, 0 for haven't.
β_0 = Constant
β_0 to β_5 are the coefficients of each independent variable.

For farming characteristics……model (2)

$$Y_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \varepsilon_I$$

Where,
Where,
Y = Adoption preferences on intercropping coded as 1 adopter and 0 for non- adopter
X_1 - Farming Experience
X_2 – Types of labor coded as 1 for family labor, 0 for hired labor
X_3 – Ownership of land 1 for own land, 0 for hired land
X_4 – Nature of the time allocation for farming 1 for full time, 0 for part time
X_5 – Nature of land coded as 1 for flat, 0 for sloped
β_0 - Constant
β_0 to β_5 are the coefficients of each independent variable.

For economic related characteristics……...model (3)

$$Y_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \varepsilon_I$$

Where,
Y = Adoption preferences on intercropping coded as 1 for adopters and 0 for non-adopters
X_1 - Income of farm
X_2 - Size of immature rubber land
X_3 - Availability of fertilizer subsidies 1 for available, 0 for not
X_4 - Distance to market
β_0 - Constant
β_0 to β_4 are the coefficients of each independent variable.

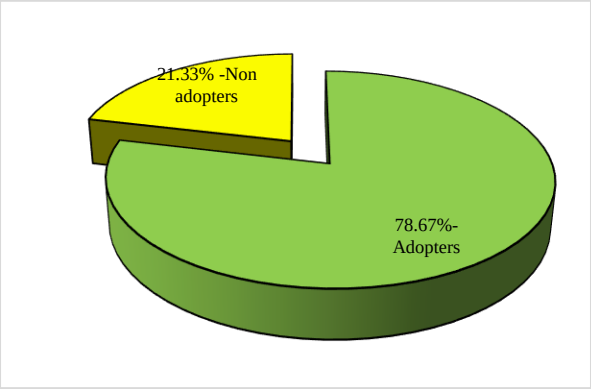
4. Results and Discussions

This section describes the results obtained from different analytical tools such as frequency, descriptive statistics, independent samples t – test, chi - square test and probit regression model which are applied in the study.

Results of frequency of the variables

In the beginning, frequency of the dependent and independent variables related demographic, economic related and farming characters were illustrated using graphs as well as tables as below.

Figure 1: Frequency of adopters and non- adopters on intercropping



Out of 150 rubber farmers, nearly 79% of them engaging with rubber as their main cultivation and in addition to rubber other crops are grown using their mature rubber land. Those farmers engaging other crops with rubber classified as adapters of intercropping, Rest of the 21% of them only engaging with rubber cultivation and they are classified as non- adapters of intercropping.

Results of descriptive statistics

In table 2 shows descriptive statistics related to the demographic, economics and some farming characteristics of paddy farmers in the study area.

Table 2: Results of descriptive statistics

Variables	Mean	Standard deviation	Minimum	Maximum
Age	45.50	9.626	25	60
Family size	5.13	1.028	2	8
Farming experience	21.59	11.087	2	40
Farming income	27870	8540.356	10000	45000
Immature rubber land	5.277	2.2729	1	12
Distance to market	2.717	1.2723	5	7

Source: Estimated by author using SPSS

According to table 2 the average age of rubber farmers was 45 years which implies that these middle-aged farmers are likely to adopt intercropping systems to earn additional income than the older and younger farmers. The study also found that an average household size of the farmers is five and this much of household size ensures growing other crops in addition to the rubber using same land for purpose of income earning and food security. The average farming experience was about nearly 21 years and if the farmers have more experience with farming it is supports to the adopting of intercropping. The farmers earn the average income of Rs 27870/= from their farming activities with the minimum income of Rs 10000 and a maximum of Rs 45000. As well as this study found that an average immature rubber land sizes is 5.27 acres and if the rubber farmers have more immature rubber land, it is discouraging the adaption of intercropping. Average distance to the market shown as 2.7km and this much of distance enhance the adoption of intercropping.

Independent samples t-test

The independent samples t-test was used to check whether there is a significant difference in the mean values of the age, family size, farming experience, farm income, immature rubber land size, and distance to the market between the adopters and non-adopters.

Table 3: Results of independent samples t – test

Variables	Mean of the variables for	
	Adopters	**Non - adopters**
Age***	48.02	36.22
Family size***	5.46	3.94
Farming experience***	25.61	6.78
Farm income***	31436.44	14718.75
Immature rubber land	5.674	3.813
size***	2.267	4.375
Distance to market***		

Source: Estimated by author using SPSS
Note: *** represents 1% significant level.

