CHAPTER 5

FACTORS INFLUENCING SUSTAINABLE COCONUT-BASED FARMING SYSTEMS

This chapter mainly discusses the results of ordered probit analysis used to find out the factors influencing sustainable coconut-based farming systems**.** Coconut based three farming systems (monocropping, livestock integration and intercropping) were considered as dependent variable and socio-economic (hired labour used, farm income, extension contacts, off-farm income, location, access to subsidy, technologies used, access to training) bio-physical (land size, use of organic fertilizer, soil fertility condition) and demographic (age, education, occupation, experience) variables combined in factor analysis were taken as independent variables.

5.1 The results of factor analysis

It was found out that there were many multi-correlations among the independent variables themselves and it made complications in developing a model. Therefore data reduction (under Factor Analysis) was applied to extract the main factors or components which have higher value of variance (eigenvalue greater than one).

Table 5.1 KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		.659
Bartlett's Test of Sphericity	Approx. Chi-Square	0.0011
	df	105
	Sig.	.000

KMO and Bartlett's Test was done to find out the significance of variables for factor analysis (Table 5.1). KMO test measures the sampling adequacy and the value varies between 0 and 1 and values closer to one are better. A value of 0.6 is a suggested minimum. According to the value gained in Table 5.1 (0.659) it was accepted since the value was higher than 0.6. Bartlett's test of sphericity rejected the null hypothesis since the significant value was lesser than 0.000. According to that it can be mentioned that correlation matrix was not an identity matrix. Taken these tests together provided with a minimum standard to be passed for conducting factor analysis.

5.1.1 Descriptive statistics of independent variables

The descriptive statistics such as mean, standard deviation, minimum and maximum values of each independent variable including in the factor analysis are shown in Table 5.2.

Table 5.2: Descriptive statistics of independent variables used in the factor analysis

Variable	Minimum	Maximum	Mean	Std. Deviation
LAND - X_1	0.5	12	3.06	2.86
LABOR- X_2	0	348	54.6	66.1
FARMIC- X_3	25,000	54,80,000	4,09,711	6,37,918
EXTEN- X_4	0	11	2.55	2.32
D-OCCUP- X_5	0	1	0.33	0.47
OFFFARMIC- X_6	0	15,00,000	4,01,971.4	3,18,364.3
EDU- X_7	5	16	11.34	2.26
AGE- X_8	27	88	54.3	11.1
EXP- X_9	4	52	29.6	10.8
LOCATION- X_{10}	0.8	18	5.1	3.1
D-SUBSIDY- X_{11}	0	1	0.24	0.43
TECHNO- X_{12}	0	3	0.73	0.66
TRAIN- X_{13}	0	2	0.35	0.54
D-TYPE- X_{14}	0	1	0.34	0.47
D-FERTILITY- X_{15}	0	1	0.91	0.29

Source: Survey, 2011

Note: Coconut based land size (LAND) - Acre
Hired labour used (LABOR) - Labour units used
Farm income (FARMIC) - Rupee/ year
Access to extension contacts (EXTEN) - Time / last year
Full time or part time farming (D-OCCUP) - Occupation1. If full time =1
Off-farm income (OFFFARMIC) - Rupee/ year
Education of smallholder farmer (EDU) - Years of schooling
Age of smallholder farmer (AGE) -Years
Experience on coconut farming (EXP) – Years
Distance from the city to farm (LOCATION) – kms
Access to subsidy facilities (D-SUBSIDY) - If yes=1
Presence of land improvement technologies (TECHNO) – No. of technologies
Access to training (TRAIN) - Time/ last 3years
Use of organic fertilizer (D-TYPE) - If yes=1
Soil fertility condition (D-FERTILITY) – At least medium fertility=1

By the results of extraction method of factor analysis, five components were found to have Eigen values greater than one and they explained 65.345 percent variance as cumulative. It was also found that there was a vast difference in the percent of variance in component one and others and on the other hand there was only a little difference among other components. According to the results gained, the percentage of variance of component (1) was 19.613 percent, component (2) was 13.568 percent, component (3) was 12.604 percent, component (4) was 10.913 percent and component (5) was 8.647 percent as shown in Table 5.3.

