CHAPTER-6
Rental Markets of Agricultural Capital Goods and Use of Better Farm Practices

6.1 Core research question of the study is whether the emerging rental markets of agricultural capital goods have substituted the pending agrarian reforms especially related to consolidation of holdings. For contextualizing the research question, an overview of literature will be instructive.

The goals of land reform programmes in India initiated soon after independence can be broadly summarized into followings-

(a) Elimination of intermediaries and absentee landlordism.
(b) Improving security and reducing exploitation of tenant farmers.
(c) Achieving greater equality of land holding and so on.

Thus the land reform programmes were targeted the twin goals of achieving higher efficiency and productivity in agriculture by creating right incentives and securing greater social justice in the rural society. Apart from elimination of intermediaries, tenancy reform and redistribution of land holdings through land ceiling Act; the land reform programmes in India also attempted consolidation of small and fragmented holdings.

The consolidation programme was felt to be necessary as small and fragmented holdings were thought to be unsuitable for adoption of arrangement and practices for fuller realization of agricultural productivity. As Vaidyanathan stated,

“\textit{The size and pattern of land holdings could affect the profitability of innovations and hence their adoption in other ways. An excellent case in point is groundwater irrigation where holdings are small and highly fragmented; the cost of constructing wells and installing pumpsets tend to be higher relative to the returns compared to a situation in which large, consolidated holdings prevail. The big spurt in groundwater development through tube}
wells in the Haryana-Punjab-western Uttar Pradesh tract was preceded by land consolidation. The average size of holdings in these tracts is also large. By contrast, in the eastern part of the Gangetic plain the average size of holdings is relatively small and they are highly fragmented, both of which tend to reduce the private rate of returns to well irrigation in these tracts” (cited in Vaidyanathan, 1986).

Vaidyanathan’s argument can well be extended for the case of private investment in agricultural capital goods. However, this argument does not take into account the existence and role of rental markets of agricultural capital goods especially of ploughing and irrigating implements. With the emergence of rental markets of agricultural capital goods, the limitation of small and fragmented holdings discussed in the above argument alters in two ways: first of all the possibility of renting out opens up another source of returns to an owner of agricultural capital goods. Thus, even if a farmer cannot extract an attractive rate of return from his own agricultural operation, he/she may be able to get sufficiently good total return from his/her investment in such capital goods by using it in his/her own farm and renting it out at other times. Secondly, in the possibility of hiring-in agricultural capital goods, the smallness of holdings of the farmers need not to be preventing from using agricultural machinery and other improved practices in his farm. Capital to these farmers is no longer the lumpy indivisible capital goods but the divisible machine time which he can hire in to the extent required for his farm. From these two points of view, it is arguable that the emergence of rental markets of agricultural capital goods along with similar other factor markets such as water market have largely substituted to necessary land reforms for consolidating holdings.

As already reported in chapter-4, rental markets of agricultural capital goods, especially ploughing and irrigating machineries, are vibrant and functioning in Assam. The issue presented in this chapter therefore is the extent to which the rental markets of agricultural capital goods have
succeeded in obviating the need for consolidating holdings for viable use of farm machinery and for increasing other improved practices.

6.2 Role of Rental Markets of Agricultural Capital Goods in Farm Mechanization

Impact of rental markets of agricultural capital goods on farm mechanization has been investigated in following stages. First, discussion has been done on the extent of use of machinery by sample farmers. Next, extents of would be users in absence of rental markets of ploughing and irrigating machinery have been examined. Thereafter study has been done to check whether intensity of mechanization by owner users is significantly more than that of pure hiring-in users. Final step involves the examination of presence of correspondence between rental market participation rates and intensity of use of agricultural capital goods.

6.2.1 Extent of Use of Machinery by Sample Farmers

Extent of use of machinery has been measured in terms of percentage of sample farm households used machinery to the total sample farm households.

![Figure-6.1(a): Percentage Distribution of Users and Nonusers of Ploughing Machinery](image)

![Figure-6.1 (b): Percentage Distribution of Users and Nonusers of Irrigating Machinery](image)
As figure-6.1(a) depicts, a total of 41.38 percent of sample households have used tractor while 61.21 percent sample households have used power tiller. The fact that percentage use of power tiller is more than tractor is tally with the observation come out from the discussion in Chapter-3 based on the data supplied by Input Survey reports of Assam of 1996-97, 2001-02 and 2006-07. One factor causing large scale use of power tiller over tractor may be more accessibility of former than the latter. The present study itself revealed this fact as 25 power tillers are owned by sample households against only 7 tractors. Again, the percentage of users of ploughing machinery to the total sample family is 78.45 percent. Again, irrigating machinery has been used by 45.26 percent of the total sample households. Proportionately more use of ploughing machinery than the irrigating machinery could be due to the fact that while ploughing of farm land is required irrespective of the type of crops, irrigation is not so essential for all types of crops and also affected by weather as mentioned earlier.

