Heterogeneity in Diffusion of Better Farm Practices across Different Types of Farmers in the Brahmaputra Plain of Assam

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Abstract

The non-farm employment in the rural areas of the state has grown from 35 per cent in 1999-2000 to 40 per cent in 2011-12. It is against this backdrop; this study examines the extent of diversification of farmers in terms of their income sources and the nature of utilization of farm land by farmers of different types. The present paper throws light on the extent of diversification of farm households towards activities other than cultivation in the Brahmaputra Plain of Assam and compares the extent of diffusion of better farm practices between pure farmers and mixed income farmers. Based on field study data collected from nine villages in the Brahmaputra plain, it has been found that pure farmers have more mechanized farming practices than the mixed income farmers in terms of adoption and use of irrigation machinery while there is no such significant difference between them in case of ploughing mechanization.

1. Introduction

In India cultivation is the principal source of income for 63.5 per cent of farm households (Some Characteristics of Agricultural Households in India 2013). Since cultivation is the only source of income for a segment of farmers while for the rest it is one among the sources of their income, we cannot expect that farming as a source of livelihood is equally important for all types of farmers. On an average, income from non-farm business, livestock and wage/salary accounts around 52 per cent of monthly income of agricultural households (Key Indicators of Situation of Agricultural Households in India 2014). Generally, cultivation is more important for pure farmers than the mixed income farmers. This is because pure farmers depend exclusively on cultivation for their livelihood while the mixed income farmers derive their income from multiple sources. Moreover, owing to the engagement in activities other than cultivation time spent in cultivation is also likely to be less by the mixed farmers compared to the pure farmers. Taking in to account all these propositions, it can be expected that the adoption of better farm practices such as multiple and diversified cropping, application

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of fertiliser, the extent of farm mechanization etc. are more extensively used by pure farmers compared to the mixed income farmers. However, in so far as income is concerned, due to the multiple sources of income generation, mixed income farmers are likely to be financially better off than the pure farmers. The NSSO data on Consumption Survey for the year 2011-12 showed that one fifth of rural households with self employment in agriculture as their principal occupation had income less than the poverty line (Chand 2017). Past strategies in agricultural development focused on raising productivity through improved farm practices and ensuring food security of the country. The question of raising farmer's income did not find any mention in these strategies. Farmer's income remained low compared to non-farm income; during early 1980s, farm income was 34 percent of the income of non-agriculture worker which worsened further after 1993-94 and reached one-fourth of income of non-agricultural workers (Chand 2017). The National Sample Survey Office (NSSO) survey on employment and unemployment showed the number of cultivators declined at the rate of 1.80 per cent per year during 2004-05 to 2011-12 (Saxena *et al.* 2017). The NSSO 2014 Survey on situation of agricultural households showed that 60 per cent income of agricultural households is derived from farm sources while remaining 40 per cent is derived from off farm and non-farm sources (Key Indicators of Situation of Agricultural Households in India 2014). The data shows that for income across size classes, small farmers derive maximum share from non-farm sources but as one moves up in the size class category, the share of income derived from crop cultivation improves significantly and the share of non-farm activities, i.e. wages and salaries, and non-farm business activities declines (Birthal *et al.* 2017).

Assam is one among the agriculture based states of India[1] and over the years the state has experienced a declining trend of proportion of people engaged in agriculture. In terms of usual activity status (principal status and subsidiary status), workers engaged in agriculture sector was 63.6 per cent as per 66th round of NSS (Government of India 2009-10) and it declined to 56.1 per cent as per 68th round of NSS (Government of India 2011-12). The decrease in proportion of people engaged in agriculture in Assam can be attributed to factors like small and decreasing farm size, frequent flood and un-remunerative nature of agriculture to a great extent. The average size per holding in the state has decreased from 1.47 hectares in 1970-71 to 1.10 hectares in 2010-11(Report on Agricultural Census, 2010-11, Government of Assam). There has been large scale marginalisation of land; proportion of marginal size land in the state has increased from 21 per cent in 2000-01 to 26 per cent of the total land in 2010-11 (Economic Survey, Assam 2015-16). The state has in the recent decades experienced improvement in the level of educational attainment, emergence and expansion of non-

