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Analysing social attributes of loan default among small Indian dairy farms: A discriminant approach

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The study examines the socio-economic factors discriminating defaulters and non-defaulters of credit repayment. Multi-stage sampling design was adopted for selection of farm respondents. The data were collected through structured questionnaire by personal interview method. A linear discriminant function considered to examine the relative importance of different factors in discriminating between non-defaulters and defaulters. The result revealed that per capita income from crop and milk production, expenditure to total income, earning adults and off-farm income explained major share in discriminating the non-defaulters from defaulters. The mean discriminant score for the non-defaulters (Z_1) and defaulter (Z_2) were found to be 0.316 and -1.322, respectively. The critical mean discriminant score (Z) for the two groups was found to be -0.503. The high value of *Z* corresponds to non-defaulter and low value to defaulter. Later the derived classification analysis was observed that 50 out of 83 defaulters and 32 out of 37 non-defaulters were rightly classified in Z function. Thus, grouped cases classified correctly as 68.33% as factors of default. Hence, the model is found to be valid to predict whether an unknown borrower is likely to be defaulter or non-defaulter more precisely.

Key words: Discriminant function, credit, defaulter, dairy farmers.

INTRODUCTION

Animal husbandry in India play an important role in national economy and socio-economic development. Its contribution to agricultural gross domestic product (GDP) is 24.8% at current price (GOI, 2012-2013) and supports the livelihood of over 200 million rural poor (World Bank, 1999). Further, it generates continuous stream of income and employment (Nargunde, 2013; Sinha et al., 2012; Enoma, 2010) and also supports to reduce seasonality in livelihood patterns (Birthal and Ali, 2005) due to its more egalitarian distribution compared to land (Ahuja et al., 2000). Most of the milk is produced by small and marginal farmers as well as landless labourers, who owns 87.7% of the livestock (NSS, 2011). About 40 million landless poor families earns a major part of their income from milk production (World Bank, 2005), with some very limited hired labor. At the same time, farm credit and sponsored programmes is an important intervention to address the issue of rural poverty among smallholder and landless farmers (Meyer and Nagarajan, 2000). Expanding the availability of agricultural credit has been widely used as a policy to accelerate agricultural and rural development (World Bank, 2000). It is traditionally employed as a tool for providing the priority sectors with access to production inputs and enabling production to be increased. Many efforts have been made and a continuous search for sustainable interventions through appropriate credit schemes is being conducted to improve the living conditions and quality of

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life of small farmers in the rural areas (World Bank, 2000). However, such efforts and interventions are often hindered by problems of repayments, which contribute to the failures of some rural credit programmes. The assumption behind credit delivery for production process is that it will generate sufficient additional income to meet the repayment obligations and have a reasonable surplus to the producers. It is in this context, the factors which influences the repayment position of borrowers assumes great significance, and identifying the potential defaulters based on social and economic parameters are of immense importance. This study is an attempt to explore the important determinants which force the small dairy farmers to default the loan repayment.

MATERIALS AND METHODS

A multi-stage purposive sampling technique was employed to select 240 households as respondents covering 120 beneficiaries and 120 non-beneficiaries of dairy loan from 3 village clusters spread over three blocks of Ranchi district of Jharkhand state. Primary data were collected by personal interview of small farmers who borrowed for dairy activities.

To examine the relative importance of different socio economic factors in discriminating between non-defaulters and defaulters, linear discriminant function analysis was used in the study. The coefficient of discriminant function measures the net effect of an individual variable, when all other variables are considered as constant. The function specified was estimated using the SPSS software.

The following functional form was used for the present analysis as shown in Equation 1:

$$Z = \sum_{n=1}^{11} I_n X_n \quad (1)$$

Where, Z = Total discriminant score for loan defaulters and non-defaulters; X_1 = Size of operational holding in acres; X_2 = Number of milch animals; X_3 = Per capita income from crop production (INR); X_4 = Per capita income from dairying (INR.); X_5 = Per capita off-farm income (INR); X_6 = Total expenditure to total income (%); X_7 = Investment in dairying (INR); X_8 = Percentage of earning adults in family; X_9 = Per capita food expenditure (INR); X_{10} = Per capita expenditure on dairy products (INR); X_{11} = Education level of family head, and I_n = (n=1,2,3,....,11) are the linear discriminant coefficients of n^{th} variable.

