

Parameters Influencing the Farm Net Income in an Agrarian Distressed Area of India

Nikhilesh Bagade^{1,*}, Bakul Rao¹, S. B. Kedare², Mukul Yambal¹ & Shraddha Vekhande¹

¹CTARA office, IIT Bombay, Powai, Mumbai, PIN: 400076, India

²DESE office, IIT Bombay, Powai, Mumbai, PIN: 400076, India

*Corresponding author: CTARA office, IIT Bombay, Powai, Mumbai, India. PIN: 400076.
E-mail: nikhileshsd@gmail.com

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Abstract

Rural poverty in India is linked with agricultural earnings, which can be assessed with Farm Net Income (FNI). This study identified the parameters significantly affecting the FNI for Yavatmal, India, during 2016-17 and 2017-18. The R^2 values computed by Multivariable Linear Regression Analysis for explaining FNI are 73% and 79% for 2016-17 and 2017-18. In 2017-18, the FNI was influenced by household (HH) head education, working population in HH, operating farmland, agriculture machine usage, and livestock sale. This study can help farmers in their farm-decisions for improving FNI and policy makers for designing and implementation of farm policies and schemes.

Keywords: agrarian distress, agrarian crises, farm net income, parameters influencing farm net income

1. Introduction

The drastic changes in the agrarian system in the twentieth century have resulted in increased indebtedness of farmers leading to farmers' suicide in the recent past . In addition, the contribution of agriculture to the world's total GDP has reduced from about 8% in 1995, to about 3.9% in 2014 . Complexities involved in the interactions of agriculture with industrialization and liberalization of food and agricultural market provoked the agrarian distress that further manifested the economic and financial distress in agriculture sector . Changes in the agriculture sector are driven by economic growth and cost/price squeeze, technology change, public policies, and population pressure . Agrarian distress in developing countries has resulted in indebtedness and declining nutrition for the majority of the poor, which adversely affects employment opportunities and leads to declining income .

In India, privatization, liberalization, and globalization policies enhanced agrarian distress due to the increased dependency on the volatile agriculture market to purchase farm inputs and sell farm produce. The agricultural system is also affected by climate change, insufficient returns to meet household expenses, the vicious cycle of indebtedness, and increased risk of crop failure . Agrarian distress in the last two decades has resulted in a declining growth rate of food crop, and reduction in the share of agriculture in overall GDP. There is an increase in rural unemployment rates, farmers' suicide, farmers' indebtedness, and prices of agriculture inputs. All of these factors have contributed in widening the gap between non-agriculture and agriculture sector .

Various authors considered the parameters like agriculture labor, gross yield, gross production, agriculture GDP, input cost, and average debt while studying the agrarian economic distress . The cost of cultivation and earnings from farm produce were used in farm income analysis and for studying farm household economics . It is essential to identify the significant parameters affecting the crop earning and cost of cultivation, ultimately causing the agrarian distress. The farm net income (FNI) represents the overall cost of inputs for the farm and total earnings from the farm.

$$\text{Farm net income (FNI)} = \text{Farm income} - \text{Farm expenses} \quad (1)$$

$$\text{Farm income} = \text{Sum of the income from} \left(\begin{array}{l} \text{crop sell, animal based products,} \\ \text{insurance earned, rented out farm} \end{array} \right) \quad (2)$$

$$\text{Farm expenses} =$$

$$\text{Sum of expenses on} \left(\begin{array}{l} \text{crop cultivation, animal rearing, interest paid on loan,} \\ \text{paid insurance, farm rent, equipment maintenance} \end{array} \right) \quad (3)$$

The parameters affecting the FNI are not readily available in the literature. Hence the parameters used in defining different effects of agrarian distress are considered in the analysis for FNI. The parameters that significantly influence agrarian distress were identified from research articles related to farmers' suicide, loan, crop yield, farm household income, shift to nonfarm livelihood options, and change in land usage (Table 1). A total of 40 parameters were identified and are grouped under different categories like agricultural (13), demographics (7), environmental (4), financial (13), and social (3). It was found that 16 parameters affect

farmers' suicide, 14 parameters on loan procurement, 10 parameters on crop yield, 9 parameters on farm household income, 5 parameters on choosing of livelihood option, and 12 parameters on land usage decisions.

Table 1. Effects and Factors of Agrarian Distress

Category	Parameters X	Effects Y						
			Farmer's suicide Y01	Loan Y02	Crop yield Y03	Household income Y04	Change in livelihood options Y05	Land use decisions Y06
Agriculture	Land size owned	X01	■	■	■	■	■	■
	Total cultivated land	X02	■	■	■	■	■	■
	Cropping intensity	X03	■	■	■	■	■	■
	Irrigation facility	X04	■	■	■	■	■	■
	Livestock size	X05	■	■	■	■	■	■
	Labor	X06	■	■	■	■	■	■
	Wage labor	X07	■	■	■	■	■	■
	Pesticides	X08	■	■	■	■	■	■
	Fertilizers	X09	■	■	■	■	■	■
	Seed	X10	■	■	■	■	■	■
	Herbicide	X11	■	■	■	■	■	■
Demographic	Food storage capacity	X12	■	■	■	■	■	■
	Use of bullock	X13	■	■	■	■	■	■
	Family size	X14	■	■	■	■	■	■
	Education of household head	X15	■	■	■	■	■	■
	Occupation (farmer or farmer plus laborer)	X16	■	■	■	■	■	■
	Age of household head	X17	■	■	■	■	■	■
	Farming experience	X18	■	■	■	■	■	■
	Caste	X19	■	■	■	■	■	■
Environment	Gender	X20	■	■	■	■	■	■
	Location (rural or urban)	X21	■	■	■	■	■	■
	Disaster loss	X22	■	■	■	■	■	■
	Saline water intrusion	X23	■	■	■	■	■	■

