Factors responsible for defaulters of dairy credit: A discriminant function analysis approach

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Abstract: Credit is the most critical factor in stimulating private capital formation in agriculture. It is reported that 66.33% of the private investment in agriculture was facilitated through institutional finance. Studies suggest that the incidence of overdues in the agricultural credit system had been increasing over the years there by steadily eroding the commercial viability of the system in the past though the things have altered marginally during the nineties. The study based on primary data was carried out in Karnataka, India using Multistage Random Sampling. Discriminant function analysis was used for identifying factors responsible for discriminating defaulters from non-defaulters of dairy loans. The study revealed that important discriminating factors were per capita food expenditure, percentage of earning adults in the family, per capita income from dairy, percentage expenditure to total income and capital investment in dairying. While the first four factors were positively related to the higher repayment, the later was negatively related with the repayment. Further the model was used to predict whether a borrower is likely to be a non-defaulter or defaulter. The model correctly predicted 69% of defaulters and wrongly predicted 31% of defaulters. Similarly model was able to predict 72% of non-defaulters correctly as non-defaulters and 28% wrongly as defaulters. Overall model was successful in classifying 70% of the borrowers correctly. Thus model was found to be valid to predict whether an unknown borrower is likely to be defaulter, more precisely.

Key Words: Discriminant function, dairy credit, defaulters, non-defaulters

Introduction

Institutional credit, a vital factor for the success of Green Revolution, is also true for the dairy farmers. Credit is found to be the most critical instrument in increasing private capital investment in agriculture. Therefore, rural credit has been an area of policy intervention since long in India. In fact the main objective of bank nationalization in the year 1969 was primarily to ensure the flow of credit to the rural areas.

While credit lending is one side of the story, the recovery is also much important for the financial viability of the lending institutions and the sustainability of such lending. The prompt repayment of credit with interest is very important for recovery as well as to instill confidence among the lenders and is central for smooth functioning of institutional credit agencies, while mounting over dues adversely affect both the credit agencies and the farmers. The lending agencies generally were confronted with problem of assessing the financial position and credit worthiness of individual household in advancing loan. Efficient management of recovery of dues is of crucial importance and also the most complex of all problems associated with institutional credit. Agriculture loan default rates have been chronically high. The incidence of overdues in the agricultural credit system had been increasing over the years thereby steadily eroding the financial soundness of the system in the past, though the things have altered during the nineties (Gulati and Bathla, 2002). The situation was not quite different in case of dairy credit. It has been reported that repayment was as low as 6.5%, 17% and 42% by Regional Rural Banks, Cooperative Banks and Commercial banks respectively in some districts of Karnataka. (Vedamurthy, 2011). Even more, credit obtained from the institutional sources is reported to be used for onlending (Vedamurthy 2014).

Statement of the problem and objective

Thus for improving the effectiveness of dairy financing, there is a need to understand and identify the factors responsible for default in repayment, so that necessary measures could be taken to avoid default.
to formulate rational lending policy at regional level and reduce
the amount of over dues to a certain extent. Many aspects of non-
repayment of loans have been discussed at different levels but a
perspective analysis of the socio-economic factors, which account
for the intra-group variation in repayment performance are yet to
erase. Similarly it would go a long way in achieving the
objective of development through credit if perceptible socio-
economic criteria could be identified. However, it is necessary to
identify methods to motivate the borrowers to make them good
re-payers. The objective of the paper is to develop criteria for
classifying the borrowers into defaulters and re-payers of loan
on the basis of quantifiable socio-economic factors.

Methodology and data collection

This study involves both primary and secondary data. Primary
data on operational land holdings, number of milch animals,
income from dairying, off farm income, expenditure on food etc.,
were collected from the Shimoga Milk Zone of Karnataka (SMZ)
which includes three districts namely, Chitradurga, Davanagere
and Shimoga (Karamathullah, 2003). Out of three districts of
SMZ, Chitradurga district was selected randomly. Two talukas,
namely Chitradurga and Holalkere were again selected randomly
from this district. Out of six blocks of the Chitradurgatuluka, two
blocks namely, Chitradurga Kasaba and Bharamasagara were
selected randomly. Similarly two blocks, namely Holalkere
Kasaba and B.Durga were selected randomly from Holalkere
taluka. Thereafter two villages from each of the blocks were
selected randomly. Thus, in all eight villages were finally selected
for the present investigation. A complete enumeration of the eight
selected villages was carried out. Then the borrowers of dairy
loan were classified according to their institutional source of
financing. A sample of 160 borrowers was selected according to
probability proportion to the number of borrowers from different
sources. The final sample consisted of 63 borrowers from
Commercial Banks (CBs), 36 borrowers from Regional Rural
Banks (RRBs) and 61 borrowers from Self Help Groups (SHGs).
The primary data was collected in the year 2006-07 with
the help of pre-tested interview schedule, specially designed for
the study. Personal interview method was used to collect
information from households, who availed dairy loan facilities
under different development programmes since 2000.

