Discriminant analysis: a tool for identifying significant socio-economic correlates in farming system - a case study

Sh. H. SINGH, L. NARASIMIAH, S. DE, K. SINHA, G. SATHISH AND P.K. SAHU

Department of Agricultural Statistics,
Bidhan Chandra Krishi Viswavidyalaya, Mohanpur-741252, India

ABSTRACT

Food security in India and its agricultural growth depends on the performance of its small and marginal farmers as these farming group constitute 85.01 per cent of total farmers. To minimize uncertainty, increase income and productivity in agriculture, integrated farming system is being advocated with the incorporation of components like fishery, dairy, poultry, goat rearing, etc. with crop production. In this present study, an attempt has been made to study and analyses major factors involved in different farming systems practiced in Charangpat village of Thoubal district in Manipur where small and marginal farmers are dominant. Fisher's Linear Discriminant Analysis (LDA) was used for discrimination of 100 randomly selected households into four farming system groups viz. Rice, Rice-fish, Rice-vegetable and Others group using nine discriminating variables and it could discriminate them 76 per cent correctly. Other group of farming which includes rice-fish-fruit, rice-fish-fruit-vegetable, rice-fish-vegetable, rice-fish-fruit-vegetable-pig and rice-fruit farming systems was found significantly better than others followed by rice-vegetable farming system in terms of income and saving. Important discriminating variables found are farm income, agriculture land, number of earners, agricultural assets, service income, other income, etc.

In India, number of small and marginal land holdings (below 2ha.) constituted 85.01 per cent in 2010-11 and 83.29 per cent in 2005-06 (Agriculture census report, 2011). Thus, future of India's food security and agricultural growth depends on the performance of its small and marginal farmers. With the increasing demand for land for various purposes and to feed the fast growing population, it has become imperative to produce maximum output per unit area per unit time per unit of resource. Dependence only on crop production is invariably subjected to a high degree of uncertainty in terms of success in crop husbandry vis-à-vis income and employment. So, as to increase income and productivity, farmers has to integrate ancillary propositions like fishery, dairy, poultry, goat rearing, *etc*. with crop production. An appropriate combination of farming system combining cropping system, horticulture, livestock, fishery, forestry, and poultry is supposed to raise the profitability and thereby lifting the economy and standards of living of the farmers. Success of such enterprises depend on situation, type of farming system practiced *etc*.

Singh, Gangwar and Singh (2009) revealed that vegetables based farming system provides the maximum employment. Dorge, *et al*. (2015) found income from farming system consisting of agricultural crops, livestock and horticulture crops to be four times higher than that of sole agricultural crops. Vishwajith *et al*. (2015) identified major contributing farm factors in discriminating the farmers into different groups and ranked the factors using discriminant analysis in Arecanut based farming system. In each case, success of farming system is supposed to be situation specific, factors playing major role with particular farming system in one situation may not be equally important in other situations. With this pretext, in this present study an attempt has been made to analyses the nature of farming systems in a village where small and marginal farmers are dominant. In Manipur number of small and marginal land holdings constituted 83.38 per cent in 2010-11. For our study a village was selected purposively viz. Charangpat of Thoubal district in Manipur. The selected village consists of more than 1000 farm households practicing varied range of farming systems. The households not only cultivate various seasonal crops, they also have other enterprises like fishery, poultry, piggery, *etc*. This study aims at studying farming systems prevailing and analyzing major factors involved in different farming systems practiced in the region.

MATERIALS AND METHODS

This study is based on the primary data collected on 25th Oct. to 10th Nov., 2015 from one hundred randomly selected households using a well-structured and tested survey schedule. In addition to regular descriptive statistical measures, Fisher's Linear Discriminant Analysis (LDA) was used for discrimination of the households based on their different farming systems. LDA is a useful statistical technique for classifying observation(s) correctly to one of the several pre-defined

---

Table 1: Descriptions of household characteristic variables

	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9
Minimum	0	1	0.25	11700	0	0	2500	134500	-47700
Maximum	12	5	3	537500	1200000	1000000	72319000	1257950	845650
Mean	6.8	1.82	1.03	82498.6	245210	132570	938313.5	460278.6	140757.7
Std. Error	0.3	0.08	0.05	8852.73	27219.5	16670.2	721903.1	26468.28	16931.31
Median	7	2	1	52500	240000	110000	82875	382525	85606.25
Mode	6	2	1	44625	0	0	23500	608625	-
Kurtosis	-0.65	1.06	4.63	11.74	2.03	10.34	99.49	0.77	4.21
Skewness	-0.07	0.91	1.77	3.21	1.41	2.72	9.96	1.17	1.86

Note: X_1 = family average education, X_2 = number of earners, X_3 = agriculture land (ha.), X_4 = annual farm income (Rs.), X_5 = annual service income (Rs.), X_6 = annual other income (Rs.), X_7 = total annual saving (Rs.), X_8 = agriculture asset value (Rs.) and X_9 = non-agriculture asset value (Rs.).