Category	Parameters	Effects	Y					
			Farmer's suicide	Loan	Crop yield	Household income	Change in livelihood options	Land use decisions
	X		Y01	Y02	Y03	Y04	Y05	Y06
Financial	Waterlogging	X24						
	Household assets	X25	■					
	Farm income	X26	■	■				■
	Nonfarm income	X27	■	■				■
	Household efficiency	X28				■		
	Saving history	X29		■				
	Amount of saving	X30		■				
	Access to credit	X31			■			■
	Loan from formal sources	X32	■					
	Loan from non-formal sources	X33	■					
	Distance from formal source	X34		■				
	Food aid program	X35				■		
	Presence of pension/remittances	X36		■				
	Selling of local brewery	X37				■		
Social	Training provisions	X38						■
	Extension services	X39	■					
	Part of financial group	X40		■				

Shaded cells – significant factors for the listed effects. Farmers suicide parameters , Loan parameters , Crop yield parameters , Household income parameters , Change in livelihood option parameters , and Land use decision parameters .

Multivariable linear regression analysis (MLRA) helps identify the parameters influencing different effects of the agrarian distress . So, MLRA was used in the current study to identify the parameters significantly affecting the FNI. The data for the parameters was collected from Yavatmal district, Maharashtra, India and FNI computed. Yavatmal district was chosen because it has been facing the consequences of agrarian distress since the past twenty years.

2. Methodology

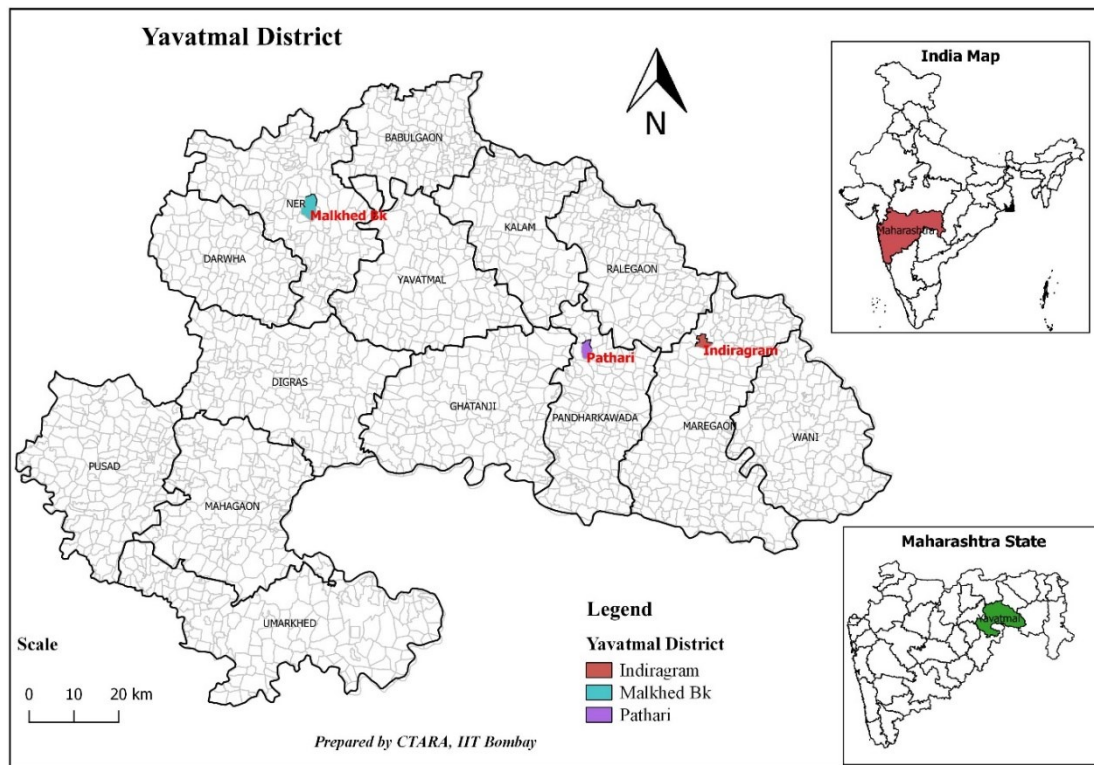


Figure 1. Yavatmal District Map

The 40 parameters identified in the literature (Table 1) are restructured for the study area. The questionnaire for data collection was designed based on the restructured parameters and the financial data required for computing FNI. A quota sampling method (note 1) helped to determine the cases in each predominant category and diversified the population. In Yavatmal, the predominant categories are tribal / non-tribal habitats and irrigated / non-irrigated land. For the survey, three representative villages, namely Pathari, Malkhed, and Indiragram, were identified in Yavatmal (Figure 1 and Table 2). A snowball-sampling method (note 2) was used to select farmers in the sampled village. Total 108 farm households were surveyed, representing the variations in family size, working age, education, livelihood options, and agriculture resources. The effect of rainfall patterns, pest attacks, weather conditions, and support from government schemes was captured by collecting data for two years, 2016-17 and 2017-18. In these years there was a drought, a crop loan waiver scheme, and a pest attack on cotton crop in Yavatmal, and the effect of these on FNI was captured.