Analytical frame work

Discriminant function analysis

To examine the relative importance of different factors in
discriminating between defaulters and non-defaulters, the
discriminant function analysis was used. The coefficient of
discriminant function measures the net effect of an individual
variable, when all other variables are taken as constant. The
discriminant function is helpful to the financial institutions to
understand the characteristics of prompt repayers before
advancing loan. This could also be used for developing a credit
screening instruments for banks to do a preliminary review of
loan applications to identify potential defaulters.

The discriminant function used for the present study was:
\[ Z = l_1X_1 + l_2X_2 + l_3X_3 + l_4X_4 + l_5X_5 + l_6X_6 + l_7X_7 + l_8X_8 \]

Where,
\[ Z = \text{Total discriminate score for defaulters and non-defaulters} \]
\[ X_1 = \text{Total Operational Holdings (Acres)} \]
\[ X_2 = \text{Number of milch animals} \]
\[ X_3 = \text{Per capita income from dairying (Rs.)} \]
\[ X_4 = \text{Per capita off-farm income (Rs.)} \]
\[ X_5 = \text{Expenditure to total income (%)} \]
\[ X_6 = \text{Capital investment in dairying (Rs.)} \]
\[ X_7 = \text{Percentage of earning adults} \]
\[ X_8 = \text{Per capita food expenditure other than dairy item (Rs.)} \]

\[ l_k = (K = 1, 2, \ldots, 8) \] are the coefficients of linear
discriminant function.

Fisher has given a method to devise the coefficients of
the above equation in such a way that if we were to make analysis
of variance of the Z value, the ratio of the variance between two
groups to that within the group would be a maximum.

Calculation of the discriminant function model involves
solution of the following 8 equations shown in the matrix notation:
\[ SL = D \]

\[ S = \begin{pmatrix}
    s_{11} & \cdots & s_{1K} \\
    \vdots & \ddots & \vdots \\
    s_{K1} & \cdots & s_{KK}
\end{pmatrix},
\]

\[ L = \begin{pmatrix}
    l_1 \\
    l_2 \\
    \vdots \\
    l_K
\end{pmatrix},
\]

\[ D = \begin{pmatrix}
    d_1 \\
    d_2 \\
    \vdots \\
    d_K
\end{pmatrix},
\]

Where,
\[ K = 1, 2, \ldots, 8 \]

\[ S = \text{Pooled dispersion matrix} \]

\[ L = \text{Vector of coefficient of discriminant function} \]
Step 3: Matrix was then inverted by Fisher’s method (Fisher, 1958) and inverted matrix \( C_{ik} \) prepared. Later, the difference between the means of the two samples for each variable \( X_i \) to \( X_k \), called \( d_{ik} \), was obtained by one-dimensional subtraction of mean score of non-defaulters and for mean score of defaulter \( X_k \) on the same dimension. From these values, a matrix for the product of mean difference \( (d_{ik}) \) was obtained.

Step 4: With the help of \( C_{ik} \) and \( d_{ik} \) matrices, the value of \( D^2 \) based on all the characteristics was obtained. In practice, this value was obtained by summing all the products of each cell of \( C_{ik} \) matrix and the corresponding cell of \( d_{ik} \) matrix.

Step 5: For testing the significance of \( D^2 \), the value so obtained was transformed into F-value by following formula :

\[
F = \frac{Na \times Nb \times (Na + Nb - P - 1)}{P \times (Na + Nb) \times (Na + Nb - 2)} x D^2
\]

Where, \( P \) is the number of characteristics, the F-value was tested for its significance with \( (P) \) and \( (Na + Nb - P - 1) \) degrees of freedom.