[1] In Assam, as per Land Utilisation Statistics for the year 2011-12 (provisional), around 36 percent of the total reported area of the state was net sown area (Economic Survey, Assam 2015-16) and the state comprises 3.8 per cent of agricultural households of India (Some Characteristics of Agricultural Households in India 2013). Moreover, agriculture sector provides employment and support to more than 50 per cent of the total workforce of Assam and a total of 20.28 percent of the GSDP at constant (2011-12) prices of the state was contributed by agriculture and allied sector in 2014-15 (Q) (Economic Survey, Assam 2015-16).

farm sector particularly unorganised sector. The non-farm employment in the rural areas of the state has grown from 35 per cent in 1999-2000 to 40 per cent in 2011-12 (Saha 2016). It is against this backdrop; this study examines the extent of diversification of farmers in terms of their income sources and the nature of utilisation of farm land by farmers of different types. The present paper would try to throw light on the extent of diversification of farm households towards activities other than cultivation in the Brahmaputra Plain[2] of Assam and compare the extent of diffusion of better farm practices between pure farmers and mixed income farmers.

The paper has been divided into four sections. Section 1 is introductory section. Section 2 comprises the data sources, explanation of data collection procedure and analytical framework of the study. The extent of diversification of farmers in terms of their income sources and the discussion on diffusion of better farm practices by different types of farmers have been incorporated in section 3. Final section comprises the broad conclusion of the study and policy implications thereof.

2. Methodology

2.1 Data Source and Sampling Procedure

The study is based primarily on field survey. The survey data were collected through multi-stage sampling procedure. Three districts one each from three different regions of the Brahmaputra Valley of Assam, were selected at the first stage. The selected districts were namely Lakhimpur, Kamrup and Morigaon. These districts also represent three different agro-climatic zones viz. north bank plain zone, lower Brahmaputra valley zone and central Brahmaputra valley zone respectively among the four agro-climatic zones of the Brahmaputra Valley. At the next stage, from each selected district, three villages were chosen at random. Lechai Gaon, No. 2 Kowadanga and Bhoroluwa Gaon were the three villages chosen from Lakhimpur. The villages selected from Morigaon were Chenimari, Bihubori and Hariapar. The three villages selected from Kamrup were Doloi Gaon, Pub-Sitara and Karara Garbhitar. Finally, a total of 232 farm households (around 12 percent of the total farm households in surveyed villages) were selected at random and surveyed during November, 2013 to January, 2014 to get the required information.

2.2 Analytical Approach

To understand the difference between pure farming households and mixed households, the households had been divided with respect to their primary occupation. Thus, if cultivation is the primary occupation of all the working family members of a farm household, the household is treated as pure farmer. In case of households where besides farming, there are other income activities, the households have been considered as mixed income farmers. The extent of diversification towards activities other than cultivation among farm households has been examined by looking into their distribution by income source.

[2] Brahmaputra Valley constitutes around two third of the geographical area of Assam.

The study on adoption and use of better farm practices has been divided in to two groups. First, whether the degree of mechanisation of ploughing and irrigation activities between pure farmers and mixed income farmers are same or not has been examined. Farm mechanisation has been analysed with respect to ploughing and irrigation activities as these are the two key farming activities. Using Fisher's *t*-test the degree of mechanisation between the two groups of farmers has been compared.

In the final stage, efficient utilisation of cultivable land by the two types of farmers has been examined in terms of three indices of land utilisation, viz., cropping intensity, diversification of cropping and fertiliser consumption. The values of these indices have been calculated for both types of farmers. Subsequently, using regression analysis presence of any significant difference between the two types of farmers with respect to all the three indices have been examined. As there are three indices, three equations have been formulated to capture the effects. The three dependent variables have been defined as:

Cropping Intensity (CI): It is the ratio of gross cropped area to the net sown area of the farm expressed in percentage.

Crop Diversification (CD)*:* Herfindahl Index (H) has been used to measure crop diversification as follows-

CD = 1-H

$=1 - \sum_{i=1}^{n} s_i^2$, where s_i is the share of the *i*-th crop in the gross cropped area.

Fertiliser Consumption (FC): It is the application of NPK (in kg) per hectare of gross cropped area.

Since the three indices are expected to vary with types of farming practices, the variable types of farmers (TYP) constitute our independent variable which is a binary variable that takes 1 for pure farmers, 0 otherwise (mixed income farmers).

