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An Analysis of Extent of Farm Mechanization in North Bank Plains Agro-Climatic Zone of Assam

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Authors' contributions

This work was carried out in collaboration among all authors. Author AR designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors IB and SDD managed the analyses of the study. Authors PKD and AS managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Farm mechanization plays an important role for effective utilization of inputs which ultimately increase the productivity of land and labour by reducing the drudgery in farm operations in agriculture. There has been a substantial progress in farm mechanization in India; however, its spread has not been equal in all states for various reasons. This study was conducted in Sonitpur and Udalguri districts under North Bank Plain Agro-Climatic Zone of Assam with 160 farmers to analyse the factors influencing the extent of farm mechanization across different farm size groups. The findings revealed that majority of marginal (64.86%), small (64.52%), medium (72%) and large (72.73%) farmers had medium level of farm mechanization. In case of pooled sample, majority (67.5%) of the respondents had medium level of farm mechanization. The findings of the study indicated that majority of the respondents belonged to medium mechanization category. It implies

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that concerned agencies/ organizations should put more efforts in accelerating the adoption of farm mechanization by the farmers for sustainable agricultural production. The findings of regression analysis showed that in case of pooled farmers 8 variables, viz. education level, occupational status, scientific orientation, economic motivation, cropping intensity, social participation, working capital availability and innovativeness significantly contribute towards the extent of farm mechanization. It implies that there is possibility for the extension agencies to manipulate these crucial factors in order to bring about desirable changes in the farm mechanization adoption behaviour of farmers.

Keywords: Farm mechanization; farm size; mechanization index; Sonitpur; Udalguri; Assam.

1. INTRODUCTION

The farming scenario of Indian agriculture is changing day by day. Initially, just after independence, Indian agriculture attributes as bullock based farming practices. Government of India has initiated various schemes to rebuild the farming system to adopt the advance science and technological practices in farming. The Indian scenario relating to use of farm machineries in various region differ significantly from each other. During last 53 years the average farm power availability in India has increased from about 0.30 kw/ha in 1960- 61 to about 2.02 kw/ha in 2013-14. Singh et al., [1]. 8000 tractors were produced in the year 1950-51, but in the year 2013, India produce 619,000 tractors accounting for 29% of world's output. Power tiller was introduced in the country in the sixties, but could not gain popularity like tractor due to its limitation in the field and on the road (Singh et al., 1999).The term "Farm mechanization" refers to the use of suitable tools, implements and machinery in agricultural activities with the aim of improving the productivity of farm labour and land. The tools, implements and machinery may need either human, animal, mechanical or electrical power, or a combination of these as the source of power. (Sims and Kienzle, 2016).

There has been a substantial progress in farm mechanization in India; however, its spread has been in the most uneven manner. Further, efforts to identify specific farm equipments, implements and machines, for different agro climatic zones, as well as their promotion in the respective zones has been lacking. The Ministry of Agriculture & farmer Welfare, Government of India is giving a focus to farm mechanization including R&D, custom hiring and better technology infusion, through its various schemes. But this progress of mechanization shows that mechanization of agriculture in India is very much confined among the rich farmers only and the small and marginal farmers remain totally untouched. Moreover, the growth of farm mechanization in India in comparison to that of advanced countries is found not very significant. Again whatever farm mechanization that has been reported, it is very much confined among the states like Punjab, Haryana and Western Uttar Pradesh, whereas other states could not reap much benefit from it.

In north-eastern states, the level of mechanization is extremely low and a good number of reasons are behind this. Factors such as hilly topography, high transportation cost, lack of state financing and other financial constraints due to socio-economic conditions and dearth of agricultural machinery manufacturing industries have hindered the growth of farm equipment sector within these states. Farm power, available at 0.66 HP/ha, in Assam is meager. Most of the available power also comes from drought animal (about 80 percent). In spite of state government plan to increase the farm power availability to 1.30 HP/ha by the end of 11th five year plan, animal power will remain a major source of farm power in Assam, especially for small-scale farmers. Therefore the question of what level of technology is to be adopted for an effective farm mechanization programme is of utmost importance especially in the context of use of machinery in small farms Barua and Das, [2]. In case of north-eastern region, Department of Agriculture and Farmers Welfare is implementing a scheme for Promoting Agricultural Mechanization through "Outsourcing of training and demonstrations of newly developed equipments". Beside above interventions, the Department is promoting Farm Mechanization by making agricultural equipment available among farmers at cheaper rates. A level of 25-50% subsidy on procurement cost is made available under revised "Macro Management of Agriculture (MMA)" scheme for different categories of equipment [3]. In addition, the Govt. of Assam has launched a new Scheme " Chief Minister *Samagra Gramyana Unnayan Youjana* (CMSGUY)" to be implemented over a period of five years from 2016-17 and culminating in the