The results show that there is a significant difference in the mean values of age, family size, farming experience, farm income, immature rubber land size and distance to the market between the adopter and non-adopters. According to that, age of the farmers who adopt the intercrop is higher than non – adopters while number of family size is higher in the farmers who adopt intercrop than non – adopters. Farming experience and farm income are higher among the adopters than non – adopters. Compared to non – adopters, adopters have more size of immature rubber land and distance to the market for non – adopters are higher than adopters in the study. These findings are more useful to differentiate the adopters and non – adopters on intercropping in terms of their demographic and farming characteristics among the respondents.

Chi- square test

In this study chi- square test was conducted to find out the association between demographics characters such as gender, education level and adoption preferences whether the farmer is adopter or non – adopter on intercropping as well as analysis the association between farming characteristics such as type of labour, ownership of land, nature of the time allocation for farming and nature of the land with adopters and non-adopters on intercropping.

Table 4: Results of chi-square test

Variables	Adoption preferences			
	Adopters	**Non-adopters**	χ^2	**Significant**
Gender			3.845	0.050
Male	86.4%	71.9%		
Female	13.6%	28.1%		
Education level			38.246	0.000
Primary	70.3%	9.4%		
Secondary	29.7%	90.6%		
Type of labour			20.864	0.000
Family labour	25.4%	68.8%		
Hired labour	74.6%	31.2%		
Ownership of land			73.656	0.000
Own	85.6%	6.2%		
Tenant	14.4%	93.8%		
Nature of time allocation			87.229	0.000
Full time	89.8%	6.2%		
Part time	10.2%	93.8%		
Nature of land			76.907	0.000
Flat	94.9%	25%		
Sloped	5.1%	75%		

Source: Estimated by author using SPSS

According to the above results reveal that, all the characters significantly associated with the status of adopting or non-adopting of intercropping. Based on that education level, type of labour, ownership of land, nature of time allocation for farming and nature of land has high significant association with the status of adopting intercropping of the rubber smallholders at 1% level than gender as well as gender also significantly associate with the status of adoption of intercropping of rubber smallholder farmers in Kalutara district at 5% of significant level.

When consider about the gender, among male farmers, nearly 86% farmers were adopting rubber based intercropping systems while nearly 28% of females like to do only rubber growing. This shows that, majority of the male farmers select the intercropping and they don't like to be limited to rubber only. But females like to do only rubber growing due to they have more family responsibilities than males. In case of education level and status of adopting of intercropping show that, nearly 70% less educated or primary educated farmers were engaging with rubber-based intercropping and nearly 90% secondary educated farmers do not engage intercropping and were involved another off-farm activity for purpose of income earning. The adoption of intercropping across type of labour usage suggest that, nearly 75% of rubber farmers using hired labour for the cultivations and only 25% of them using their family members' support. In case of ownership of land and status of adoption of intercropping shows that, nearly 86% of rubber farmers having their own land and they were engaging with intercropping. Out of 93.8% of farmers grow rubber in tenant land and they were not engaged with intercropping.

Results of probit model and marginal effects

In order to identify the impact of each characteristic on adopting of intercropping among the selected rubber smallholder farmers in Kalutara district, probit model in terms of coefficients and marginal effects of the model were employed in the study. Following results show the estimated parameters of the probit model to conclude the impact of demographic characteristics of the farmers on the income diversification.

Table 5: Results of probit model and marginal effects for demographic characters

Variables	Coefficients	Standard error	Significant	Marginal effects
Age	0.065	0.026	0.015	0.00538
Gender	0.013	0.474	0.978	0.00110
Education level	1.118	0.492	0.023	0.09237
Family size	1.401	0.309	0.000	0.11574
Membership	1.218	0.435	0.005	0.10058
Constant	-9.7821	2.159	0.000	
Number of observations = 150				
LR chi^2 (5) = 110.48				
Probability > chi^2 =0.0000				
Pseudo R^2 = 0.7105				
Log likelihood = -22.51				