The data cleaning removed the redundant entries, duplicate entries, missing data, and incorrect data. The directionality of the data was checked with the correlation coefficients among the outcome and explanatory variables. Multicollinearity among the explanatory variables was identified with the Variance Inflation Factor (VIF). The DFBETAs (difference in fits) test was applied to identify the possible outliers. The ordinary least square method was used to estimate the statistical model and goodness of fit. The backward elimination method

was used to finalize the model, and the finalized model was tested with the new set of values.

Table 2. Sampled Villages, Developed Based on the Census of India, 2011

	Indiragram	Malkhed	Pathari
Tehsil	Maregaon	Ner	Kelapur
Households	192	575	385
Population	760	2,319	1,241
Working population	68%	37%	57%
Literacy rate	Male (80%), Female (59%)	Male (91%), Female (77%)	Male (82%), Female (67%)
Majority population	ST (95%)	OBC (74%)	SC (39%), ST (17%), OBC and NT (44%)
Irrigated land	0%	70%	40%
Non-irrigated land	100%	30%	60%
Remarks	2nd and 3rd generation farmers, hilly terrain, got farmland in the land sealing act.	Black soil, large landholding	Mixed population, mixed soil type

3. Parameters Influencing Farm Net Income

3.1 Restructuring of Parameters

The 40 parameters identified (Table 1) needed restructuring given in Table 3 for agriculture and demographic parameters and in Table 4 for the environment, financial, and social parameters. Thus, the 40 parameters were restructured, resulting in 55 parameters. All the 55 parameters explained the FNI using the MLRA in the current study. The 55 parameters are grouped under different headings, namely -

- 1) Household (HH) parameters (details of HH head, family size, and major family asset) (Table 5)
- 2) Agriculture land (land owner-ship, operated land, soil type, and land under commercial crop) (Table 6)
- 3) Agriculture facilities (availability of manure, machines, and equipment) (Table 7), livestock (cattle distribution) (Table 7)
- 4) Livelihood (primary and secondary livelihood options as product trading, service providing, renting services, animal rearing, wage-earning, and farming) (Table 8)
- 5) Loan (from private bank and moneylender, microfinance groups, banks, and borrowing) and saving (amount saved and member of microfinance group) (Table 9)

Table 3. Restructuring of Parameters for the Selected Field Area – Agriculture and Demographic

Parameters	Required restructuring	
Agriculture	X01, X02	Rented land and land operating in sharing need to be added
	X03	Co-related with irrigation facility
	X04	Irrigation source and irrigation tools
	X05	Number of cows (old / new), bulls (old / new), buffaloes, and goats
	X06, X07	Daily labor and bonded labor. As A2 cost of cultivation has been considered
	X08, X09, X10, X11	In addition to this use of manure, machine cost, transport cost, services cost for the crop cultivation has considered.
	X12	Not significant
	X13	Use of bullock for tillage, transport, and manure.
Demographic	X14	Also need to consider male-female ratio, working population, working population in farm, average working age, and population taking education.
	X15	Up to schooling, up to SSC and HSC, and above HSC
	X16	All are farmers; hence, in additional nonfarm earning sources categories marked are trading, service providing, renting services, monthly earning jobs, and wage earning.
	X17, X18	Age of HH head is correlated with farming experience.
	X19	Agrarian distress is applicable in all the casts.
	X20	Male female ratio, number of working women

Refer Table 1 for parameter details

Table 4. Restructuring of Parameters for the Selected Field Area – Environment, Financial, and Social

Parameters	Required restructuring	
Environment	X21, X22, X23, X24	Yavatmal district is in Moderate rainfall agro-climatic zone. Hence, the effect of pest attack and precipitation is similar for all the farms. There are three types of soils, (A) deep black, (B) medium black, and (C) shallow course (reddish brown and brownish) in the Yavatmal district, and this needs to be considered.
		Waterlogging and salinity need to be considered with soil type.
Financial	X25, X26, X27, X28, X29, X30	All these points are considered in the financial statements given in Annexure A. Schemes related to HHs need to be considered.
	X31, X32, X33, X34	Types of credit source, loan amount, interest rate, and loan duration need to be considered. Distance from the credit source is a non-significant factor.
	X35	Food aid program applies to all farmers
	X36	This parameter will reduce the dependency on loan.
	X37	This parameter should be considered in nonfarm earning sources.
Social	X38, X39, X40	This parameter needs to be asked to the farmers to identify the source of information.