Step 6: The percentage contribution of individual characteristics to the total distance increase was calculated as:

1. The difference between means of two samples for each variable \( X_1, X_2, \ldots, X_k \) called \( d_1, d_2, \ldots, D \) were obtained. The coefficient of discriminant function was then multiplied by the difference between the means of two samples (dis).

2. The products of discriminant coefficients and difference between means of the two samples was multiplied by hundred and then divided by \( D^2 \) value which ultimately gave the percentage contribution of individual characteristics to the total distance measured.

Step 7: In order to predict whether a borrower is likely to be a defaulter or non-defaulter, following computations were made.

1. \( Z_i \) was calculated by multiplying the mean values of the significant characteristics to their respective coefficient for the group of non-defaulter and adding them.

2. Similarly \( Z_2 \) was calculated by multiplying the mean values of the significant characteristics to their respective coefficient for the group of defaulter and adding them.

3. \( \bar{Z} \) was calculated by adding \( Z_i \) and \( Z_2 \) and then divided by two \( = (Z_i + Z_2) / 2 \). The value so obtained was critical value \( () \) which then was used to classify the borrowers into one or the other group. If the individual \( Z_1 \) is greater than \( \), then the household categorized as defaults, otherwise non-defaulters.

Results and Discussion

Socio-economic characteristics of the borrowers are listed in the Table 1 along with the means and their mean differences for the
two groups of defaulters and non-defaulters. The discriminant function considering the socio-economic characteristics postulated in the above equation was fitted to the data of loan defaulters and non-defaulters (table 2). The discriminant function was tested for significance to examine whether or not the characteristics considered together were sufficiently discriminating between the groups of defaulters and non-defaulters. The significance of discriminant function is a test of hypothesis that there are no differences in the mean values of the chosen characteristics in the two populations of defaulters and non-defaulters. Wilks’ Lambda was used to test the significance of the discriminant function as a whole. Accordingly the value of Wilks’ Lambda was worked out and found to be 0.800481. With chi-square value of 34.27 at 8 degrees of freedom the discriminant function as a whole was significant at 1% level. This means that eight characters considered together were useful in classifying the borrowers into the groups of defaulters and non-defaulters.

To indicate the relative importance of characteristics in their power to discriminate between two groups, the percentage contribution to total distance was measured and the results are presented in the Table 2, based on the Mahalobis D². The results revealed that characteristics like per capita food expenditure (44%), percentage earning adults (33%), percentage expenditure to total income (11%), per capita income from dairy (11%) capital investment in dairying (~ 3%) were the major ones which led to classify borrowers into two groups of defaulters and non-defaulters.

The results showed that percentage of earning adults and per capita income from dairy had a positive relationship with the level of repayment. This suggests that households with higher income and higher earning adults in the family have less chance of becoming defaulters. These findings are in agreement with the findings of Afolabi (2002), Sinha and Dhaka (2005). However, variables like per capita food expenditure and percentage expenditure to total income were also found to be positively related with level of repayment, indicating that higher expenditure is associated with higher level of repayment. This was observed in the study area because the borrower households such as landless and marginal farmers whose expenditure was more than the gross income were found to have fewer overdue compared to other categories (table 4). Farmers belonging to these categories normally fear legal complications of defaulting and also do not want to lose further credit by the banks. Similar findings were obtained by Afolabi (2008), Gandhimathi and Vanitha (2009), while the results were in contrary to the findings of Maurya (1981) and Singh and Singh (1988).

The ‘t’ test was calculated for testing the mean difference between the groups for each variable. The variables, percentage earning and per capita food expenditure were found to be significant at 1% level, while other variables like, per capita income from dairy, percentage expenditure to total income and capital investment in dairying were significant at 5% level. Hence, these variables were the major characteristics, which discriminate the borrowers into defaulters and non-defaulters. Thus discriminant function was rerun by including only these variables to find out the relative importance of these variables in discriminating between the two groups. The new estimated discriminant function with significant mean values is given in table 3. The function was tested for significance to examine whether or not these characteristics considered together are significantly discriminating between the groups of defaulters and non-defaulters. The value of Wilks’ lambda was 0.805, with chi-square 33.74 with 5 degrees of freedom was significant at 1%. This means that averages of five characters considered together were useful in classifying the borrowers into the groups of defaulters and non-defaulters. Thus the difference in the groups was mostly oriented towards per capita food expenditure, percentage of earning adults, per capita income from dairy and percentage expenditure to total income and lower capital investment in dairying.