In examining the impact of types of farmers on CI, CD and FC with the help of regression analyses, the effect of some other factors need to be controlled. For example, tenancy is likely to affect CI, CD and FC adversely since a part of the total production from cultivation has to be shared by the tenant with landlord in lieu of sharing the cost. Studies have shown adverse effects of tenancy particularly share cropping on CI and CD in case of Assam (Goswami 2012). Irrigation is another common factor which has important bearing on CI, CD and FC. With adequate irrigation facility, a farmer is likely to cultivate more intensively by adopting dry season cultivation which results more crop diversification and application of fertiliser. There are evidences of the impact of irrigation on cropping intensity (Dhawan and Datta 1992; Karunakaran and Palanisami 1998) and on crop diversification (Goswami 2012). Farm size is another determinant of CI (Agarwal 1984), CD (Mandal and Bezbaruah 2013) and FC (Quasem and Hossain 1979; Ahmad *et al*, 2001; Goswami, 2012). However, impact of farm size is not very

clear on all these three indices. Small farmers may use land more intensively; apply more fertiliser and diversify more to enhance their agricultural output. At the same time, given the relatively better financial condition of large farmers, this may also happen that large farmers realise higher cropping intensity and apply more fertiliser than the small farmers. We may also anticipate higher crop diversification by large farmers if there is absence of economies of scale and they are risk averse. Besides these factors, the extent of use of ploughing machinery may enhance cropping intensity and crop diversification by reducing both the physical labour involved in ploughing operation and the time of ploughing. The extent of HYV seeds adoption may also raise the intensity of cropping as it gets matured in shorter period of time than the traditional verities of seeds. Access to finance can enhance purchase and use of FC and in increasing CI and CD by facilitating the use of different farm inputs. Similarly, access to extension services may help in improving CI, CD and FC by creating and increasing awareness among farmers. Moreover, there may be some impacts of locational characteristics such as soil quality, agricultural infrastructure, access to markets for both inputs and outputs etc. on CI, CD and FC. The construction of variables is presented in Table 1.

Table 1: Variables and expected impact

Variable	Notation	Definition	Expected impact		
			CI	CD	FC
		Independent variable			
Types of farmers	TYP	1 for pure farmers, 0 otherwise (mixed income farmers)	+	+	+
		Control variables			
Tenancy	TEN	proportion of lease in area to the total operational holdings	-	-	-
Farm size	FS	Size of operational holding in hectare	+/-	+/-	+/-
Extent of ploughing mechanisation	EPM	Ratio of gross mechanically ploughed area to gross cropped area	+	+	
NA					
Extent of irrigation	ERR	Ratio of gross irrigated area to gross cropped area	+	+	+
Access to finance	ATF	1 for borrowers, 0 otherwise	+	+	+
Access to extension services	ATE	1 if consulted with extension workers, 0 otherwise	+	+	+/-
Area under HYV	HYV	percentage of area under boro paddy to the total paddy acreage	+	NA	NA
Location dummy	L_1&L_2	L_1=1 for Morigaon, 0 otherwise and L_2=1 for Kamrup, 0 otherwise assuming Lakhimpur as reference location	+/-	+/-	+/-

Specification of functional form and regression equation

The functional relation for each of the three indices is defined as:

$CI=F(TYP,TEN,FS,EPM,ERR,ATF,ATE,HYV,L_1,L_2)$……(i)

$CD=F(TYP, TEN,FS,EPM,ERR,ATF,ATE,L_1,L_2)$……...……(ii)

$FC=F(TYP, TEN,FS,ERR,ATF,ATE,L_1,L_2)$……..……..….(iii)

The minimum value that cropping intensity can take is 100 and we have a cluster of observations at that value. The value of crop diversification, another dependent variable, ranges from 0 to 1 and in our data set we have a cluster of observations at CD=0. The minimum value of fertiliser consumption is 0 without any restriction on the upper limit and we have a cluster of observations at FC=0. Under such cases left censored TOBIT formulation is better than the simple linear regression (Goswami 2012; Kumar *et al* 2012; Pandey 2016). Hence, left censored TOBIT regressions corresponding to (i), (ii) and (iii) respectively are specified as-

$CI_i^*=\beta_0+\beta_1TYP_i+\beta_2TEN_i+\beta_3FS_i+\beta_4EPM_i+\beta_5ERR_i+\beta_6ATF_i+B_7ATE_i+\beta_8HYV_i+\beta_9L_{1i}+\beta_{10}L_{2i}+U_i$…...(iv)

Where $CI_i=100$ for $CI_i^*< 100$, $CI_i=CI_i^*$ for $CI_i^* \geq 100$and U_i is the usual disturbance.