year 2021-22 with an objective to achieve desired growth of Agricultural Mechanization by providing one Tractor to each revenue village . As a result of different programmes implemented by the Government of India, State Government over the years and equal participation from Private Sector, the level of mechanization has been increasing steadily over the years. Labour availability crisis along with the need to ensure food security in the country, the benefits of farm mechanization makes it a crucial component of shaping the future of the Indian agriculture. Keeping these facts in view, the present study was undertaken to analyse the factors influencing extent of farm mechanization across different farm size groups in North Bank Plains Agro-Climatic Zone of Assam.

2. METHODOLOGY

The present study was conducted in Udalguri and Sonitpur districts selected at random under North Bank Plain Agro Climatic Zone of Assam. A proportionate-cum-random sampling (probability proportionate to size) technique was followed for selection of 160 respondents which constituted the sample for the study. Data for the study were collected through personal interview method with the help structured schedule. The collected data are analyzed and interpreted using statistical measures like percentage, frequency, mean, standard deviation and coefficient variation, correlation and regression.

In the present study farm mechanization was measured with the help of Mechanization Index (MI) as suggested by Nowacki, 1974 [4] and Singh, 2006. Mechanization index (MI) was expressed the percentage of machine work (E_M) to the sum of manual (E_H), animal (E_A) and machine work (E_M) expressed in energy units.

A mechanization index based on the matrix of use of animate and mechanical energy inputs can be expressed as follows.

$$MI_E = \frac{E_M}{E_T} = \frac{E_M}{E_H + E_A + E_M} \times 100\%$$

Where,

MI_E = Mechanization Index (%)
E_M = Sum of averages of all mechanical operational works of the machine in kWhr/ha
E_T = Sum of all average work outlays in kWhr/ha by animals (E_A), human (E_H), and tractor powered machines (E_M).

Based on the mean ($\overline{x}$) and standard deviations (σ) of the total mechanization index score obtained by the respondent were classified into following three categories:

In order to analyze the factors influencing extent of farm mechanization, the correlation of the selected independent variables with farm mechanization was found out with the help of Pearson's Product-Moment Correlation Coefficient(r). A total of 17 independent variables viz., age, education level, family type, family size, social participation , occupational status, degree of information exposure, size of operational land holding, working capital availability, gross annual income, risk orientation, scientific orientation, economic motivation, innovativeness, labour availability, credit seeking behavior and cropping intensity were selected for examining their relationship with extent of farm mechanization.

3. RESULTS AND DISCUSSION

3.1 Extent of Farm Mechanization across Different Farm Size Groups

To assess the extent of farm mechanization, a mechanization index was worked out. Mechanization index was expressed the percentage of machine work (E_M) to the sum of manual (E_H), animal (E_A) and machine work (E_M) expressed in energy units.

Table 1 reveals that in case of pooled farmers; majority of the respondents (67.50%) belonged to medium mechanization category, followed by 22.5 per cent to low mechanization category and remaining 10 per cent belonged to high mechanization category. As regards marginal farmers; majority of the respondents (64.86%) belonged to medium mechanization category, followed by 24.32 per cent to low mechanization category and remaining 10.81 percent belonged to high mechanization category. As regards small farmers; 64.52 per cent were medium mechanization category. A sizeable proportion of them (24.19%) had low mechanization status. Only 11.29 per cent of them were highly mechanized. In case of medium farmers; 72 per cent of the respondents belonged to the medium mechanization category followed by 20 per cent of them belonged to low mechanization category. Only 8 percent of the respondent belonged to high mechanization category. As regards large farmers; majority of the respondents (72.73%) belonged to medium mechanization category,

followed by 18.18 per cent to low mechanization category and remaining 9.09 percent belonged to high mechanization category.