Refer Table 1 for parameter details

Table 5. Parameters Considered for Multivariable Linear Regression Analysis – Household

	No	Parameter	Unit	Description	
Household	Head	1	Age	Years	HH head is the person taking important decisions related to the family livelihood. The decisions of the HH head vary with age and experience.
		2	Education_SSC and/or HSC	1 / 0	These parameters affect the family livelihood decisions of the HH head.
			Education_higher than HSC		
	Population	4	Population		Number of people living and sharing HH resources. This parameter is linked with the earning and expenditure in HH.
		5	Working	Number	Number of people from the HH contributing to the livelihood activities. This parameter contributes to the earning and HH activities.
			Working_own farm		Number of people from the HH working on the own farm is linked with the input cost in the farm.
		7	Average working age	Years	Average age of the working population in the HH. This parameter is linked with the HH decisions and contribution in work.
			Telephone		1 / 0
		9	Motor cycle		

Refer Table 1 for parameter details

Table 6. Parameters Considered for Multivariable Linear Regression Analysis – Agriculture Land

	No	Parameter	Unit	Description
Agriculture land_own	10	Own		The agriculture land owned by the HH and availability of the irrigation facility is linked with the food availability in the HH and agriculture earning and expenditure.
	11	Own_irrigated		
	12	Own_non irrigated		
Agriculture land_in operation	13	In operation		The agriculture land in operation is all the cultivated land by the HH that includes own land in operation, rented land, land operated in sharing, land cultivated in kind, and encroached land. The total operated land and irrigation facility is linked with the agriculture expenditure and earning.
	14	Irrigated	Acre	
	15	Non irrigated		
	16	Soil type A	Soil type A (deep black soil), soil type B (medium black soil), and soil type C (shallow coarse) are linked with the expenditure and earnings in the farm.	
	17	Soil type B		
	18	Soil type C		
	19	Area under commercial crop		The crop cultivated for the earning from the farm is a commercial crop. The area under commercial crop is linked with the earning and expenditure.

Refer Table 1 for parameter details

Table 7. Parameters Considered for Multivariable Linear Regression Analysis – Agriculture Facilities and Livestock

No	Parameter	Unit	Description
20	Using manure		Use of manure in farm is linked with crop expenditure and crop production.
21	Having bullock cart		Bullock cart is used for material transport.
22	Having agriculture machines		Agriculture machines such as tractor, thresher, and feed chopper are directly linked with the input cost in farm.
23	Having irrigation equipment		Irrigation equipment is linked with agriculture production.
Agriculture facilities	24	Capacity to wait for good price	1 / 0 The farmer's capacity to wait for earning good crop price and not selling the crop with low price because of the loan repayment, lack of cash for transactions, not having crop storage capacity, and no market available nearby.
	25	Food_self grown_pulses	Growing pulses for self-consumption is related to HH consumption cost.
	26	Food_self grown_grain	Growing grains for self-consumption is related to HH consumption cost.
27	Cows		This is linked with manure availability, giving birth to a male calf, and selling milk products.
Livestock	28	Bulls	Number This is linked with the farm operations and availability of manure.
	29	Buffalo	These parameters are linked with the earning by animal and milk sell.
	30	Goat	These parameters are linked with the earning by animal sell.

Refer Table 1 for parameter details

Table 8. Parameters Considered for Multivariable Linear Regression Analysis – Livelihood

	No	Parameter	Unit	Description
Farm earning	31	Renting out the farm		Earning by renting the farm
	32	Crop insurance amount		Crop insurance amount earned
	33	Livestock_primary		Livestock earning is maximum among all the earning sources
	34	Livestock_secondary		One of the earning sources
	35	Farm income_primary		Farm earning is maximum among all the earning sources
	36	Farm income_secondary		One of the earning sources
Wage earning	37	Wage earning_primary		Wage earning is maximum among all the earning sources
	38	Wage earning_secondary		One of the earning sources.
	39	Product trading_primary		Earning by-product trading is maximum among all the earning sources
	40	Product trading_secondary	1/0	One of the earning sources.
	41	Renting services_primary		Earning by renting services is maximum among all the earning sources
	42	Renting services_secondary		One of the earning sources.
Service providing	43	Service providing_primary		Earning by service providing is maximum among all the earning sources
	44	Service providing_secondary		One of the earning sources.
	45	Monthly earning_primary		Monthly earning is maximum among all the earning sources
Monthly earning	46	Monthly earning_secondary		One of the earning sources.
	47	Other earning_primary		Other earning (other than listed above) is maximum among all the earning sources
	48	Other earning_secondary		One of the earning sources.

Refer Table 1 for parameter details

Table 9. Parameters Considered for Multivariable Linear Regression Analysis – Loan and Saving

	No	Parameter	Unit	Description
Loan	49	Loan_private	1 / 0	Loan taken from private bank
	50	Loan_microfinance group	1 / 0	Microfinance group loan
	51	Loan_bank	1 / 0	Loan taken from the bank
	52	Loan_borrowing	1 / 0	Borrowing without interest
	53	Pending liability	1 / 0	Old financial liabilities
Saving	54	Saving_microfinance group	1 / 0	Saving in microfinance group
	55	Saving_amount	₹	Amount saved.

Refer Table 1 for parameter details

There were four parameters among the selected 55 parameters that duplicated the information. The parameter *Agriculture land_own* is the sum of *Agriculture land_own_irrigated* and *Agriculture land_own_non irrigated*; any two of these parameters can explain the third parameter, and hence *Agriculture land_own_non irrigated* parameter was eliminated. Similarly, the parameters *Agriculture land_in operation_non irrigated*, *Agriculture land_in operation_soil type C*, and *Livelihood_farm income_secondary source* was eliminated. In the primary data collection for 2016-17, the data for two parameters *Livelihood_monthly earning_primary source* and *Livelihood_other earning_primary source* is not available, and hence these parameters are eliminated. Similarly, in the primary data collected for 2017-18, the data for three parameters *Livelihood_farm earning_crop insurance amount*, *Livelihood_monthly earning_primary source* and *Livelihood_other earning_primary source* is not available, and hence these parameters are eliminated.