Table 2: Average values of 9 discriminating variables for different farming systems

Variables	Farming Systems			
	Rice(68)	Rice-fish(11)	Rice-vegetable(11)	Others (10)
Family average education	6.76	6.09	7.27	7.4
Number of earners in a family	1.63	1.55	2.82	2.1
Agriculture land (ha.)	1.09	0.75	1	0.93
Farm income (Rs. Yr^{-1}.)	**50242.64**	**135935.9**	**113036.3**	**209661.3**
Service income (Rs. Yr^{-1})	281447.8	76363.64	257454.6	166800
Other income (Rs. Yr^{-1})	126223.9	177090.9	129454.6	142800
Saving (Rs. Yr^{-1}.)	**135080**	**104899.6**	**176792.6**	**181510.2**
Agricultural Asset value*(Rs.)	85941.04	33336.36	137136.4	96350
Non-agricultural Asset value*(Rs.)	1300877	346695.5	99359.09	164980

*Note: Number in parentheses under farming systems indicates number of farmers practising the corresponding farming system. *excluding land.*

Table 3: Intergroup D^2 value for different farming systems

Farming Systems		D^2	Hotelling T^2	F	F critical	POM
Rice	Rice-fish	11.70	110.78	9.54	2.02	
	Rice-vegetable	16.63	157.44	13.55		
	Others	11.99	104.56	8.99	2.02	0.24
Rice-fish	Rice-vegetable	9.51	52.33	2.62	2.80	
	Others	3.01	15.78	0.75	3.02	
Rice-vegetable	Others	3.93	20.61	0.98	2.90	

Note: POM - Probability of misclassification

Table 4: Ranking of different variables on discrimination of farming systems

Farming Systems		X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9
Rice vs.	Rice-fish	8	7	2	1	3	9	6	4	5
	Rice-vegetable	7	2	3	1	5	6	9	4	8
	Others	6	5	4	1	2	8	3	9	7
Rice-fish vs.	Rice-vegetable	8	1	5	7	2	3	4	6	9
	Others	5	7	8	3	9	6	1	2	4
Rice-vegetable vs.	Others	8	2	3	1	5	4	9	7	6

distinct groups and to work out the contribution of different factors on group discrimination. To distinguish among the groups we have to select a collection of discriminating variables that measure characteristics on which the groups are expected to differ. Then, based on the Linear Discriminant function, one can allocate an observation to some group.

Then we allocate X0 to population 2 where, and are mean vectors of the two groups, is the vector of discriminant coefficients and is the pooled sample variance-covariance matrix of the two groups under comparison. For testing equality of two farming systems, Hoteling's T2 statistic was used. It is given by where, n1 and n2 are number of observations of the two farming systems and is vector of their mean difference for p characters. This T2 is distributed as assuming that the variance-covariance matrices of the two farming systems are identical but unknown. Contribution of different characteristics towards group discrimination can be worked out with the help of the formula where and di are respectively the discriminant coefficient and mean difference of the ith character between the two groups.

Rice is the main crop grown in the study area. After rice, some farmers grow vegetables, fruits (banana) and some farmers rear fish, pig, and poultry birds also. Thus, based on the available information 100 households have been grouped into four farming system groups *viz.* Rice, Rice-fish, Rice-vegetable and Others group. Others group includes Rice-fish-fruit, Rice-fish-fruit-vegetable, Rice-fish-vegetable, Rice-fish-fruit-vegetable-pig and Rice-fruit farming systems. LDA has been used to find the contribution of 9 household characteristics viz. family average education(X_1), number of earners(X_2), agriculture land (X_3), annual farm income (X_4), annual service income (X_5), annual other income (X_6), total annual saving (X_7), (X_8) and non-agriculture asset value (X_9) of a household on the group discrimination.

RESULTS AND DISCUSSION

Demographic, economic and household characteristics of 100 households of the study area have been described in table 1. From the table it shows that family average education of the households is 7th standard and it ranges from illiterate to 12th standard. During the study, graduates and postgraduates were also found in many families. However, its mean, median and mode clearly indicate that the education has not been spread evenly, thereby recording a low average family education standard. Agricultural land holding of the households skewed positively from 0.25 to 3 ha with an average of 1.03 ha. A few households having high land holdings make it possible to have the average value of 1.03 ha. Average total annual income of the households

is Rs.4.6 lakh and skewed positively from Rs. 1.34 lakh to Rs. 12.58 lakh. Thus, average per capita monthly income is more than Rs. 6000 and average monthly income of the families varies between Rs. 11,166 to Rs. 1, 04,833.