$CD_i^*=\beta_0+\beta_1TYP_i+\beta_2TEN_i+\beta_3FS_i+\beta_4EPM_i+\beta_5ERR_i+\beta_8ATF_i+B_7ATE_i+\beta_9L_{1i}+\beta_9L_{2i}+U_i$……..(v)

Where CDi=0 for $CD_i^*< 0$, $CD_i=CD_i^*$ for CD_i^* $0 \leq CD_i^* \leq 1$and U_i is the usual disturbance.

$FC_i^*=\beta_0+\beta_1TYP_i+\beta_2TEN_i+\beta_3FS_i+\beta_4ERR_i+\beta_5ATF_i+B_6ATE_i+\beta_7L_{1i}+\beta_8L_{2i}+U_i$……..……(vi)

Where $FC_i=0$ for $FC_i^*< 0$, $FC_i=FC_i^*$ for $FC_i^* \geq 0$ and U_i is the usual disturbance.

3. Results and Discussion

3.1 Diversification of Farm Households by Income Sources

The overall sample distribution comprises of 57.8 per cent mixed income farmers and 42.2 per cent belong to pure farmers category (Table 2). Cultivation is one of the sources of income for 84.1 per cent sample farmers while it is only source of income for only 42 percent of sample households. Activities under the 'other' category appeared as the second preferred primary sources of income among the sample farmers. Trade is the primary source of income for 23.7 per cent farmers followed by service (17.7 per cent) and 'other agricultural activity' (6.9 per cent) respectively. There are also some service holders for whom cultivation still continue to be a source of income. Across size classes by operational holdings, small size farmers turn out to be mostly pure farmers while large farmers are mostly mixed income farmers. Among the various sources of income for the sample households, excluding cultivation, the income from trade, service and 'other' are taken up relatively more by large farmers and 'other agricultural activity' is preferred and adopted more by small farmers. Diversification of income sources among farm households of lower size class of holding may reflect

unaccomodativness of agriculture sector; but multiple sources of income in farm households of higher size class of holdings may be for different reasons.

Table 2: Distribution of Farm Households by Income Source

Size class	Pure	Mixed income farmers						Total
(in hectare)	farmers	*Cultivation*	*Trade*	*Service*	*Other agricultural activity*[3]	*Other*	Overall*	
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
							(3+4+5+6+7)	*(2+8)*
<1	41	*40*	*16*	*22*	*10*	*34*	60	101
	(40.59)	*(39.60)*	*(15.84)*	*(21.78)*	*(9.90)*	*(33.66)*	(59.41)	(100.00)
1 to 2	39	*40*	*28*	*11*	*6*	*23*	53	92
	(42.39)	*(43.48)*	*(30.43)*	*(11.96)*	*(6.52)*	*(25.00)*	(57.61)	(100.00)
2 to 3	13	*09*	*6*	*4*	*0*	*2*	11	24
	(54.17)	*(37.50)*	*(25.00)*	*(16.67)*	*(0.00)*	*(08.33)*	(45.83)	(100.00)
3 to 4	02	*03*	*1*	*2*	*0*	*3*	04	06
	(33.33)	*(50.00)*	*(16.67)*	*(33.33)*	*(0.00)*	*(50.00)*	(66.67)	(100.00)
4 to 5	02	*03*	*2*	*2*	*0*	*1*	04	06
	(33.33)	*(50.00)*	*(33.33)*	*(33.33)*	*(0.00)*	*(16.67)*	(66.67)	(100.00)
5 e”	01	*02*	*2*	*0*	*0*	*0*	02	03
	(33.33)	*(66.67)*	*(66.67)*	*(00.00)*	*(0.00)*	*(00.00)*	(66.67)	(100.00)
All	98	*97*	*55*	*41*	*16*	*63*	134	232
	(42.24)	*(41.81)*	*(23.71)*	*(17.67)*	*(6.90)*	*(27.16)*	(57.76)	(100.00)

Source: Author's field study
In parentheses percentage to the total households
** Overall is not equal to sum of column 3, 4, 5, 6 and 7 as such households are earning from more than one sources.*

3.2 Characteristics of Farmers

Farm Size

Distribution of farmers by size class of operational holdings and ownership holdings of cultivable land, showed that that pure farmers have smaller land sizes compared to the mixed income farmers. Size of operational holdings of pure farmers is 1.3 hectare against 1.4 hectare of mixed income farmers. Similarly, size of ownership holdings of cultivable land of pure farmers is 0.7 hectare and it is 1.1 hectare for mixed income farmers (Table 3).