Two groups of equal size are required for the application of discriminant function (Bala Krishna and Iyer, 1968). In the present study, there were 37 non-defaulters and 83 defaulters; hence, a sub-sample of 37 defaulters from the total 83 defaulters was randomly taken in order to make both the groups alike for the analysis. The discriminant function was constructed by choosing the value of I_k in such a way that the ratio was equal to variation of 'Z' between groups of defaulters and non-defaulters divided by variation of `Z' within the groups of defaulters and non-defaulters, was the maximum. The calculation of the discriminant function involves the solution of the following 11 equations shown in matrix notation (Brandow and Potter, 1953):

$$SI = D \quad (2)$$

Where,

$$S = \begin{pmatrix} S_{11} & S_{12} & .... & S_{1K} \\ S_{21} & S_{22} & .... & S_{2K} \\ : & : & : & : \\ S_{k1} & S_{k2} & .... & S_{kK} \end{pmatrix} \quad I = \begin{pmatrix} I_1 \\ I_2 \\ : \\ I_k \end{pmatrix} \text{ and } d = \begin{pmatrix} d_1 \\ d_2 \\ : \\ d_k \end{pmatrix}$$

Where, K = 11; I_k = Vector of coefficient of discriminant functions, S_kI_k = Pooled dispersion matrix, and d_k = Elements representing difference between means of two groups.

The discriminant function was tested for significance to examine whether the variables considered together were sufficiently discriminating between groups of defaulters and non-defaulters or not. The Mahalanobis D^2 test was used to measure the distance between the two groups. After transformation of the D^2 statistics, it becomes an F statistic, which was then used to see the group difference from each other.

$$D^2 = \sum_{i=1}^{11} \sum_{k=1}^{11} C_{ik} d_i d_k \quad (3)$$

$$F = \frac{N_a N_b (N_a + N_b - P - 1)}{P(N_a + N_b)(N_a + N_b - 2)} \times D^2 \quad (4)$$

Where, Cik = inverted matrix for the coefficients, D_1dk = matrix of the product of mean differences, P is the number of characteristics. The value of F is to be tested for significance with (P) and (N_a+N_b-P-1) degrees of freedom.

RESULTS AND DISCUSSION

The socio-economic characteristics of the borrowers together with means and their mean differences for the two groups of non-defaulters and defaulters of dairy loan were calculated. For this purpose, a sample of 37 defaulters and 37 non-defaulters was taken to have a valid comparison. The discriminant function for the data was estimated and presented as:

$$Z = 0.5941\ X_1 + 0.2390\ X_2 + 0.0032\ X_3 + 0.0021\ X_4 + 0.0287\ X_5 - 0.2321\ X_6 + 0.00012\ X_7 + 0.1162\ X_8 - 0.0032\ X_9 - 0.0188\ X_{10} + 0.0164\ X_{11} \quad (5)$$

The discriminant function was tested for significance to examine whether or not the characteristics considered together were sufficiently discriminating between the groups of non-defaulters and defaulters. The test of significance of discriminant function is a test of hypothesis that there are no difference in the mean values of the chosen characteristics in the two populations of non-defaulters and defaulters. D^2 and

Table 1. Factor contribution of individual characteristics to total distance measured.

S/N	Social determinants	Coefficients (l_K)	Mean difference (d_k)	Contribution of variable (l_K x d_k)	Factor contribution (%)
1	Operational holding (X_1)	0.5941	0.312	0.1853	5.78
2	Number of milch animals (X_2)	0.2390	0.270	0.0645	2.08
3	Per capita income from crop (X_3)	0.0032	167.556	0.5362	17.32
4	Per capita income from dairying (X_4)	0.0021	285.970	0.6005	19.39
5	Per capita off farm income (X_5)	0.0287	16.850	0.4836	15.62
6	Percentage expenditure to total income (X_6)	-0.2321	-2.640	0.6127	19.78
7	Capital investment in dairying (X_7)	0.0001	1581.973	0.1898	6.13
8	Percentage of earning adults (X_8)	0.1162	2.990	0.3474	11.22
9	Per capita food expenditure (X_9)	0.0032	-30.108	-0.0963	-3.11
10	Per capita expenditure on dairy items (X_{10})	-0.0188	-8.241	0.1549	5.00
11	Educational status (X_{11})	0.0164	-6.092	0.0179	0.005
	Total			3.0965	100.00

variance ratio were worked out and found to be 5.0654 and 5.0931, respectively. Since the tabulated value of F statistics ($F_{11,\ 62}$) at 5% level is 2.49, the discriminant function was found to be significant. This indicates that the eleven characteristics considered together are useful in classifying the borrowers into the groups of non-defaulters and defaulters. In order to examine the relative importance of characteristics based on their power to discriminate between the two borrower groups, the percentage contribution of each character to the total distance measured were calculated and the results are exhibited in Table 1. The results revealed that the characteristics like per capita income from crop production (17.32%), per capita income from dairying (19.39%), per capita off-farm income (15.62%), percentage expenditure to total income (19.79%) and the percentage of earning adults (11.29%) were the major characteristics, which led to classify the borrowers into two groups of defaulters and non-defaulters.