As a whole, a total of 78.45 percent of the sample farm households have used ploughing machinery (tractor and power tiller) for ploughing purpose in terms of operational holding in hectare as revealed by figure-6.2(a). Size group-wise, in terms of operational holding, all the
sample farmers in the size groups of 3 to 4 hectare, 4 to 5 hectare, 5 to 6 hectare and 6 hectare and above are found to be using ploughing machinery. On the other hand, percentage of use of ploughing machinery by marginal farmers is 80.20 percent followed 79.17 percent by farmers in the size group of 2 to 3 hectare. A total of 72.83 percent farmers in the size groups of 1 to 2 hectare of operational holding have used ploughing machinery. Figure-6.2(b) depicts that 45.26 percent of sample family have used irrigating machinery. Size group-wise, in terms of operational holding, the proportions of use of irrigating machinery of each of them are more than 33 percent.

6.2.2 Users of Ploughing and Irrigating Machinery in Absence of Rental Markets

In order to know the contribution of rental markets to mechanization of agriculture, we have calculated the percentage of ‘would be’ users of both ploughing and irrigating machinery in the total users. For that, first the number of ‘would be’ users in absence of rental market has been calculated by subtracting pure hiring-in users from the total users of the implement. We have subtracted only the pure hiring-in users from the total users to get the ‘would be’ users because the users other than pure hiring-in users possesses at least one machinery of concerned type. Thus, such users would have been able to use the machinery even if rental markets are not functioning. Next, the percentages of would be users in the absence of rental markets to total users of each size group have been calculated.

The overall actual users of ploughing machinery are found to be much larger than ‘would be’ users of such machinery as shown by figure-6.3(a). Size group-wise too actual users of ploughing machinery are larger than ‘would be’ users of all of them. Again, from figure-6.3(b), it is found that the overall proportion of ‘would be’ users of ploughing machinery is 17.58 percent. It implies that 82.42 percent of the total users of ploughing machinery have been benefited by the working of rental markets of it. Moreover, the share of ‘would be’ users in the total sample households is even lower which is found to be 13.91 percent.
Across size groups 83.33 percent farmers in the size group of 4 to 5 hectare are benefited by the functioning of rental market of ploughing machinery. Looking into the ‘would be’ users belong to marginal and small farmers in absence of rental markets, it is found that there are only 3.4 percent such users from marginal farmers and 23.88 percent from small farmers whereas marginal farmers and small farmers have constituted 43.53 percent and 39.66 percent respectively by operational holding of the total sample households.

From figure-6.4(a) and figure-6.4(b), it is found that the small and marginal farmers comprise around 81 percent of actual users of ploughing machinery whereas only around 59 percent of ‘would be’ users in absence of rental markets belong to them. This indicates that while the functioning of rental market of ploughing machinery benefits all the size class farmers, the small and marginal farmers have gained more as compared to other size class farmers.
Similar to ploughing machinery, actual users of irrigating machinery are more than double of the ‘would be’ users in absence of rental market of them which is represented by figure-6.5(a). Further, numbers of actual users are larger than ‘would be’ users for all the size groups except for the size group of 4 to 5 hectare of operational holding. Figure-6.5(b) depicts that as a whole, 38.10 percent of the total users have owned at least one irrigating machineries. It implies that the rest 61.90 percent uses irrigating machinery through hiring-in. Again as a percent to the total surveyed households, there are only 17.24 ‘would be’ users of irrigating machinery. Except farmers belong to the size group of 4 to 5 hectare of operational holding, 50 percent or more farmers of other size groups are found to be using irrigating machinery through hiring-in. Thus, rental market of irrigating machinery has been contributing significantly in facilitating irrigation.
From figure-6.6(a) and Figure-6.6(b) it is found that while small and marginal farmers constitute 83.81 percent of the total users of irrigating machinery, they constitute just 77.50 percent of the ‘would be’ users in absence of rental markets. That means small and marginal farmers are relatively more benefited from the working of rental market of irrigating machinery similar to that of ploughing machinery.

![Figure-6.6(a): Percentage Distribution of Actual Users of Irrigating Machinery by Operational Holding (area in hectare)](image)

![Figure-6.6(b): Percentage Distribution of 'Would be' Users of Irrigating Machinery by Operational Holding (area in hectare)](image)

Comparing the role of rental markets in farm mechanization, it is found that rental markets of ploughing machinery have been contributing more than that of irrigating machinery. Figure-6.7 shows that percentage of ‘would be’ users to the total users is 17.58 for ploughing machinery against 38.10 for irrigating machinery. It means 82.42 percent of total users of ploughing machinery have been benefited against 61.9 percent in case of irrigating machinery. Size group-wise, except size groups of 3 to 4 hectare and 5 hectare and above, other size groups have been benefited more from rental markets of ploughing machinery than that of the irrigating machinery. In other words, rental market of ploughing machinery has been contributing farm mechanization relatively more than that of the irrigating machinery in general and smaller size group farmers in particular. Thus the study gives an idea that more the implement is costly, higher is the contribution by the rental markets of agricultural capital goods to the farm mechanization.
6.2.3 Rental Markets and Intensity of Farm Mechanization

Intensity of farm mechanization has been studied here using two indicators. These indicators are percentage of Gross Mechanically Ploughed Area (without considering the number of rounds ploughed) to Gross Cropped Area and percentage of Gross Irrigated Area\(^{12}\) (without considering the number of rounds irrigated) to Gross Cropped Area. Users of machinery have been classified into two groups namely owner users and pure hiring-in users. Pure hiring-in users are users of machinery exclusively through hiring-in while owner users include all the users other than pure hiring-in users. The rationale behind the inclusion of owner cum hiring-in users in the group of owner users is that since they have ownership on at least one of such machinery, necessarily such users will have same privileged as of the pure owner users.