The highest mean mechanization score (0.94) was obtained for medium and large farmers and lowest (0.89) for marginal farmers. All the mean scores indicated medium level of farm mechanization. The probable reason of above finding might be that the farmers had good educational status, medium level of economic motivation, medium level of availability of working capital. The values of coefficients of variation indicated that the respondents were highly homogeneous with respect to their farm mechanization.

Chart 1. Classified into following three categories

Sl. No.	Categories	Range
1.	Low farm mechanization	Up to $(\bar{x}-1\sigma)$
2.	Medium farm mechanization	$(\bar{x}-1\sigma)$ to $(\bar{x}+1\sigma)$
3.	High farm mechanization	Above $(\bar{x}+1\sigma)$

Table 1. Distribution of respondents according to extent of farm mechanization (n=160)

Category	MI Range	Marginal (%)	Small (%)	Medium (%)	Large (%)	Total (%)
Low mechanization	0.87-0.90	9 (24.32)	15 (24.19)	10 (20)	2 (18.18)	36 (22.5)
Medium mechanization	0.91-0.96	24 (64.86)	40 (64.52)	36 (72)	8 (72.73)	108 (67.5)
High mechanization	0.97-0.98	4 (10.81)	7 (11.29)	4 (8)	1 (9.09)	16 (10)
Total		37 (100.00)	62 (100.00)	50 (100.00)	11 (100.00)	160 (100.00)
Mean		0.89	0.93	0.94	0.94	0.93
SD		0.01	0.03	0.02	0.02	0.03
C.V		1.84	3.19	2.15	2.30	3.22

** Figures within parenthesis indicate percentage*

Table 2. Major farm machineries owned by farmers across different farm size

Sl. No.	Equipment/ Machineries	Marginal (37)	Small (62)	Medium (50)	Large (11)	Total farmers (160)
1.	Tractor	-	1	3	2	6
2.	Power tiller	-	2	6	5	13
3.	Country plough	10	28	35	8	81
4.	MB Plough	1	12	15	6	34
5.	Cultivator	2	10	9	5	26
6.	Rotavator	-	3	7	4	14
7.	Disc plough	2	7	9	3	21
8.	Leveller	1	5	5	3	14
9.	Puddler	-	1	5	2	8
10.	Harrow	-	4	6	3	13
11.	Power weeder	-	-	2	1	3
12.	Wheel hoe	20	42	46	9	117
13.	Electric pump sets	2	3	6	7	18
14.	Diesel pump sets	-	8	10	5	23
15.	Knapsack sprayer	37	62	50	11	160
16.	Paddy thresher	-	-	1	-	1

Table 2. indicates about the major farm machineries that were owned by sample farmers across different farm size. A total of 6 farmers were found to own tractor. Out of which 3 were medium, 1 was small and 2 were belonged to large category farmers. A total of 13 farmers were found to own power tiller. Out of which 2 were small, 6 were medium and 5 were belonged to large farmers. A sizeable (81) of the sample farmers were found to own country plough. Out of which 10 were marginal, 28 were small, 35 were medium and 8 were belonged to large farmers. A total of 34 farmers were found to own MB plough. Out of which 1 was marginal, 12 were small, 15 were medium and 6 were belonged to large farmers. A total of 26 farmers were found to own cultivator. Out of which 2 were marginal, 10 were small, 9 were medium and 5 were belonged to large farmers. A total of 14 farmers were found to own rotavator. Out of which 3 were small, 7 were medium and 4 were belonged to large farmers. A total of 21 farmers were found to own disc plough. Out of which 2 were marginal, 7 were small, 9 were medium and 3 were belonged to large farmers. A total of 14 farmers were found to own leveller. Out of which 1 was marginal, 5 were small, 5 were medium and 3 were belonged to large farmers. A total of 8 farmers were found to own puddler. Out of which 1 was small, 5 were medium and 2 belonged to large farmers. A total of 13 farmers were found to own harrow. Out of which 4 were small, 6 were medium and 3 belonged to large farmers. A total of 3 farmers were found to own harrow. Out of which, 2 were medium and 1 belonged to large farmers. Majority (117) of sample farmers were found to have wheel hoe. Out of which 20 were marginal, 42 were small, 46 were medium and 9 belonged to large farmers. A total of 18 farmers were found to have electric pump sets. Out of which 2 were marginal, 3 were small, 6 were medium and 7 belonged to large farmers. A total of 23 farmers were found to own diesel pump sets. Out of which 8 were small, 10 were medium and 5 belonged to large farmers. All the sample 160 farmers were found to have Knapsack sprayer. Out of which 37 were marginal, 62 were small, 50 were medium and 11 belonged to large farmers. Only 1 medium farmer was found to owned paddy thresher.