Others farming system group receives the highest farm income followed by rice-fish, rice-vegetable and rice. This group also has the highest total annual income associated with maximum saving. Next to others farming system rice-vegetable farming system has the highest annual saving followed by rice and rice-fish farming system. Rice-fish farming system group also receives the lowest total annual income among the four farming system groups. From table 2, it is also evident that higher the total income higher is the saving and vice-versa. The lowest saving of Rice-fish group can be attributed to the fact that many farmers in this group are in the initial stage of practicing this farming system.

Table 3 presents the D2 values across the farming systems along with their critical F values at 5 per cent level of significance. Fisher's LDA could classify the selected 100 households to the predefined four farming systems 76 per cent correctly. Rice-fish, rice-vegetable and others farming systems are significantly different from sole rice farming system while other pairs are not significantly different. Maximum distance is found in between rice and rice-vegetable farming systems (16.63) followed by distance between rice and others group and so on. Maximum distance between rice and rice-vegetable farming system indicates that there is maximum variation between these two groups with respect to the discriminating variables. Least variation is found between rice-fish and others farming system. Discriminating variables have been ranked based on their contributions in group discrimination and represented at table 4.

It is found that farm income is the most important variable in discriminating rice and rice-vegetable farming system followed by number of earners, agriculture land, agricultural assets, service income, other income, *etc*. Annual farm income also contributes most to the discrimination of rice-fish and others farming from sole rice farming system. Similarly, variables are ranked in other combinations also based on their contributions. Agriculture land next to farm income highly contributes in all farming system groups. High contributions of annual service income and other income in group discrimination also indicate that other sources of financial support is needed for a farming system to become a productive and successful farming system. Agricultural assets are also found to contribute much to the discrimination of farming systems which indicates the importance of adoption and use of improved

technology and equipments for productive farming system. An interesting feature of such ranking of variables based on their relative contribution in group discrimination is that not a single characteristic except farm income is found to contribute uniformly better or worst in group discrimination, thereby justifying the selection of variables for group discrimination.

Under this study a wide range of variability in terms of economic, agricultural and entrepreneurial variations are obtained among the selected households. With the help of Discriminant Analysis group discriminating household characteristics say farm income, agriculture land, number of earners, service income, other income, *etc.* could be identified as important factors in discrimination of households into different farming groups. Among the four different farming systems, others farming system (rice-fish-fruit, rice-fish-fruit-vegetable, rice-fish-vegetable, rice-fish-fruit-vegetable-pig and rice-fruit), practiced by 10 per cent of the selected households was found significantly better than others in terms of income and saving. Economic conditions of the selected village could be well improved if majority of the farmers successfully practice this particular farming system or by incorporating more than one farm enterprises instead of growing sole rice once in a year keeping the land fallow in remaining seasons. Thus, the study suggests that depending up on the critical factors, different intervention and improvement strategies could be adopted for different groups of households, which in turn may not only increase farm income but also savings of the farming community. As has already been told saving expands the scope for overall improvement of

the country, so action oriented plans should be executed towards better use of land vis-a-vis enhanced farm income and savings. Agriculture land needs to be conserved. Improved agricultural inputs, equipments and new farm technologies should be introduced and made available to the farmers. Similar studies could be extended in other places for finding suitable and productive farming systems.

REFERENCES

Anonymous, 2014. Agriculture Census 2010-11, All India Report on Number and Area of Operational Holdings. Department of Agriculture and Cooperation, Ministry of Agriculture, Govt. of India, New Delhi. http://agcensus.nic.in/document/agcensus2010/completereport.pdf

Dorge, J. T., Joshi, G. G. and Sanap, D. J. 2015. Employment and income pattern of different farming systems in Western Maharashtra. *Int. Research J. of Agri. Econ. and Statistics*, **6(2)** : 356-63

Sahu, P.K., and Das, A.K. 2007. Agriculture and Applied Statistics – II, Kalyani Publication, Ludhiana, India: 468-470

Singh, P., Gangwar, B. and Singh, M.P. 2009. Economics of Farming Systems in Uttar Pradesh. *Agri. Econ Research Review*, **22 :** 129-38

Vishwajith, K. P., Sahu, P. K., Dhekale, B. S., Noman, Md. and Mishra, P. 2015. Exploring the feasibility of arecanut based farming systems in augmenting farm economy- a case study in Karnataka, India. *J. Crop Weed,* **11 (Special Issue)**: 127-33