The parameters having VIF values greater than ten are considered for multicollinearity, and such parameters were eliminated. In the primary data collected for 2016-17, multicollinearity existed for five parameters – *Agriculture land_own_irrigated*, *Agriculture land_in operation*, *Agriculture land_in operation_area under commercial crop*, *Livelihood_wage earning_primary source*, and *Loan_bank* and hence these parameters were eliminated. Similarly, in the primary data collected for 2017-18, multicollinearity existed for the three parameters *Agriculture land_in operation_soil type A*, *Agriculture land_in operation_area under commercial crop*, and *Livelihood_farm income_primary source*, and hence these parameters were eliminated.

After removing the parameters with repeating information, parameters having no data, and parameters having multicollinearity in the primary data collected, there were 44 and 45 parameters for 2016-17 and 2017 -18, respectively to explain FNI with MLRA.

3.2 Summary Statistics

The data was collected from 150 farm households (FHH) in which data from 16 FHHs was incomplete, biased, and defective; hence not considered in the analysis. From the remaining data of 134 FHHs, 80% data points (data from 108 FHHs) were considered in the MLRA for

explaining FNI. The 20% data points out of 134 FHHs (data from 26 FHHs) were considered to test the statistical model developed after MLRA to understand FNI. The data from five FHHs were identified as outliers with the DFBETAs method and were eliminated from the analysis. The summary of statistics for the remaining 103 FHHs are given in Table 10, Table 11, and Table 12.



Figure 2. Data Points Considered for Statistical Modeling

Table 10. Summary Statistics of the Parameters Considered in MLRA – Household and Agriculture Land

No#	2016-17					2017-18				
	Minimum	Maximum	Average	SD	% HH	Minimum	Maximum	Average	SD	% HH
1	25	60	43.5	8.6	100	26	61	44.5	8.6	100
2					50					50
3					6					6
4	2	11	4.9	1.7	100	2	11	4.9	1.7	100
5	1	8	3.4	1.4	100	1	8	3.5	1.4	100
6	1	4	2.1	0.9	99	1	4	2.1	0.9	99
7	28	58	39.5	6.0	100	29	59	40.4	6.0	100
8					86					86
9					36					36
10	2	20	6.9	4.4	86	2	20	6.9	4.4	87
11	3	20	6.8	4.0	40	3	20	6.8	4.0	41
12	2	16	5.9	3.4	54	2	16	5.8	3.3	54
13	2	30	7.3	4.6	99	2	21	6.9	3.8	100
14	1	30	7.8	5.4	40	1	18	6.7	3.8	41
15	1	17	5.7	2.8	72	1	16	5.9	2.9	71
16	1	30	7.0	4.8	64	1	18	6.6	3.9	63
17	1	14	5.6	2.5	39	1	16	5.4	2.5	41
18	2	9	4.2	2.0	13	2	9	4.3	2.2	13
19	2	30	6.7	4.5	99	2	20	6.5	3.8	100

No# – refer parameter numbers in Table 5 and Table 6, SD – standard deviation, and HH – household

Table 11. Summary Statistics of the Parameters Considered in MLRA – Agriculture Facilities, Livestock, and Livelihood

No#	2016-17					2017-18				
	Minimum	Maximum	Average	SD	% HH	Minimum	Maximum	Average	SD	% HH
20					81					81
21					52					52
22					5					5
23					45					46
24					17					13
25					22					22
26					67					66
27	1	7	2.2	1.2	57	1	7	2.4	1.4	58
28	1	7	2.4	1.2	72	1	7	2.4	1.2	74
29	1	4	2.2	1.1	9	1	3	2.0	0.9	8
30	1	15	4.2	3.6	28	1	25	4.6	4.9	27
31					4					4
32					2					0
33					1					1
34					24					21
35					56					48
36					44					52
37					30					36
38					23					18
39					6					5
40					6					7
41					3					4
42					1					2
43					2					1
44					13					16
45					3					7
46					14					12
47					0					0
48					4					3

No# – refer parameter numbers in Table 7 and Table 8, SD – standard deviation, and HH – household

Table 12. Summary Statistics of the Parameters Considered in MLRA – Loan and Saving

No#	2016-17					2017-18				
	Minimum	Maximum	Average	SD	% HH	Minimum	Maximum	Average	SD	% HH
49	2,000	200,000	39,292	39,237	39	2,000	300,000	41,823	56,570	33
50	3,000	90,000	26,342	18,913	33	5,000	90,000	26,111	17,425	26
51	12,000	550,000	128,750	148,098	19	15,000	300,000	84,535	64,540	27
52	1,200	50,000	24,700	16,792	6	20,000	20,000	20,000	0	1
53	3,000	720,000	115,171	185,816	24	3,000	576,000	119,738	165,925	25
54					63					64
55	600	37,700	6,064	7,655	75	600	37,700	6,242	8,370	77
FNI	-26,510	305,950	77,676	82,618	100	-20,780	280,050	73,229	70,365	100

No# – refer parameter numbers in Table 9, SD – standard deviation, HH – household, and FNI – Farm net income

3.3 Best Fit Model of MLRA to Explain FNI

The backward elimination method is used for identifying the best-fit model of MLRA to explain FNI. In the backward elimination method, the parameters having the highest p-value in the regression analysis are eliminated and the MLRA is repeated. This method is repeated until the adjusted R^2 value reaches its highest value.