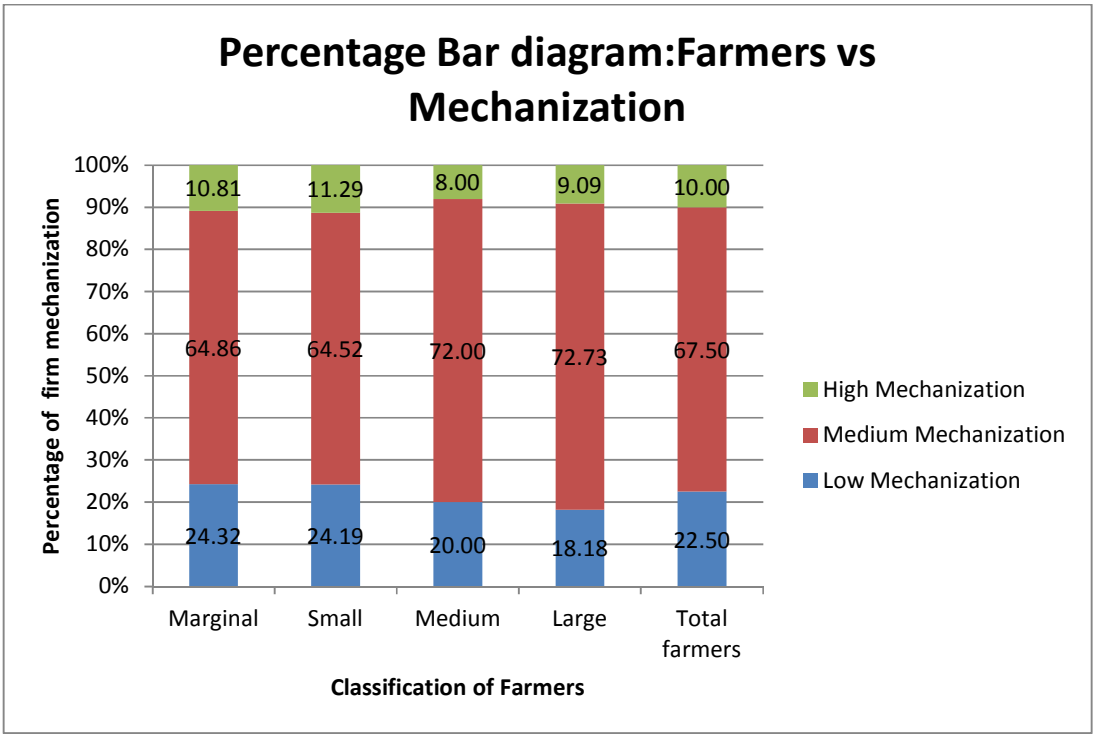

Fig. 1. Distribution of respondents according to extent of Farm Mechanization

Table 3. Relationship between extent of farm mechanization and selected independent variables