Table 3: Size of Holdings by Types of Farm Households (area in hectare)

Types of farmers	Operational holdings	Ownership holding of cultivable lands
Pure farmers	1.31	0.74
Mixed income farmers	1.36	1.10
All	1.34	0.95

Source: Author's field study

[3] It refers to the earnings by working as agricultural laborer.

Educational Status

Educational level of the head of the household (HoH) has an influence in deciding the income diversification among farm households. The sample data corroborates this as HoH from mixed income farmers are found to have higher educational attainment compared to pure farmers. Almost a quarter of pure farmers were found to be illiterate against 15.7 per cent among mixed income farmers (Table 4). Proportion of matriculates among HoH was also higher among mixed income farmers as compared to pure farmers. This indicates that with increase in educational attainment level, the diversification of activities from cultivation to other activities by farm households tend to increase.

Table 4: Percentage Distribution of Farm Households by Educational Attainment of the HoH

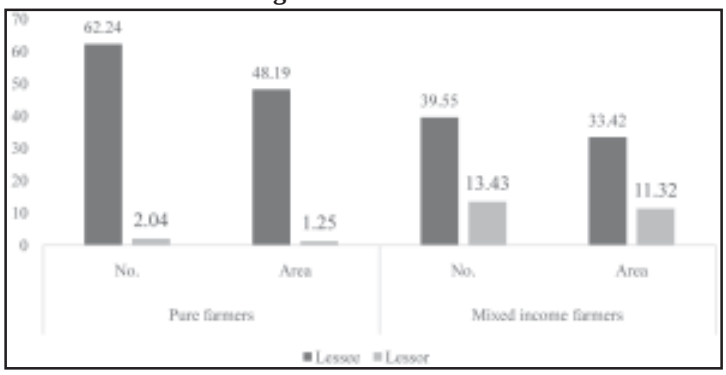
Types of farmers	Illiterate	Below Primary	Primary to High School	Matriculate to Under graduate	Graduate & above
Pure farmers	25.51	14.29	38.78	21.43	0.00
Mixed income farmers	15.67	9.70	44.78	21.64	8.21
All	19.83	11.64	42.24	21.55	4.74

Source: Author's field study

Status of tenure

As mentioned earlier security of tenure is an important factor deciding the farm practices. The survey findings revealed that a total of 62.2 per cent of pure farmers were lessee while the same for mixed income farmers was 39.6 per cent. In terms of percentage of area leased in to the operational area the pattern observed is same as in lessee (Figure 1). On the other hand, the extent of leasing out is more among mixed income farmers than the pure farmers in terms of both number of lessor and area leased out. Thus, pure farmers are mostly tenant while mixed income farmers are lessor. This practice of leasing out land by farm households is partly because of the high cost of cultivation vis-a-vis return and availability of opportunities for other gainful employment with better educational attainment.

Figure 1: Tenure Status



Source: Author's field study

Caste

In India farming practices have strong caste biases. In the early modernist discourse on Indian society, caste was invariable counterpoised to class (Jodhka 2003). The discussion on class–caste relations was well articulated in the "mode of production" debate that took place in the 1970s. Several scholars argued that the Indian agrarian economy in its contact with capitalism led to the emergence of a capitalist class—and, class-based exploitation was mediated through caste identities (Omvedt 1978; Rudra 1978; Gough 1980). Extensive debates of that time indicated that caste does perform certain crucial economic functions like it determines access to land (the principal means of production), control over the labour process, and forms of exploitation (Rao 2017).

Although sample households from general category had higher proportion, yet proportion of pure farmers was found to be lower among two types of farm households within the general category households. Pure farmers were proportionately higher among other caste groups. In contrast, mixed income farmers were mostly from general caste households. The social position of farm households decides their bargaining strength in markets and their production decisions. Besides, the level of education, access to various support services also has decisive influence on farming practices across farm households from various social groups.