Table 5.3 Components from factor analysis (from rotation sums of squared loadings)

Components	Rotation sums of squared loadings		
	Total	% of Variance	Cumulative %
1	3.557	19.613	19.613
2	1.972	13.568	33.181
3	1.944	12.604	45.786
4	1.398	10.913	56.698
5	1.386	8.647	65.345

Source: Survey, 2011
Note: Extraction method: Principal Component Analysis (PCA)
Rotation method: Varimax with Kaiser Normalization

15 independent variables were used initially to form components including four dummy variables. According to the observations of rotated component matrix (Table 5.4) the variables having the value of more than 0.5 were accepted. All 15 variables were included to form factors.

Table 5.4 Rotated component matrix

Variables	Components				
	1	2	3	4	5
Size of the land (X_1)	**0.859**	0.253	0.088	0.170	0.008
Hired labour used (X_2)	**0.881**	0.234	0.076	0.164	0.048
Farm income (X_3)	**0.843**	-0.002	0.093	-0.044	0.101
No. of extension visits (X_4)	**0.600**	0.225	-0.104	0.464	0.060
Occupation (X_5)	-0.058	**-0.818**	0.131	-0.041	0.051
Off-farm income (X_6)	0.184	**0.747**	0.151	-0.071	0.024
Education (X_7)	0.194	**0.728**	-0.169	0.086	0.080
Age of farmer (X_8)	0.115	-0.023	**0.920**	-0.043	0.046
Experience (X_9)	0.052	-0.119	**0.892**	-0.052	0.023
Distance from the city (X_{10})	0.316	0.009	-0.195	**-0.618**	0.333
Subsidy taken (X_{11})	0.255	0.222	-0.110	**0.590**	0.063
Technologies used (X_{12})	0.198	-0.057	0.066	**0.542**	0.090
Trainings received (X_{13})	0.032	-0.065	-0.241	**0.528**	0.194
Organic fertilizer used (X_{14})	0.222	-0.097	-0.071	-0.002	**0.769**
Fertility condition (X_{15})	-0.109	0.165	0.170	0.208	**0.719**

Source: Survey, 2011

Note: Extraction method: Principal Component Analysis (PCA)

Rotation method: Varimax with Kaiser Normalization

The extracted factors were named as in Table 5.5 considering the nature of variables included in each factor. The first component consisted of variables related with farm production (land size, hired labour and farm income needed to use as capital for next production cycle) and extension visits. Therefore that was termed as production and extension factor. The second component was named as off-farm supportive factor since the variables included (occupation, off-farm income, education) were related with off-farm influencing opportunities. The third component consisted of age and experience in farming was termed as experience since the age linked with gaining experience. The component four consisted of distance from the city and institutional related variables (technologies used, access to subsidy and trainings received) and that was named as location and institutional factor. The final component explained the soil fertility related variables (using of organic fertilizer and soil fertility condition) and therefore that was designated as fertility factor.

Table 5.5 Components (factors) extracted by PCA and their independent variables

No.	Name of factor	Independent variables included
1	Production and extension	land size (X_1), farm income (X_2), hired labour used (X_3) and extension visits (X_4)
2	Off-farm supportive	Occupation (X_5), off- farm income (X_6) and education (X_7)
3	Experience	Age (X_8) and experience (X_9)
4	Location and institutional	distance from the city (X_{10}), access to subsidy (X_{11}), technologies used (X_{12}) and trainings received (X_{13})
5	Fertility	using of organic fertilizer (X_{14}) and fertility condition (X_{15})

Source: Survey, 2011

5.2 The results of ordered probit regression analysis

According to the descriptive statistics it was found that out of the randomly selected 175 smallholder farmers, 82 (46.85 percent) had adopted monocropping system and 69 (39.43 percent) and 24 (13.72 percent) adopted intercropping and livestock integration systems respectively. According to the situation analysis considering the sustainability and farmer's adoptability the dependent variable (coconut-based farming systems) was ordered as fallows,

System 1= coconut monocropping

System 2= coconut livestock integration

System 3= coconut intercropping

The factor scores of five factors mentioned above were taken as independent variables for ordered probit analysis.