Source: Estimated by author using Stata 13

According to the results in table 4, out of five demographic characters of the rubber farmers, except gender of the farmer, rest of all other factors were significant at 1% and 5% levels in the model. Coefficient of age found to be positive and significant at 5% significance level means that the older farmers have more likely to adopting intercropping than younger rubber farmers. The coefficient of marginal effect for age is 0.00538 revealed that as other factors kept constant, a one-year increase in age of the farmer will increase the probability to adopting of intercropping by 0.538%. This might be due to the fact that as the age of the rubber farmers gets older, they are engaging another crop in addition to rubber. Because of awareness of rubber cultivation is also increasing with age. Thus, this might be due to strength of farmers as they become older age could be a probable reason to decrease in participation of other non - farming activities. Likewise, the coefficient of education level is positive sign indicates that it has positive impact on adopting of rubber-based intercropping. In other words, primary level educated farmers are engaging different crops with rubber compared to secondary level educated farmers. Marginal effect of this variable shows that, primary level educated farmers have 9.23% of more likely to adopting intercropping than more educated farmers in the study. The coefficient of family size has positive sign means that if family has more members, it is most probability to adopting of intercropping. In other words, large families are engaging rubber-based intercropping than small families. Marginal effect of this variable shows that farmer who are member of large family has 11.57% of more likely to adopting intercropping than farmers in small family. The coefficient of membership of farming organizations

has the positive sign indicates that having membership of any farming organization is motivated the farmers for adopting of intercropping. Marginal effect of that variable shows that farmer who are member of farming organization has 10.05% of more likely to adopting of intercropping than other farmers in this study. Gender of the farmer has positive sign. However, this is not significant impact on adoption of intercropping.

In addition to the demographic characters, farming related variables also taken to examine their impact on adopting of rubber-based intercropping and the results depicted in Table 4.9. According to that, out of five farming related variables only one is insignificant and other four were significant in the model.

Table 6: Results of probit model and marginal effects for farming characters

Variables	**Coefficients**	**Standard error**	**Significant**	**Marginal effects**
Farming experience	0.194	0.109	0.077	0.00527
Type of labour	-1.320	0.896	0.141	-0.03590
Ownership of land	2.876	1.353	0.034	0.07821
Nature of time allocation	1.696	0.825	0.040	0.46140
Nature of land	2.645	1.455	0.069	0.07192
Constant	-4.814	0.442	0.023	
Number of observations = 150				
LR chi^2 (5=140.88				
Probability > chi^2 =0.0000				
Pseudo R^2=0.9060				
Log likelihood 7.31				

Source: Estimated by author using Stata 13

The coefficient of farm experience had positive impact on adopting of intercropping indicates that the farmers who have more experience in farming are tend to adopting of intercropping not only rubber cultivation. Because of their experience they will learn more knowledge and skills not only on rubber cultivation make them as specialized in the overall agricultural sector. Thus, more experienced farmers have more probability to become as adapters of intercropping and less experienced farmers have more probability to become as non- adapters in the sample and it hasn't influenced the adopting of intercropping. Farm experience has positive value of 0.005 for marginal effect shows that as experience in farming increases, the probability to become as adapter of intercropping also increase by 0.5% assuming other variables held constant. The result was significant at 10% level.

A dummy variable was used to measure type of labour usage, ownership of land, nature of time allocation for farming and nature of land in the model. However, out of these four variables except only type of labour usage rest of all factors are significantly impacts on adoption of intercropping. The results show that, ownership of land has positive impact of on adapting of intercropping and thus the farmers who have own land the probability of being adapter of intercropping will increase compared to those who have tenant land. Since the farmers cultivate in their own land they can cultivate any other crops according to their preferences than tenant cultivators. The marginal effect of the variable reveals that, own land farmers have

7.8% of more likely to engage in intercropping compared to tenant farmers and the results were significant at 5% level.

The results show that, nature of time allocation for farming has positive sign with adopting of intercropping and implies that, farmers who allocate full time for farming activities the most probability of being adapter of intercropping compared to farmers those who allocate a part time for farming activities. The marginal effect of the variable reveals that farmers who engage with farming activities full time have 4.6% of more likely to adopting intercropping than part time farmers and the results were significant at 5% level.

Then the coefficient of nature of land has positive sign with adopting of intercropping means that, flat land users most probability to adopting of intercropping than sloped land users. The marginal effect of the variable reveals that flat land users have 7.1% of more likely to adopting of intercropping than sloped land users.

Finally, the coefficient of type of labour usage has negative sign which means that whether the farmers are using family or hired workers has negative and also insignificant in the study. The farmers who hired the workers from outside employed the workers are more likely to adopting of intercropping than the farmers who employed the workers from their family members. However, the status of adopting of intercropping was not determined by the types of labour usage in the study.