3.3.1 Best fit model for 2016-17

In the best-fit model for 2016-17 data, the R^2 of 73% shows that variability of FNI_2016-17 is dependent on 15 parameters (Table 13). Out of these 15 parameters, nine parameters bring significant information (having a p-value less than 0.05) to explain the variability of FNI_2016-17, in which eight are significant positive value parameters and one is a significant negative value parameter. In the best-fit model for 2016-17, the ownership of agriculture machines (No# 22) decreases the FNI_2016-17 by ₹ 67,677. Moreover, farm income as a primary earning source (No# 35) increases the FNI_2016-17 by ₹ 75,773, monthly earning as a secondary earning source (No# 46) increases the FNI_2016-17 by ₹ 51,827, and irrigated agriculture land in operation (No# 14) increases the FNI_2016-17 by ₹ 5,210. The causality of the significant parameters is discussed in section 0. With the maximum magnitude of the standard value, it is identified that the farm income as a primary earning source (No# 35) (standard value 0.457) is the most significant parameter in the selected model. The best-fit model is tested using data of 26 FHHs not used for statistical model development. From the parity plot (Figure 3) of predicted FNI_2016-17 (computed by putting data of 26 FHHs in best-fit model) and actual FNI_2016-17 (FNI computed from surveyed data), it is observed that 17% of FHHs (out of 26 FHHs) are placed out of the 95% confidence interval.

Table 13. Best fit model of MLRA to explain FNI 2016-17

Goodness of fit 2016-17

<i>R²</i>	<i>Adjusted R²</i>	<i>Predicted R²</i>	<i>Standard Error</i>
0.727	0.682	0.616	46624.261

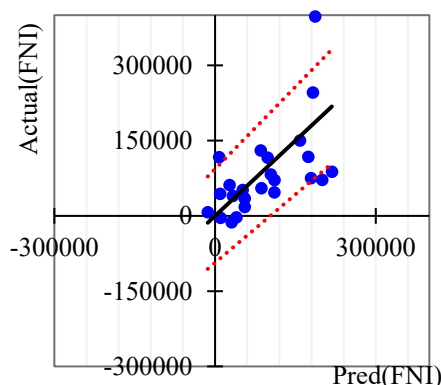
Analysis of variance 2016-17

<i>Source</i>	<i>DF</i>	<i>Sum of squares</i>	<i>Mean squares</i>	<i>F</i>	<i>Pr > F</i>
Model	15	5.16E+11	3.44E+10	15.837	0.000
Error	89	1.93E+11	2.17E+09		
Corrected Total	104	7.10E+11			

Model parameters 2016-17

<i>No#</i>	<i>Value</i>	<i>Standard error</i>	<i>t</i>	<i>Pr > t </i>	<i>Standardized coefficients</i>
I	-1.57E+04	1.27E+04	-1.239	0.218	
3	-2.75E+04	2.18E+04	-1.261	0.211	-0.078
14	5.21E+03	1.08E+03	4.847	0.000	0.323
20	-2.36E+04	1.57E+04	-1.506	0.136	-0.113
21	3.17E+04	1.12E+04	2.827	0.006	0.193
22	-6.77E+04	2.68E+04	-2.523	0.013	-0.175
26	8.71E+03	4.02E+03	2.166	0.033	0.156
28	-5.24E+03	7.48E+03	-0.700	0.485	-0.044
29	-5.26E+04	4.98E+04	-1.058	0.293	-0.088
32	7.58E+04	1.08E+04	7.027	0.000	0.457
35	1.62E+05	7.32E+04	2.208	0.030	0.191
42	5.18E+04	1.35E+04	3.838	0.000	0.221
46	1.31E+04	1.18E+04	1.114	0.268	0.075
49	-2.62E-01	1.57E-01	-1.668	0.099	-0.099
50	8.26E-01	3.25E-01	2.543	0.013	0.165
55	1.75E+00	7.03E-01	2.487	0.015	0.151

I – Intercept, No# – refer parameter number in Table 5, Table 6, Table 7, Table 8, and Table 9



.....Linear (Upper bound 95% (observation)),Linear (Lower bound 95% (observation))

Figure 3. Best fit model of MLRA to explain FNI 2016-17 – Parity plot explaining the relation between actual value and predicted value