The model can be written as, $\beta_0 + \beta_1 (F_1) + \beta_2(F_2) + \beta_3(F_3) + \beta_4 (F_4) + \beta_5 (F_5)$

Y= β_0 + β_1 Production and extension + β_2 Off-farm supportive + β_3 Experience + β_4 Location and institutional + β_5 Fertility

Where, Factor 1= Production and extension

Factor 2= Off-farm supportive

Factor 3= Experience

Factor 4= Location and institutional

Factor 5= Fertility

In ordered probit model the actual and predicted values were given in Table 5.6 and according to that in system 1 (monocropping) although the actual value was 82 the model predicted value was 67. For system 2 (livestock integration), the actual and predicted values were 24 and 0 respectively. The actual and predicted values for system 3 (intercropping) were 69 and 33. Therefore the model totally predicted 100 observations out of 175 with 57.14 percentage.

Table 5.6 Actual and predicted values of observations

System	Actual value	Predicted value
1	82	67
2	24	0
3	69	33
Total	175	100 (57.14%)

Source: Survey, 2011

According to the estimated model in Table 5.7, the chi squared value was highly significant indicating that the model fitted with data. The estimated threshold variable (μ_1) was highly and positively significant showing that the three categories of the dependent variable (systems) have been appropriate to explain the model correctly. Beside that the scaled R squared, a nonlinear transformation of the constrained and unconstrained maximum likelihood values is a good measure of fit. It is bounded within zero to one like ordinary R squared in classical regression analysis. In this estimation the goodness of fit value is 0.0875.

Further according to the table 5.7, factor one and factor five were significant at 1 percent significant level with positive coefficients. Other three factors were not significant. Therefore it was observed that Production and extension component and

Fertility component were positively influenced on the adoption of coconut-based farming systems.

Y= 0.046 + (0.31*Production and extension) +(- 0.0005* Off-farm supportive) +(0.096* Experience) +(-0.1*Location and institutional) +(0.38* Fertility)

Table 5.7 Ordered probit model of coconut-based systems

Variable	Coefficient	Standard Error	b/St. Er	P[|Z|>z]
Constant	0.046	0.100	0.46	0.65
Factor 1	0.31	0.091	3.43	0.0006***
Factor 2	-0.0005	0.093	-0.005	0.99
Factor 3	0.096	0.095	1.008	0.31
Factor 4	-0.100	0.090	-1.14	0.26
Factor 5	0.38	0.097	3.91	0.0001***
μ_1	0.395	0.755	5.243	0.0000

Correlation is significant at 1% (***) level

Observations=175, Iterations completed=9

Log likelihood function= -158.84, Restricted log likelihood= -174.06

Chi squared=30.45, Prob [ChiSqd > value] = .000012

Source: Survey, 2011

Further, for interpretation of results in more detail marginal effect for each factor and for each system (dependent variable) were calculated and listed in Table 5.8.

Table 5.8 Marginal effects of ordered probability model of coconut-based systems

Variable	Monocropping		Livestock integration		Intercropping	
	Coefficient	SE	Coefficient	SE	Coefficient	SE
Constant	0.00	0.00	0.00	0.00	0.00	0.00
Factor 1	-0.12	0.036	0.0072	0.0052	0.12	0.034
Factor 2	0.0002	0.037	-0.00	0.0022	-0.0002	0.035
Factor 3	-0.038	0.038	0.0022	0.0027	0.036	0.036
Factor 4	0.041	0.036	-0.0024	0.0026	-0.038	0.034
Factor 5	-0.15	0.039	0.0088	0.0063	0.14	0.036