The students 't' test was calculated for testing the mean difference between the groups for each variable and they exhibited significant t' values for the above identified variable at 5% level. The variables like per capita income from crop production (X_3), per capita income from dairying (X_4), per capita off-farm income (X_5), percentage expenditure to total income (X_6), and percentage of earning adults to total family (X_8) were observed to be significant. Hence, these variables were judged as the major attributes which discriminate the borrowers into non-defaulters and defaulters.

The discriminant function was again re-run by taking only those five significant variables in the equation to see whether these characteristics alone could discriminate the defaulters and non-defaulters significantly or not and it was observed from this analysis that these characteristics were very useful for measuring distance in the discriminating power. The new discriminating function taking only the significant factors was estimated as:

$$Z = 0.023\ X_3 + 0.0011\ X_4 + 0.0038\ X_5 - 0.0636\ X_6 + 0.0212\ X_8 \quad (6)$$

Again, the discriminant function was tested to examine whether these characteristics considered together are significantly discriminating between the groups of defaulters and non-defaulters. The D^2 and variance ratio were worked out to be 4.6241 and 5.3154, respectively. Since the tabular value of $F_{(5,62)}$ at 5% level is 4.43, the discriminant function is significant. This implies that the five characteristics considered together were useful in classifying the borrowers into the groups of non-defaulters and defaulters. Thus, the difference in the groups was mostly oriented towards per capita income, percentage expenditure to total income and percentage earning adult to the family. The discriminating variables obtained are quite contrary to the variable chosen by George et al. (1984), Lekshmi et al. (1998) and Gandhimathi (2012), while the results obtained were in conformity with findings of Bandyopadhyay (2006), Nawai and Shariff (2010).

Further, the relative importance of the characteristics to discriminate between the two groups of borrowers, the percentage contribution of each variable to the total distance measured were examined and the results are exhibited in Table 2. The magnitude of the coefficient of the function is an indicator of the relative importance of individual variable. The coefficient in the Z equation suggest that higher per capita income from crop production, higher income from dairying, percentage expenditure to total income, off-farm income sources and more earning adults in the family contributed high value of Z, explained major share in discriminating the non-defaulters from defaulters followed by percentage earning adults and off-farm income. The weights associated with these characteristics to the total distance measured were obtained as 38.72, 31.62, 16.87, 6.43 and 6.36, respectively.

The discriminant function was later used to predict

Table 2. Relative importance of significant characteristics for defaulter and non-defaulter.

S/N	Socio-economic variables	Coefficients (l_K)	Mean difference (d_k)	Contribution of variable ($l_K \times d_k$)	Factor contribution (%)
1	Per capita income from crop (X_3)	0.0023	167.556	0.3853	38.72
2	Per capita income from dairying (X_4)	0.0011	285.970	0.3146	31.62
3	Per capita off farm income (X_5)	0.0038	16.850	0.0640	6.43
4	Percentage expenditure to income (X_6)	-0.0636	-2.640	0.1679	16.87
5	Percentage of earning adults (X_8)	0.0212	2.990	0.0633	6.36
	Total			0.9951	100.00

Table 3. Classification analysis results (confusion matrix) of the borrower groups.

Actual group	Number of cases	Predicted group membership			
		Defaulters	%	Non-defaulters	%
Defaulters	83	50	60.24	33	39.76
Non-defaulters	37	5	13.52	32	86.48

whether a borrower is likely to be a non-defaulters or defaulters. The mean discriminant score Z_1 for the non-defaulters and defaulters Z_2, that is, sum of the products of the coefficient and corresponding mean value of significant characteristics, were found to be 0.316 and -1.322, respectively. The critical mean discriminant score (Z) for the two groups was found to be -0.503. This implies that, if the discriminant score for a respondent on the basis of significant variable is found to be more than -0.503, the respondent can be predicted to be non-defaulters, otherwise he is likely to be a defaulters. The high value of Z corresponds to non-defaulter and low value to defaulter. It will be interesting to see that what proportion of respondents considered in the present study is rightly classified by the function. With this criterion, the whole sample of 120 respondents (borrowers) was classified into defaulters and non-defaulters. Then, it was compared with the actual discriminant classification. This classification is called as derived classification analysis.