3.3.2 Best fit model for 2017-18

In the best-fit model of FNI for 2017-18 data, the R^2 value of 79% says that the variability of FNI_2017-18 can be explained by 22 parameters (Table 14). Among the 22 parameters, 15 parameters bring significant information (having a p-value less than 0.05) to explain the variability of FNI_2017-18, in which eight are significant positive value parameters and seven are significant negative value parameters. In the best-fitted model, the wage-earning as primary source (No# 37) decreases the FNI_2017-18 by ₹ 54,264, the HH head education higher than HSC (No# 3) decreases the FNI_2017-18 by ₹ 52,602, and per unit increase in working population in the HH (No# 5) decreases the FNI_2017-18 by ₹ 11,880. Moreover, per unit increase in own irrigated agriculture land (No# 11) increases the FNI_2017-18 by ₹ 3,932, per unit increase in the population working on own farm (No# 6) increases the FNI_2017-18 by ₹ 19,288, and capacity to wait for good price (No# 24) increases the FNI_2017-18 by ₹ 37,277 (causality of the significant parameters is discussed in the section 0). With the maximum magnitude of the standard value, the wage earning as a primary earning source (No# 37) (standard value – 0.37) is the most significant parameter in the best-fitted model. The best-fitted model is tested using data of 26 FHHs not used for statistical model development. From the parity plot (Figure 4) of predicted FNI_2017-18 (computed by putting data of 26 FHHs in best-fit model) and actual FNI_2017-18 (FNI computed from surveyed data), it is observed that 23% of FHHs (out of 26 FHHs) are placed out of the 95% confidence interval.

Table 14. Best fit model of MLRA to explain FNI 2017-18

Goodness of fit statistics 2017-18

<i>R²</i>	<i>Adjusted R²</i>	<i>Predicted R²</i>	<i>Standard Error</i>
0.785	0.726	0.647	36827.071

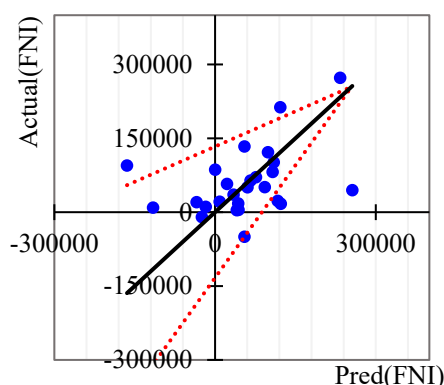
Analysis of variance 2017-18

<i>Source</i>	<i>DF</i>	<i>Sum of squares</i>	<i>Mean squares</i>	<i>F</i>	<i>Pr > F</i>
Model	22	3.97E+11	1.80E+10	13.290	0.000
Error	80	1.08E+11	1.36E+09		
Corrected Total	102	5.05E+11			

Model parameters 2017-18

<i>No#</i>	<i>Value</i>	<i>Standard error</i>	<i>t</i>	<i>Pr > t </i>	<i>Standardized coefficients</i>
I	7.58E+04	2.53E+04	2.999	0.004	
1	-6.58E+02	4.68E+02	-1.406	0.164	-0.080
2	-3.32E+04	9.40E+03	-3.527	0.001	-0.237
3	-5.26E+04	2.07E+04	-2.537	0.013	-0.176
5	-1.19E+04	5.38E+03	-2.210	0.030	-0.234
6	1.93E+04	7.19E+03	2.683	0.009	0.256
11	3.93E+03	1.27E+03	3.088	0.003	0.236
13	6.08E+03	1.47E+03	4.139	0.000	0.329
20	-3.46E+04	1.60E+04	-2.165	0.033	-0.195
21	2.92E+04	9.68E+03	3.016	0.003	0.208
22	-4.56E+04	2.23E+04	-2.045	0.044	-0.140
24	3.73E+04	1.23E+04	3.020	0.003	0.177
25	7.31E+03	3.26E+03	2.241	0.028	0.163
27	6.56E+03	3.89E+03	1.687	0.096	0.136
28	6.75E+04	3.89E+04	1.734	0.087	0.095
33	-5.43E+04	9.61E+03	-5.649	0.000	-0.372
37	-3.21E+04	1.93E+04	-1.665	0.100	-0.099
39	3.67E+04	1.36E+04	2.708	0.008	0.168
46	-2.21E+04	1.07E+04	-2.068	0.042	-0.132
49	-1.73E-01	1.15E-01	-1.511	0.135	-0.093
51	1.08E-01	9.00E-02	1.203	0.232	0.077
52	-3.37E+00	2.19E+00	-1.543	0.127	-0.094
53	1.70E-01	5.07E-02	3.360	0.001	0.236

I – Intercept, No# – refer parameter number in Table 5, Table 6, Table 7, Table 8, and Table 9



.....Linear (Upper bound 95% (observation)),Linear (Lower bound 95% (observation))

Figure 4. Best Fit Model of MLRA to Explain FNI 2017-18 – Parity Plot Explaining the Relation between Actual Value and Predicted Value

3.2 Significant Parameters

The behavior of FNI in the context of agrarian distress in Yavatmal, India, is different in the two studied years. The drought in the year 2017-18 with long dry spells and less rainfall, and lack of protective irrigation system, restricted the crop production and eventually the FNI. In addition, the pink ball worm attack on the cotton in 2017-18 has restricted the cotton production (>80% of farmers cultivate cotton in Yavatmal region). Besides, the loan waiver scheme launched by the Government in 2017-18 has provided some relief to the farmers from pending liabilities, gave access to procure loans at lower interest rates from banks, and eventually reduced the farm expenditures. The impact of drought, pest attack, and loan waiver scheme in the years of the study are clearly reflected in the selected statistical models (Table 15) in the form of significant parameters.

Table 15. Significant Parameters

No#	2	3	5	6	11	13	14	20	21	22	24	25	27	28	35	37	42	46	50	53	55
2016-17							+S	+S	-S					+S	+M		+S	+S	+S		+S
2017-18	-S	-S	-S	+S	+S	+S		-S	+S	-S	+S	-S	+S				-M	+S		+S	

No# – refer parameter number in Table 5, Table 6, Table 7, Table 8, and Table 9, +S – positive significant, -S – negative significant, +M – positive most significant, -M – negative most significant.