In order to know the relative importance of the characteristics in their power 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 presented in Table 3. The magnitude of the coefficient is an indicator of the relative importance. Variables with large coefficients viz, higher per capita food expenditure, higher percentage of earning adults, per capita income from dairy and higher percentage expenditure to income and lower capital investment in dairying contributed towards high value of Z, thus placing the borrowers in non-defaulter group.

The discriminant function was later used to predict whether a borrower is likely to be a non-defaulter or defaulter. The results are presented in the Table 5. Out of 81 actual non-defaulter households, the model correctly predicted 56 households as defaulters and wrongly predicted 23 defaulter households as non-defaulter. Thus, model could correctly predict 69.14% of defaulters and wrongly predicted 30.86% defaulters. Similarly 72.15% of non-defaulters were classified correctly as non-defaulters and 27.85% of non-defaulters were classified as defaulter. Overall model was successful in classifying 70% of the household correctly. Thus, model is found to be valid to predict whether an unknown borrower is likely to be defaulter, more precisely.

Conclusions

The study tried to establish a criterion wherein the banker can differentiate a priori, the dairy credit borrowers into potential defaulters and non-defaulters. For this various socio-economic variables were considered in developing a model using discriminant analysis. The model suggested that per capita food expenditure, percentage of earning adults in the family, per capita income from dairy, percentage expenditure to total income and capital investment in dairying were some of the important factors responsible for differentiating between defaulters and non-
### Table 1: Mean value of socio-economic variables of defaulters and non-defaulters

<table>
<thead>
<tr>
<th>Particulars</th>
<th>Mean values of non-defaulters (a)</th>
<th>Mean values of defaulters (b)</th>
<th>Pooled Mean (c)</th>
<th>Mean Difference (d) (d) = (b-a)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Operational Holdings (Acres)</td>
<td>3.86</td>
<td>5.17</td>
<td>4.51</td>
<td>1.31</td>
</tr>
<tr>
<td>Number of Milch Animals</td>
<td>1.48</td>
<td>1.39</td>
<td>1.44</td>
<td>-0.09</td>
</tr>
<tr>
<td>Per capita income from dairy (Rs)</td>
<td>4374</td>
<td>3661</td>
<td>4022</td>
<td>-713</td>
</tr>
<tr>
<td>Per capita off-farm income (Rs)</td>
<td>1194</td>
<td>737</td>
<td>968</td>
<td>-457</td>
</tr>
<tr>
<td>Per centage expenditure to total income</td>
<td>104</td>
<td>129</td>
<td>116</td>
<td>25</td>
</tr>
<tr>
<td>Capital Investment Dairying Rs)</td>
<td>6185</td>
<td>3285</td>
<td>4753</td>
<td>-2900</td>
</tr>
<tr>
<td>Percentage of earning adults</td>
<td>61.94</td>
<td>52.71</td>
<td>57.38</td>
<td>-9.23</td>
</tr>
<tr>
<td>Per capita food expenditure (Rs)</td>
<td>6039</td>
<td>6915</td>
<td>6471</td>
<td>876</td>
</tr>
</tbody>
</table>

### Table 2: Relative importance of socio-economic characteristics for defaulters and non-defaulters

<table>
<thead>
<tr>
<th>Socio-economic variables</th>
<th>Coefficients (lk)</th>
<th>Mean difference (dk)</th>
<th>Contribution of variable (lk*dk)</th>
<th>Percentage contribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Per capita food expenditure (Rs)</td>
<td>0.00050</td>
<td>876</td>
<td>0.44</td>
<td>44.00</td>
</tr>
<tr>
<td>Percentage of earning adults</td>
<td>-0.03550</td>
<td>-9.23</td>
<td>0.33</td>
<td>33.00</td>
</tr>
<tr>
<td>Percentage expenditure to total income</td>
<td>0.00431</td>
<td>25</td>
<td>0.11</td>
<td>11.00</td>
</tr>
<tr>
<td>Per capita income from dairy (Rs)</td>
<td>-0.00015</td>
<td>-713</td>
<td>0.11</td>
<td>11.00</td>
</tr>
<tr>
<td>Capital Investment Dairying Rs)</td>
<td>0.00001</td>
<td>-2900</td>
<td>-0.03</td>
<td>-3.00</td>
</tr>
<tr>
<td>Total Operational Holdings (Acres)</td>
<td>0.02216</td>
<td>1.31</td>
<td>0.03</td>
<td>3.00</td>
</tr>
<tr>
<td>Per capita off-farm income (Rs)</td>
<td>-0.00004</td>
<td>-457</td>
<td>0.02</td>
<td>2.00</td>
</tr>
<tr>
<td>Number of Milch Animals</td>
<td>0.12165</td>
<td>-0.09</td>
<td>-0.01</td>
<td>-1.00</td>
</tr>
<tr>
<td>Total</td>
<td>1.00</td>
<td></td>
<td>100.00</td>
<td>100.00</td>
</tr>
</tbody>
</table>