Sl. no.	Selected independent variables	Marginal farmers (n=37)		Small farmers (n=62)		Medium farmers (n=50)		Pooled sample (n=149)	
		r value	t value	r value	t value	r value	t value	r value	t value
X1	Age	-0.058	0.347	0.027	0.212	-0.018	0.126	-0.041	0.494
X2	Education level	0.517**	3.576	0.552**	5.119	0.634**	5.683	0.573**	8.467
X3	Family type	0.025	0.148	-0.033	0.255	-0.127	0.888	-0.058	0.713
X4	Family size	0.062	0.369	-0.131	1.021	-0.057	0.401	-0.056	0.687
X5	Social participation	0.164	0.983	0.450**	3.902	0.588**	5.038	0.442**	5.982
X6	Occupational status	0.438**	2.881	0.218	1.732	0.422**	3.225	0.367**	4.785
X7	Degree of information exposure	-0.318	1.985	0.119	0.926	0.071	0.492	0.212**	2.637
X8	Operational land holding	0.062	0.366	0.113	0.877	0.144	1.009	0.138	1.699
X9	Working capital availability	-0.156	0.938	-0.263*	2.110	0.047	0.331	-0.194*	2.403
X10	Gross annual farm income	0.066	0.394	0.032	0.253	0.226	1.608	0.067	0.823
X11	Risk orientation	0.247	1.511	-0.098	0.765	0.255	1.830	0.053	0.645
X12	Scientific orientation	0.328*	2.053	0.432**	3.709	0.790**	8.943	0.577**	8.565
X13	Economic motivation	0.551**	3.906	0.513**	4.630	0.694**	6.687	0.612**	9.386
X14	Innovativeness	0.386*	2.479	0.353**	2.921	0.382**	2.864	0.353**	4.579
X15	Labour availability	-0.277	1.713	0.002	0.017	-0.105	0.733	-0.212**	2.634
X16	Credit seeking behavior	0.092	0.548	0.379**	3.172	0.486**	3.858	0.367**	4.788
X17	Cropping intensity	0.676**	5.434	0.531**	4.852	0.740**	7.628	0.635**	9.969

*** Highly Significant at 0.01 level of probability; * Significant at 0.05 level probability; Degrees of freedom= (n-2) for all cases*

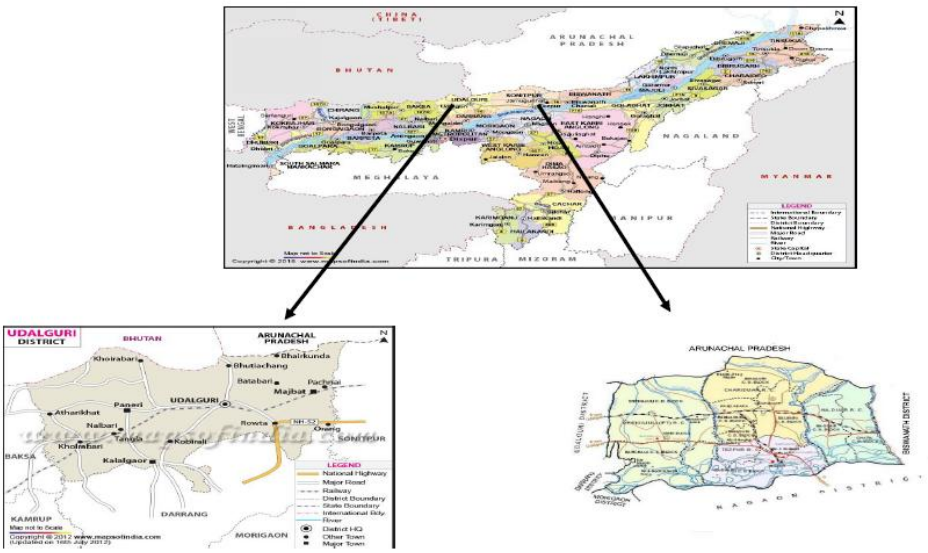

Fig. 2. Map of study area

3.2 Factors Influencing Extent of Farm Mechanization

The results of the correlation analysis of marginal, small, medium and pooled farmer respondents are presented in the Table 3**.** Due to the inadequate number of respondents in large farms, the Pearson Product- Moment Correlation Co-efficient(r) could not be carried out.

Findings of correlation analysis indicated that in case of marginal farmers, out of 17 independent variables 6 independent variables were significantly correlated with the extent of farm mechanization. All the 6 variables, viz., education level (0.517), occupational status (0.438), economic motivation (0.551), cropping intensity (0.676), scientific orientation (0.328) and innovativeness (0.386) were positively correlated with extent of farm mechanization and found to be highly significant at 0.05 and 0.01 level.

In respect of small farmers, 8 independent variables were significantly correlated with the extent of farm mechanization. The variables education level (0.552), social participation (0.450), scientific orientation (0.432), economic motivation (0.513), innovativeness (0.353), credit seeking behavior (0.379) and cropping intensity (0.531) were positively correlated and found to be highly significant at 0.01 level, whereas only working capital availability (-0.263) was negatively correlated with extent of farm mechanization and found to be significant at 0.05 level. In regard to medium farmers, 8 independent variables were significantly correlated with the extent of farm mechanization. The variables education level (0.634), social participation (0.588), occupational status (0.422), scientific orientation (0.790), economic motivation (0.694), innovativeness (0.382), credit seeking behavior (0.486) and cropping intensity (0.740) were positively correlated with extent of farm mechanization and highly significant at 0.01 level.