Source: Survey, 2011

Note: SE= Standard error

According to the estimated coefficients of marginal effects (Table 5.8) it is observed that when all other independent variables are constant held at their sample means, one unit change in the Factor 1 negatively influences (decreases) the probability of adopting monocropping system by 12 percent and in contrast that positively influences (increases) the probability of adopting diversified more sustainable livestock integration system and intercropping system by 0.72 percent and 12 percent respectively. Therefore the variables used to form production and extension factor (land size, farm income, hired labour used and extension visits) were positively influenced on adopting more sustainable systems while those were negatively affected to adopt least sustainable monocropping system. It means that a smallholder coconut farmer who practised monocropping may convert his field into livestock integration (with 0.72 percent probability) or intercropping (with 12 percent probability) when the production and extension factor score increases by one unit. Further, one unit change in the factor 5 negatively influences (decreases) the probability of adopting monocropping system by 15 percent and in contrast that positively influences (increases) the probability of adopting livestock integration system and intercropping system by 0.88 percent and 14 percent respectively. Therefore the variables used to form Fertility factor (using of organic fertilizer and soil fertility condition) were positively influenced on adopting more sustainable coconut-based farming technologies while those were negatively affected to adopt least sustainable monocropping. When the fertility factor score increases by one unit, smallholder farmer who practised monocropping tends to change his system into livestock integration by 0.88 percent or intercropping by 14 percent probability.

According to the factor coefficient matrix the significant factors can be written in detail as fallows;

Factor 1 = 0.304 land size (X_1) + 0.354 farm income (X_2) + 0.314 hired labour used (X_3) + 0.169 extension visits (X_4)

Factor 5 = 0.598 using of organic fertilizer (X_{14}) + 0.592 fertility condition (X_{15})

These coefficients of variables included in each factor illustrate the relative importance of that variable within a particular factor. The coefficient value is a measure of the expected change of the factor score for a unit change of the value of variable.

In relation with factor one the results can be explained further as large farms are able to obtain more extension visits and farm income which can be used as financial asset of farm to pay for more hired labour units to be employed in sustainable technologies than small farms.

Furthermore, related to factor 5 the results can be further discussed as fallows; soil fertility can be improved by addition of organic matter and that condition improve the sustainability of the field by applying sustainable technologies.

The above results can be discussed as fallows; Hosseini *et al*. (2010); Rahman (2008); Cho *et al*. (2011) viewed that social factors such as extension contacts influence the sustainable agriculture. Agricultural extension can be considered as one of the important sources of information dissemination directly relevant to agricultural production practices. This is reinforced by the fact that many studies find a significant influence of extension education on the adoption of land improving technologies.

Although hired labour has positive influence on sustainable technologies in this study, D'souza *et al*. (1993) stated sustainable agricultural systems rely on more natural processes and labour saving. Therefore hired labour utilization has been negatively influence on sustainable technologies. But however Yesuf *et al*. (2008) found out that access to labour markets enhances the farmer's decision to adopt soil conservation technologies.

Land or plot size of farm households has influence on new farm technologies. A study (Yesuf *et al*., 2008; Cho *et al*., 2011) revealed that the farmers with larger area or plot sizes were more likely to adopt soil conservation technologies and therefore the causes for land fragmentation have strong indirect effect on technology adoption decisions. Due to conversion of agricultural land to property development, the rapid growth and escalating land values threaten farming by discouraging farmers to adopt sustainable practices

Economic factors too contribute to sustainability and limited financial returns for farmers are a major barrier hampering adoption of sustainable agriculture practices. In a study of adoption of soil conservation measures (Cho *et al*., 2011) the farm income became positive revealing that farmer need financial status for technology application in the field.

Hosseini *et al*. (2010) found out that the replacement of chemical inputs by organic inputs would influence the adoption of sustainable agriculture. Further, soil quality improvement has influenced the development of sustainable agriculture by green house owners in Iran.

5.3 Summarized results

The results of the Ordered probit regression proved that there was a relationship between the combination of main components of demographic, socio-economic and bio-physical variables with the influencing of coconut-based farming systems. Out of the five factors extracted from factor analysis two factors (production and extension and fertility) factors significantly positively influenced on livestock integration and intercropping coconut-based systems in ordered probit analysis. Therefore the variables included to form those factors (land area, hired labour used, farm income, extension visits, use of organic fertilizer and soil fertility condition) have influenced the sustainable smallholder coconut-based farming in the study area.