### Table 3: Relative importance of significant socio-economic characteristics for defaulters and non-defaulters

<table>
<thead>
<tr>
<th>Socio-economic variables</th>
<th>Coefficients (lk)</th>
<th>Mean difference (dk)</th>
<th>Contribution of variable (lk*dk)</th>
<th>Percentage contribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Per capita food expenditure (Rs)</td>
<td>0.00053</td>
<td>876</td>
<td>0.4643</td>
<td>47.22</td>
</tr>
<tr>
<td>Percentage of earning adults</td>
<td>-0.03740</td>
<td>-9.23</td>
<td>0.3452</td>
<td>35.27</td>
</tr>
<tr>
<td>Per capita income from dairy (Rs)</td>
<td>-0.00014</td>
<td>-713</td>
<td>0.0998</td>
<td>10.30</td>
</tr>
<tr>
<td>Percentage expenditure to total income</td>
<td>0.00381</td>
<td>25</td>
<td>0.0953</td>
<td>9.98</td>
</tr>
<tr>
<td>Capital Investment Dairying Rs)</td>
<td>0.00001</td>
<td>-2900</td>
<td>-0.0290</td>
<td>-2.78</td>
</tr>
<tr>
<td>Total</td>
<td>0.9755</td>
<td></td>
<td>100.00</td>
<td>100.00</td>
</tr>
</tbody>
</table>

### Table 4: Overdue of the sample households

<table>
<thead>
<tr>
<th>Land size category</th>
<th>Total credit</th>
<th>Overdues</th>
<th>% overdues</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land</td>
<td>10554</td>
<td>2422</td>
<td>22.95</td>
</tr>
<tr>
<td>Marginal</td>
<td>13871</td>
<td>4666</td>
<td>33.64</td>
</tr>
<tr>
<td>Small</td>
<td>13761</td>
<td>2966</td>
<td>21.55</td>
</tr>
<tr>
<td>Medium</td>
<td>13134</td>
<td>3561</td>
<td>27.11</td>
</tr>
<tr>
<td>Large</td>
<td>14795</td>
<td>6042</td>
<td>40.84</td>
</tr>
<tr>
<td>Total</td>
<td>13125</td>
<td>3649</td>
<td>27.80</td>
</tr>
</tbody>
</table>

### Table 5: Comparison of actual classification with predicted group of

<table>
<thead>
<tr>
<th>Actual Group</th>
<th>Predicted Group Membership</th>
<th>No. of cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-Defaulter</td>
<td>56(69.14)</td>
<td>81 (100.00)</td>
</tr>
<tr>
<td>Defaulter</td>
<td>22 (27.85)</td>
<td>79(100.00)</td>
</tr>
</tbody>
</table>
defaulter. While the first four factors were positively related to
the higher repayment, the latter was negatively related with the
repayment. Further the model was used to predict whether a
borrower is likely to be a non-defaulter or defaulter. The model
correctly predicted 69% of defaulters and wrongly predicted 31%
of defaulter. Similarly model was able to predict 72% of non-
defaulter correctly as non-defaulter and 28% wrongly as
defaulter. Overall model was successful in classifying 70% of
the borrowers correctly. Thus model was found to be valid to
predict whether an unknown borrower is likely to be defaulter,
more precisely. The results clearly demonstrated that the farmers
are not willful defaulters as they are prompt in repayment when
family income from dairy is high and when the numbers of earning
adults are more.

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