As regard to pooled sample of farmers, 11 independent variables were significantly correlated with the extent of farm mechanization. The variables education level (0.573), social participation (0.442), occupational status (0.367), degree of information exposure (0.212), scientific orientation (0.577), economic motivation (0.612), innovativeness (0.353), credit seeking behavior (0.367) and cropping intensity (0.635) were positively correlated and found to be highly significant at 0.01 level, whereas labour availability (-0.212) was negatively correlated with extent of farm mechanization and highly significant at 0.01 level. Working capital availability (-0.194) was also negatively correlated with extent of farm mechanization and significant at 0.05 level. The findings of the present study are supported by the findings of Bhattarai and Narayanmoorthy [5], Olaoye [6], Mohammed et al. (2014), Kazemi et al. [7] and Kalita [8]

The variables which were found to have significant correlation with the extent of farm mechanization were further selected for multiple linear regression analysis with a view to determining the relative influence of those variables in predicting the variation in the extent of farm mechanization. The prediction power of multiple regressions was estimated with the help of coefficient of multiple determination (R^2) and adjusted R^2. It is vivid from the Table 4 that as regard to marginal farmers, out of 6 independent variables, only 3 variables were found to contribute significantly towards the extent of farm mechanization. The variables *viz.* education level (0.004), scientific orientation (0.001) were positively correlated and found to be significant with extent of farm mechanization at 0.05 level. Whereas, cropping intensity (0.02) was positively correlated and found to be highly significant with extent of farm mechanization at 0.01 level. The value of R^2 (0.688) indicated that six independent variables selected for the study were efficient in predicting and could predict 68.80 per cent of the variation in the extent of farm mechanization. The adjusted R^2 (0.626) indicated the actual measure of R^2 which meant that all the variables included in the regression equation was not equally efficient in explaining the variation in the dependent variable. The value of adjusted R^2, thus, indicated that the independent variables fitted in the regression equation could actually explain 62.60 per cent of the variation in the extent of farm mechanization. In respect of small farmers, out of 8 independent variables, only 3 variables were found to contribute significantly towards the extent of farm mechanization. The variable education level (0.005) was positively correlated and found to be highly significant with extent of farm mechanization at 0.01 level. Whereas, economic motivation (0.001) and cropping intensity (0.002) were positively correlated and found to be significant with extent of farm mechanization at 0.05 level. The value of R^2 (0.707) indicated that 8 independent variables selected for the study were efficient in predicting and could predict 70.70 per cent of the variation

Table 4. Relative contribution of selected independent variable towards farm mechanization

Sl. No.	Independent Variables	Marginal farmers (n=37)			Small farmers (n=62)			Medium farmers (n=50)			Pooled sample (n=149)		
		bi	S.E of bi	t value	bi	S.E of bi	t value	Bi	S.E of bi	t value	Bi	S.E of bi	t value
1	**Age**	-	-	-	-	-	-	-	-	-	-	-	-
2	**Education level**	0.004	0.002	2.198*	0.005	0.001	4.696**	0.003	0.001	2.653*	0.004	0.0007	5.562**
3	**Family type**	-	-	-	-	-	-	-	-	-	-	-	-
4	**Family size**	-	-	-	-	-	-	-	-	-	-	-	-
5	**Social participation**	-	-	-	0.003	0.002	1.451	0.003	0.002	1.566	0.002	0.001	2.072*
6	**Occupational status**	0.003	0.002	1.294	-	-	-	0.005	0.002	2.790**	0.003	0.001	3.076**
7	**Degree of information exposure**	-	-	-	-	-	-	-	-	-	0.0008	0.0005	1.499
8	**Operational land holding**	-	-	-	-	-	-	-	-	-	-	-	-
9	**Working capital availability**	-	-	-	-0.01	0.0001	1.046	-	-	-	-0.0001	0.00005	2.001*
10	**Gross annual farm income**	-	-	-	-	-	-	-	-	-	-	-	-
11	**Risk orientation**	-	-	-	-	-	-	-	-	-	-	-	-
12	**Scientific orientation**	0.001	0.007	2.228*	0.001	0.0007	2.002	0.002	0.0007	3.237**	0.002	0.0004	4.999**
13	**Economic motivation**	0.001	0.001	1.133	0.001	0.0007	2.356*	0.0009	0.0008	1.001	0.001	0.0004	2.852**
14	**Innovativeness**	0.004	0.003	1.217	0.003	0.002	1.580	0.005	0.003	1.813	0.003	0.001	2.113*
15	**Labour availability**	-	-	-	-	-	-	-	-	-	-0.001	0.001	0.922
16	**Credit seeking behavior**	-	-	-	0.002	0.001	1.234	0.0004	0.001	0.301	0.001	0.0007	1.353
17	**Cropping intensity**	0.02	0.007	3.284**	0.002	0.0007	2.458*	0.000	0.00009	3.009**	0.0002	0.00004	6.148**
	R2	0.688			0.707			0.856			0.771		
	Adj. R^2	0.626			0.663			0.827			0.752		