The percentage of cases classified correctly is an indicator of the productive power of fitted discriminant function, while evaluating this measure, it is important to consider the observed mis-classification rate to that by chance. It was seen from the Table 3 that 50 out of 83 defaulters and 32 out of 37 non-defaulters were rightly classified in the Z function. The number of respondents wrongly classified was 38 out of 120 respondents of defaulters and non-defaulters. Thus, grouped cases classified correctly as 68.33%. Therefore, the model is found to be valid to predict whether an unknown borrower is likely to be defaulter or non-defaulter, more precisely.

CONCLUSION AND RECOMMENDATION

Farm credit and supported programme for dairy development is a policy intervention to improve livelihoods of small and marginal farmers as well as landless people. The study investigated the localized social factors that should be used by the lender in risk rating their farm customer. The study suggests that lower income from the crop production, dairy and off -farm activities coupled with high expenditure proportionate to income and less number of earning adults in the family leaves lesser surplus with the farmer that makes them to default. The derived classification analysis cross verified the predicted variables and found that the group classified correctly by 68.33% as factors of default. Thus, the model is considered as valid in predicting the defaulters based on localized factors precisely. The results will address the concerns of the lenders in advance to assess the credit risks of their capital and risk adjustment for serving larger group of small holding/farmers. Therefore, lending agencies must take note of important social as well as other locally important variables and social characteristics before granting the loan to small holder to reduce the incidence of loan delinquencies and defaults.

REFERENCES

Ahuja V, George PS, Ray S, Kurup MPG, Gandhi V (2000). Agricultural services and the poor: case of livestock health and breeding services in India. IIM Ahmedabad, The World Bank, and Swiss Agency for Development and cooperation, Bern, Switzerland. P. 148.

Bala krishna S, Iyer RB (1968). Characteristics of adopters of family planning methods of Panjab: A discriminant function approach. Beh. Sci. Comm. Dev. 2(1):16.

Bandyopadhyay A (2006). Predicting probability of default of Indian corporate bonds: Logistic and Z-score model approaches. J. Risk Financ. 7(3):255-272.

Birthal PS, Ali J (2005). Potential of livestock sector in rural transformation, In: Rural Transformation in India: The Role of Non-farm Sector, eds (Rohini Nayyar and A N Sharma editors) Institute for Human Development, New Delhi.

Brandow GE, Potter AK (1953). An application of linear discriminant function. Rural. Sociol. 18(4):321-326.

GOI (2012-2013). Annual report of Department of Animal Husbandry, Dairing and Fishery, Ministry of Agriculture, Government of India, New Delhi. P. 3.
Enoma A (2010). Agricultural credit and economic growth in Nigeria: an empirical analysis. Bus. Econ. J. 14(7):1-7.
Gandhimathi S (2012). Determinants of repayment and over-dues in agricultural sector. Int. J. Econ. Bus. Res. 4(5):590-602.
George PT, Namasirayam D, Ramachandraiah G (1984). Application of discriminant function in the farmers repayment performance. J. Rural. Dev. 3(3):149-167.
Lekshmi S, Rugmini P, Thomas J (1998). Characteristics of defaulters in agricultural credit use – a macro level analysis with reference to Kerala. Ind. J. Agric. Econ. 53(4):640-67.
Meyer R, Nagarajan G (2000). Rural financial markets in Asia: policies, paradigms and performance, Vol. 2005.
Nargunde AS (2013). Role of dairy industry in rural development. Int. J. Adv. Res. Eng. Tech. 4(1):8-16.
Nawai N, Shariff MNM (2010). Determinants of repayment performance in microcredit programs: A review of literature. Int. J. Bus. Soc. Sci. 1(2):152-161.
NSS (2011). Report of national sample survey 66th Round, Ministry of statistics and programme implementation, National Sample Survey Office, Govt. of India, New Delhi.
Sinha MK, Jhaka JP, Meena MS (2012). Milk production economics and micro financing impacts in Chhotanagpur platue of Jharkhand. Indian J. Anim. Sci. 82(7):757-761.
World Bank (1999). India livestock sector review: Enhancing growth and development, The World Bank, Washington DC.
World Bank (2005). Agriculture investment sourcebook: Agriculture and Rural development. The world Bank, Washington, DC, P. 169.
World Bank (2000). Philippines rural development and natural resource management: trends, strategy implementation and framework performance indicator system. The World Bank Rural Development and Natural Resources Sector Unit.