Table 5: Percentage Distribution of Farmers by Caste

Types of farmers	General	SC	ST	OBC/MOBC
Pure farmers	37.76	10.20	24.49	27.55
Mixed income farmers	47.76	4.48	22.39	25.37
All	43.53	6.90	23.28	26.29

Source: Author's field study

Dependency on Credit

It has been found that pure farmers are more dependent on credit than the mixed income farmers for conducting their farm operation. Indebtedness was fairly high (67.4 percent) among pure farmers for cultivating their land as against 41.8 percent of mixed income farmers found to have borrowed money for cultivating their land. The mixed income farm households who are primarily engaged in government jobs have ready source of funds for investing in their farm activity unlike the pure farming households who do not have alternate sources of income available for investment in farm activities. One of the reasons for high incidence of indebtedness among pure farmers is the lack of own investible resource. Among the mixed income farmers households who derive their income from trade and other agricultural activity are more likely to be indebted.

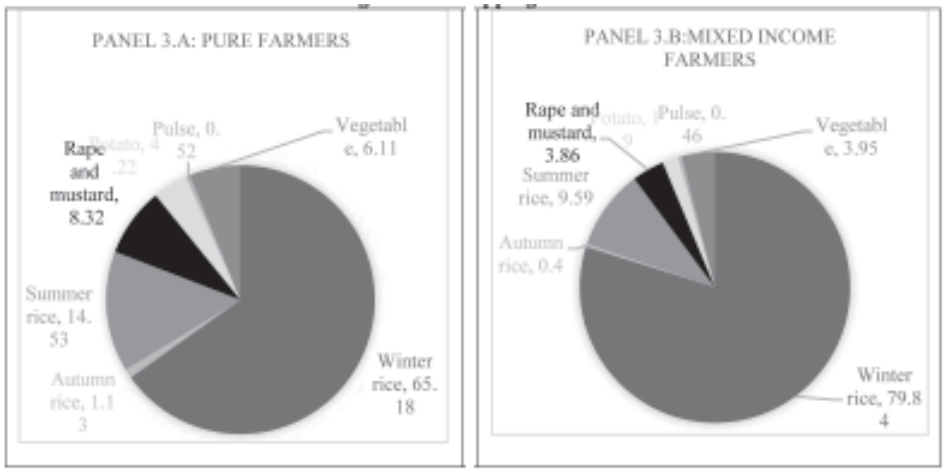
Figure 2: Extent of Borrower

Source: Author's field study

Cropping Pattern

While rice is the major crop grown by the sample households, pure farmers are found to be relatively more diversified towards cultivating other crops compared to the mixed income farmers in terms of area under crop (Figure 3). Around 81 per cent of the cropped area of pure farmers is under rice cultivation while it is around 90 per cent in case of mixed income farmers. Further, winter rice is the dominant crop for both groups of farmers. The second major crop grown by pure farmers is rape and mustard followed by vegetable, potato and pulse repetitively. In case of mixed income farmers, vegetable is the second major crop followed by rape and mustard, potato and pulse respectively. Crop diversification by pure farmers is mostly taken up for two reasons: (a) it helps the farmers to reduce the risk of crop failure and (b) they are able to earn extra cash from cultivation of dry season crops.

Figure 3: Cropping Pattern



Source: Author's field study

3.3 Degree of Mechanisation

In India, the level of mechanisation varies greatly by region. States in the north such as Punjab, Haryana and Uttar Pradesh have high level of mechanisation due to the highly productive land in the region as well as a declining labour force. Studies have shown that there are evidences of positive impacts of mechanisation on production and productivity enhancing practices of agriculture (Hamid 1972, Agarwal 1984, Singh, G 2006, Singh, J 2006 and Verma 2008) and on efficient utilisation of cultivable land. However, the level of mechanisation continues to be low in Assam (https://farmech.dac.gov.in/FarmerGuide/NE/index1.html). There are a number of reasons behind this. Factors such as 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 the state. Nevertheless, in order to boost up farm mechanisation, special thrust has been given by the State Agriculture Department. Mechanisation of farm practices also varies with farming practices.

In our study, the sample observations revealed that with respect to ploughing, there has been fairly high level of mechanisation among both the groups of farmers though it was more extensive among the mixed income farmers (80.6 per cent) than the pure farmers (75.5 per cent). Also, the intensity of mechanised[4] ploughing was more across mixed income farmers (78.3 per cent) compared to pure farmers (65.4 per cent). In respect of mechanised irrigation, it was observed that a little more than half the proportion of pure farmers (52.0 per cent) went for mechanised irrigation and it was even lower in case of mixed income farmers (40.3 per cent). The intensity of mechanised irrigation was also found to be fairly low among both groups of farmers, though pure farmers (26.9 per cent) relatively used more mechanised irrigation compared to mixed income farmers (19.0 per cent). In order to see whether the observed difference between the two groups of farmers with respect to intensity of mechanisation of irrigation and ploughing was significant, we have used Fisher's *t*-test[5].