*** Highly Significant at 0.01 level of probability * Significant at 0.05 level of probability*

in extent of farm mechanization. The adjusted R^2 (0.663) indicated the actual measure of R^2 which meant that all the variables included in the regression equation was not equally efficient in explaining the variation in the dependent variable. The value of adjusted R^2, thus, indicated that independent variables fitted in the regression equation could actually explain 66.30 per cent of the variation in the extent of farm mechanization. In case of medium farmers, out of 8 independent variables, only 4 variables were found to contribute significantly towards the extent of farm mechanization. The variables *viz.* occupational status (0.005), scientific orientation (0.002) and cropping intensity (0.0002) were positively correlated with extent of farm mechanization and found to be highly significant at 0.01 level. Whereas, only education level (0.003) was positively correlated with extent of farm mechanization and significant at 0.05 level. The value of R^2 (0.856) indicated that 8 independent variables selected for the study were efficient in predicting and could predict 85.60 per cent of the variation in the extent of farm mechanization. The adjusted R^2 (0.827) indicated the actual measure of R^2 which meant that all the variables included in the regression equation was not equally efficient in explaining the variation in the dependent variable. The value of adjusted R^2, thus, indicated that the independent variables fitted in the regression equation could actually explain 82.70 per cent of the variation in the extent of farm mechanization. As regard to pooled sample of farmers, out of 11 independent variables, 8 variables were found to contribute significantly towards the extent of farm mechanization. The variables *viz.* education level (0.004), occupational status (0.003), scientific orientation (0.002), economic motivation (0.001) and cropping intensity (0.0002) were positively correlated with extent of farm mechanization and highly significant at 0.01 level. Whereas, the variables *viz.* social participation (0.002), working capital availability (-0.0001) and innovativeness (0.003) were positively correlated with extent of farm mechanization and significant at 0.05 level. The value of R^2 (0.771) indicated that 11 independent variables selected for the study were efficient in predicting and could predict 77.10 per cent of the variation in the extent of farm mechanization. The adjusted R^2 (0.752) indicated the actual measure of R^2 which meant that all the variables included in the regression equation was not equally efficient in explaining the variation in the dependent variable. The value of adjusted R^2, thus, indicated that the independent variables fitted in the regression equation could actually explain 75.20 per cent of the variation in the extent of farm mechanization.

4. CONCLUSION

The study indicates that there was substantial gap in extent of farm mechanization in sampled districts. The findings of the study revealed that majority of the respondents belonged to medium mechanization category. It implies that concerned agencies/ organizations should put more efforts in accelerating the adoption of farm mechanization by the farmers for sustainable agricultural production. The findings of regression analysis showed that in case of pooled farmers that variables such as education level, occupational status, scientific orientation, economic motivation, cropping intensity, social participation, working capital availability and innovativeness significantly contribute towards the extent of farm mechanization. It implies that there is possibility for the extension agencies to manipulate these crucial factors in order to bring about desirable changes in the farm mechanization adoption behaviour of farmers. On the basis of current findings, the study ultimately would help the policy maker to take appropriate measures for mechanization adoption amongst the farmers of NBPZ which will boost up the agricultural sector in the study area in particular and in the state of Assam as a whole.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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