Table 7: Results of probit model and marginal effects for economics characters

Variables	Coefficients	Standard error	Significant	Marginal effects
Farm income	0.00038	0.00014	0.006	0.000011
Size of immature land	-0.44420	0.23283	0.056	-0.013637
Availability of subsidies	1.10995	0.81472	0.173	0.340763
Distance to market	-0.10238	0.32156	0.750	-0.003143
Constant	-5.63551	2.65722	0.034	
Number of observations = 150				
LR chi^2 (5) = 138.39				
Probability > chi^2 = 0.0000				
Pseudo R^2 = 0.8900				
Log likelihood = -8.5563099				

Source: Estimated by author using Stata 13

In addition to the demographic and farming characters' economics related variables also taken to examine their impact on adopting rubber-based intercropping and the results depicted in Table 7. According to that, out of four economics related variables two factors were significant at 1% level and 10% level respectively. The rest of two factors were insignificant in the model.

Farm income of the rubber farmer has positive impact on adopting of intercropping revealed that as farm income increases, the probability to adapting of intercropping also will be higher. In other ward, when farmers earn enough income through rubber cultivation furthermore, they give attention to earn more profit using same land and other hand when farmers earn less income through farming they will engage in another off-farm activity. It is expected that a farmer with more farm income will engage in intercropping and it is significant at 1% level. The marginal

effect of the variable reveals that more income earners have 0.001% of more likely to adopting of intercropping than less income earners through the farming activities.

Then, size of immature rubber land has negative sign implies that when farmers have more immature rubber land they don't like to engaging with other crops because they thought intercropping is damage the quality of rubber tress. But if the size of their mature rubber lands is more those land will be used for intercropping. It is expected that when farmers have more immature rubber lands they do not engage with intercropping and it is significant at 10% level. The marginal effect of the variable reveals that farmers who own more mature rubber lands have 1.36% of more likely to adopting of intercropping than farmers who own more immature rubber lands.

Availability of fertilizer subsidies has positive sign that implies receiving fertilizer subsidies is an advantage of adopting of intercropping and most of farmers who having fertilizer subsidies were engaging with intercropping. But this factor was insignificant in the model.

Distance to market has negative sign means that farmers who close to the market have more probability to adopting of intercropping and if market is far they don't like to adopting of intercropping. However, this factor was insignificant in the model.

5. Conclusion

The potential adoption of rubber intercropping in Kalutara district seen as a means to improve food security as well as farmers' income and livelihood of the rural community. Intercropping among rubber farmers generates income, food and significant public environmental services such as biodiversity and carbon sequestration. Thus, identify the preferences of rubber framers towards intercropping in the study is an important for policy makers and the government. In this context, results of frequency analysis indicate that, nearly 79% of farmers adopted the intercropping while 21% of them not adopted. This represents that, the majority of the farmers were engage with other crops in addition to rubber growing and less of them only depend on rubber farming for their livelihood activities in the study area.

By analyzing the differences in demographic, economic and farming characteristics among rubber farmers, it is easy to identify the differences between adopters and non – adopters in intercropping. Thus, independent samples t – test done by the researchers and its results suggested that on average age, family size, farming experience, farm income immature rubber land size and distance to market were significantly differ across adopters and non- adopters in the study.

Chi- square test was used to identify to significant association between adoption or non- adoption preferences on intercropping with categorical variables such as gender, education level, type of labor, ownership of land, nature of time allocation for farming and nature of land. Its results found that all these characteristics were statically significant association with adoption preferences towards intercropping in the study.

Probit model was used to examine impact of the demographic, economic and farming characters on the adoption preferences on intercropping in Kalutara district.

The estimated results revealed that, age of the farmer, education level, family size, membership of farm organizations, farming experience, ownership of land, nature of time allocation for farming, nature of land, farm income and size of immature rubber land were significantly influencing the adoption of intercropping in the study.
Among demographic characteristics, farm size and membership were found to be the most influential variable that had a positive impact on adoption preferences towards intercropping.

Since farm size is the main source of income generation for small farmers, appropriate policies need to be designed to improve its efficacy for farmers to achieve increase agricultural productivity. Membership of farmers organization serves as a forum for access to information, credit and other productive inputs.

Among farming characteristics, ownership of land and time allocation also had positive impact on adoption preferences towards intercropping. Farm income is the main factor in determining the preferences on intercropping among the rubber farmers in the study.

The adoption preferences on intercropping are influenced by both biophysical and socioeconomic factors. However, this study limits the factors and considered only demographic characteristics, economic characteristics and farming characteristics in determining the adoption preferences on intercropping in Kalutara district.

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