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[4] Intensity of mechanisation of ploughing has been defined as the percentage of gross area ploughed using machinery at least for one round of ploughing during the reference period of the study to the gross cropped area. Similarly, the intensity of mechanised irrigation has been defined as the percentage of gross irrigated area using machinery at least for one round of irrigation during the reference period of the study to the gross cropped area.

[5] The null hypothesis for both ploughing and irrigation mechanisation are-H_O: there is no difference between values of intensity of mechanisation (both ploughing and irrigation) of pure farmers and mixed income farmers Alternative hypotheses for ploughing and irrigation mechanisation are respectively-H_A: value of intensity of loughing mechanisation of pure farmers < value of intensity of ploughing mechanisation of mixed income farmers H_A: value of intensity of irrigation mechanisation of pure farmers > value of intensity of irrigation mechanisation of mixed income farmers

Table 6: Results of Fisher's t-test

Activity	Levene's Test for Equality of Variances	Fisher's *t*-test for Equality of Means	
		t-statistic	p-value
Ploughing	F=3.971 p-value =0.047Result= variances are not same	-1.529 (200.521)	0.064
Irrigation	F=3.353p-value =0.068Result= variances are same	1.908(230)	0.029

Source: Author's field study In parentheses degrees of freedom

Results of the Fisher's *t*-test showed that the intensity of mechanisation with respect to irrigation for pure farmers was significantly more than that of the mixed income farmers (Table 6). This observed difference could be due to the relatively large-scale adoption of crops like summer rice, winter vegetable, rape and mustard, potato, pulse and so on by the former group than by the latter group (Figure 3). On the other hand, in case of the intensity of mechanised ploughing the observed advantage of mixed income farmers over pure farmers was not significant and irrespective of farmer types, mechanised ploughing has been adopted by both the group of farmers.

3.4 Land Productivity Utilisation

The sample data showed that pure farmers had reported higher incidence of cropping intensity, crop diversification and consumption of fertiliser in their farm practices[6] (Table 7). On an average, the extent of area under HYVs is 16.6 per cent. It was also found that some farm households grow only the HYVs of crops while some others grow only traditional variety of crops. The farm size ranges from 0.1 hectare to 6.8 hectare with an average size of 1.3 hectare. The proportion of leased in area to the total operational holdings is 0.3 across the sample farmers. The ratio of gross mechanically ploughed area to gross cropped area was found to be fairly high (0.72). In contrast, the proportion of gross area irrigated to the gross cropped area is just 0.3. The average application of fertiliser by sample farmers has been found to be 62.1 kg/hectare with a maximum of 768.4 kg/hectare while some farm households has not used fertiliser at all.

[6] The values of cropping intensity, crop diversification and fertiliser consumption are 120 per cent, 0.5 and 78 kg/hectare for pure farmers respectively against 111 per cent, 0.4 and 38 kg/hectare in case of mixed income farmers respectively in the sample households.

Table 7: Descriptive Statistics of Explanatory Variables

Variable	Obs	Mean	S.D.	Min	Max
Percentage of area under HYVs	232	16.58	32.76	0	100
Types of farmers (1=pure farmer, 0= mixed income farmer)	232	0.42	0.50	0	1
Farm size (in hectare)	232	1.34	1.04	0.13	6.76
Extent of tenancy	232	0.32	0.36	0	1
Extent of ploughing mechanisation	232	0.72	0.41	0	1
Extent of irrigation	232	0.26	0.35	0	1
Access to credit (1= borrower, 0=otherwise)	232	0.53	0.50	0	1
Access to extension service (1= if consulted, 0=otherwise)	232	0.24	0.43	0	1
NPK (in kg) per hectare of gross cropped area	232	62.07	103.48	0	768.41
Lakhimpur	232	0.41	0.49	0	1
Morigaon	232	0.31	0.46	0	1
Kamrup	232	0.28	0.45	0	1

Source: Author's field study

The results of regression analysis reveal that coefficient of independent variable TYP is positively significant at five per cent in case of both cropping intensity and fertiliser consumption. However, it is not significant in case of crop diversification[7]. It implies that the probability of intensive cultivation and use of fertilise per unit of cropped area is significantly more by pure farmers as compared to the mixed income farmers while there is no such difference between them with respect to diversification of cultivation. Thus, it is found that pure farmers utilise land productivity more the mixed income farmers.