A total of 21 parameters have been finally identified to be significant for the study years and explained as below,

(2) *HH_head_education_SSC and/or HSC* and (3) *HH_head_education_higher than HSC*:

In the drought year (2017-18), the household head (HH) having education above secondary school certification (SSC) or higher secondary school certification (HSC) preferred to earn

from nonfarm livelihood sources. Hence, the decision taken by the HH head having education above SSC or HSC affects the FNI.

(5) HH_population_working and (6) HH_population_working_own farm:

In the drought year (2017-18), the working population preferred to earn from nonfarm livelihood sources and hence the FNI gets affected. The working population in their farms reduces labor costs and ensures careful farm management in a drought year (2017-18).

(11) Agriculture_land_own_irrigated, (13) Agriculture_land_in_operation, and (14) Agriculture_land_in_operation_irrigated:

In the case of drought and pest attack (2017-18), the total operating land and own irrigated land ensures the crop production and operating irrigated land became most significant for FNI.

(20) Agriculture_facility_using_manure, (21) Agriculture_facility_having_bullock_cart, (22) Agriculture_facility_having_agriculture_machines, (24) Agriculture_facility_capacity_to_wait_for_good_price, and (25) Food_self_grown_pulses:

The use of manure on a farm increases the expenses of transport and labor cost and the manure purchasing cost in some cases. In the drought year (2017-18), the crop production was decreased despite the use of manure. Moreover, the farmers having bullock carts are significant saving in the transport cost and conducting farm operations in time. The farmers having agriculture machines like tractors and threshers focused more on renting out the farm equipment and farm earning became secondary in such cases. In the drought year (2017-18), the increase in crop earnings by waiting for the good crop price becomes significant to increase FNI. The capacity to wait for a good crop price is linked with the loan amount and interest rate on the loan, household expenses, and monthly/weekly earning sources. In the drought year (2017-18), the pulses grown for self-consumption becomes significant as the overall crop production was reduced.

(27) Livestock_cows and (28) Livestock_bulls:

In the drought year (2017-18), farmers sold cows to overcome the deficit of crop income and hence the number of cows is significant for the change in FNI. In 2016-17, the bull ownership ensures timely tillage operations with reduced input cost and hence it is significant in changing FNI.

(35) Livelihood_farm_income_primary_source, (37) Livelihood_wage_earning_primary_source, (42) Livelihood_renting_services_secondary_source, and (46) Livelihood_monthly_earning_secondary_source:

In 2016-17, the farm income as primary earning source was the most significant parameter because the maximum share of earning of the farmers is from the farm and hence it was taken care of to earn maximum FNI. In the drought year, wage earning became the primary earning source and it was most significant in 2017-18. The focus of earning was shifted to wage earning as primary earning sources because of the drought. The parameters renting services

and monthly earning as secondary earning sources support the primary agriculture earning a livelihood and hence these parameters are significant to change FNI.

(50) Loan_microfinance group, (53) Pending liability, and (55) Saving_amount:

Most of the farmers before the loan waiver scheme (before 2017-18) are defaulters in the bank and hence they are dependent on the microfinance group loan in 2016-17 and hence it became significant in changing FNI. The pending liabilities were nullified in 2017-18 because of the loan waiver scheme and hence the defaulter farmers became regularized in the banks for procuring a new loan. The access to the low-cost loan (having less interest rate) ultimately increases the FNI. Moreover, the farmers' saving is useful in reducing the loan, purchasing the input material in time, and meeting household expenditure. The saved amount is ultimately significant in changing the FNI.

4. Conclusion

The data collected from the sampled farm households in the representative villages in Yavatmal, India, for two years 2016-17 and 2017-18 gives the variations in human resources (education and age of household head, family size, and working population), agriculture resources (land size, irrigation facility, and equipment), livestock, nonfarm livelihood options, and loan procurement. In addition, the variation in the collected data due to drought, pest attack, and loan waiver scheme was captured during the years the study was carried out. It was observed that in 2016-17, the FNI was affected by the operating irrigated land size, ease of farm operations with machines, having supportive earning sources (monthly earning and renting services), and easy loan procurement options and saved amount.

In 2017-18, the FNI was affected due to the pest attack, drought, and loan waiver scheme. In 2017-18, the FNI was influenced by the household head capacity to earn from nonfarm livelihood sources (household head education), the household's working population, operating farmland, use of agriculture machines, and livestock sell. Moreover, in 2017-18 it was identified that the focus of earning was shifted to the wage-earning sources, and the loan waiver scheme reduced the pending liabilities. Both these factors had a significant effect on FNI.

The identified significant parameters to improve the FNI can apply to the farmers in other villages in Yavatmal and, similar areas and situations. The interventions can be planned to improve the FNI by making effective changes in the significant parameters. Moreover, the significant parameters for improving FNI can be useful for the district planners and policymakers in designing and implementing farm-related policies and by the farmers in farm-related decision-making.

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Notes

Note 1. Quota sampling – A sampling method of gathering representative data from a group .

Note 2. In snowball sampling, the researcher locates a few persons of the population and then seeks their help to find out other respondents .

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