[7] As data set is cross sectional, problem of heteroskedasticity and multicollinearity have been checked. While there is no such problem of multicollinearity, heteroskedasticity has been found to be present with respect to all the three regressions. Estimating robust standard error, problem of heteroskedasticity has been corrected.

Table 8: Results of Regressions

	Cropping Intensity			Crop Diversification			Fertiliser Consumption		
	Breusch-Pagan / Cook-Weisberg test for heteroskedasticity			Breusch-Pagan / Cook-Weisberg test for heteroskedasticity			Breusch-Pagan / Cook-Weisberg test for heteroskedasticity		
	$chi^2(1)$ = 75.85			$chi^2(1)$ = 13.72			$chi^2(1)$ = 311.17		
	Prob > chi^2 = 0.0000			Prob > chi^2 = 0.0002			Prob > chi^2 = 0.0000		
	Average VIF=1.66			Average VIF=1.34			Average VIF=1.28		
	Maximum VIF=3.09			Maximum VIF=1.74			Maximum VIF=1.53		
Variable	Coefficient	Robust SE	p-value	Coefficient	Robust SE	p-value	Coefficient	Robust SE	p-value
TYP	15.39**	7.84	0.05	0.06	0.05	0.22	31.61**	13.34	0.02
TEN	-3.19	11.77	0.79	-0.07	0.07	0.36	-15.06	19.80	0.45
FS	-6.88	4.26	0.11	0.03	0.02	0.21	0.59	4.10	0.89
EPM	-3.91	9.62	0.69	-0.20***	0.06	0.00	--	--	--
ERR	31.18**	15.66	0.05	0.32***	0.08	0.00	225.68***	32.38	0.00
ATF	19.79**	8.27	0.02	0.18***	0.05	0.00	20.12	14.07	0.15
ATE	13.54	9.56	0.16	0.11**	0.05	0.05	-15.16	13.14	0.25
HYV	0.29	0.19	0.14	--	--	--	--	--	--
Morigaon	3.18	11.81	0.79	0.25***	0.06	0.00	-38.40**	17.08	0.03
Kamrup	-9.09	10.33	0.38	0.11	0.07	0.11	-3.34	12.21	0.79
Constant	78.66***	10.99	0.00	-0.09	0.06	0.15	-11.67	10.87	0.28
F		4.09 (10, 222)***			9.58 (9, 223)***			20.86 (8, 224)***	
n			232			232			232
Pseudo R^2			0.0355			0.2498			0.0611

In parentheses degrees of freedom *** and ** represents significant at 1% and 5% respectively

Among the control variables, coefficient of EPM has been found to be negatively significant in case of crop diversification. This may be because mechanisation of ploughing is more among the mixed income farmers while the extent of diversified cultivation is less among them compared to pure farmers. The coefficient of ERR has been found to be positively significant in case of all the three indices considered while coefficient of ATF has been found to be significant positively only in case of cropping intensity and crop diversification. It implies that the cropping intensity and crop

diversification are positively affected by both irrigation and access to finance while fertiliser application is enhanced by irrigation but not by access to finance. The positively significant coefficient of ATE in case of crop diversification depicts that spread of agricultural extension services by the state government departments has helped in encouraging farmers to diversify their cultivation basket. Results also reveal the presence of impact of locational factors on crop diversification and application of fertiliser. Across locations, it has been found that crop diversification is more in Morigaon as compared to Lakhimpur and vice versa in case of fertiliser consumption. In Lakhimpur, monsoon rainfall has increased continuously over the years during Kharif season and thus incidence of flood and its severity also increased that has more damaging impact on the late summer and autumn crops (De and Bodosa 2014).

4. Conclusions and Policy Implications

From the present study, it has been found that the adoption and use of irrigation mechanisation is more among pure farmers than the mixed income farmers. However, there is no such difference between the two types of farmers in case of ploughing mechanisation. Regarding the utilisation of farm land, pure farmers are found to be cultivating more intensively than the mixed income farmers. The pure farmers are also well ahead of the mixed income farmers with respect to application of fertiliser. However, both types of farmers are more or less equally diversified crops grower. Findings thus indicate that the pure farmers utilise cultivable land more intensively than the mixed income farmers.

This calls for provisioning of government support to for achieving higher return in farming for small sized farm households. Further, government can concentrate in development of land lease market to the hands of cultivators who utilise the agriculture land efficiently.

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