It is evident from figure-6.8(a) that the percentage of Gross Mechanically Ploughed Area (GPA) to Gross Cropped Area (GCA) of owner user group is 92.39 percent against 88.46 percent for pure hiring-in users. Again, the percentage of Gross Irrigated Area (GIA) to Gross Cropped Area of owner users is 49.28 percent against 43.33 percent for pure hiring-in users.

\(^{12}\) Gross area irrigated using machinery only are considered in section 6.2.3 and in 6.2.4
percent of pure hiring-in users as revealed by figure-6.8 9(b). Thus, it is found that owner users are at a slightly advantageous position than the pure hiring-in users.

![Figure-6.8 (a): Percentage of Gross Mechanically Ploughed Area to GCA](image)

![Figure-6.8 (b): Percentage of Gross Irrigated Area to GCA](image)

Now to confirm whether the differences of percentages of Gross Mechanically Ploughed Area to Gross Cropped Area and percentages of Gross Irrigated Area to Gross Cropped Area between owner users and pure hiring-in users are significant or not, let us turn to test of significance. For the purpose, hypotheses are formulated as follows-

**H_0:** There are no differences of percentages of Gross Mechanically Ploughed Area to Gross Cropped Area and percentages of Gross Irrigated Area to Gross Cropped Area between owner users and pure hiring-in users, i.e., (μ_1 = μ_2)

**H_A:** Percentages of Gross Mechanically Ploughed Area to Gross Cropped Area and of Gross Irrigated Area to Gross Cropped Area of owner users are higher than that of the pure hiring-in users, i.e., (μ_1 > μ_2)

Where, μ_1 represents the average percentages of Gross Mechanically Ploughed Area to Gross Cropped Area and Gross Irrigated Area to Gross Cropped Area of owner users. Again, μ_2 represents average percentages of Gross Mechanically Ploughed Area to Gross Cropped Area of pure hiring-in users.
Area and Gross Irrigated Area to Gross Cropped Area of pure hiring-in users.

As test is about the existence of differences between population means, Fisher’s t-test (Nagar and Das, 2009), suitable for the purpose, has been applied. Fisher’s t-statistic is given by-

\[
t = \frac{\bar{x}_1 - \bar{x}_2}{S \sqrt{\frac{1}{n_1} + \frac{1}{n_2}}} \text{ with } n_1+n_2-2 \text{ degrees of freedom}
\]

Where, \(\bar{x}_1 = \frac{\sum_{j=1}^{n_1} x_{1j}}{n_1}\) and \(\bar{x}_2 = \frac{\sum_{j=1}^{n_2} x_{2j}}{n_2}\)

\[
S^2 = \frac{\sum_{j=1}^{n_1} (x_{1j} - \bar{x}_1)^2 + \sum_{j=1}^{n_2} (x_{2j} - \bar{x}_2)^2}{n_1+n_2-2}
\]

We have conducted the Fisher’s t-test for ploughing and irrigating machinery separately. The results of the tests are tabulated below-

<table>
<thead>
<tr>
<th>Implement</th>
<th>Levene’s test for equality of variances</th>
<th>t-statistic</th>
<th>p-value (one-tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ploughing Machinery</td>
<td>3.221</td>
<td>0.074</td>
<td>0.929 (180)</td>
</tr>
<tr>
<td>Irrigating Machinery</td>
<td>0.304</td>
<td>0.582</td>
<td>0.374 (103)</td>
</tr>
</tbody>
</table>

The t-values of both ploughing and irrigating machinery are not significant both at 1% level as well as at 5% level. That means there is no significant difference of intensities of farm mechanization between owner users and pure hiring users of agricultural machinery. In other words rental markets of agricultural machinery have a significant role in farm mechanization.

6.2.4 Correspondence between Rental Market Participation Rates and Intensities of Mechanization

Figure-6.9(a) represents a scatter diagram between MPRs and intensities of mechanized ploughing. The scatter diagram depicts a positive relation between rental market participation rates and intensities of mechanized ploughing across villages.
For examining the correspondence between rental market participation and intensity of mechanized ploughing, radar diagrams have been used. Figure-6.9(a) and Figure-6.9(b) represents a rough correspondence between rental market participation rates and intensities of mechanized ploughing.

With regard to irrigating machinery, scatter diagram has explained a positive relation between rental market participation rate and irrigation intensity as similar to ploughing machinery. Further, figures 6.10(b) and 6.10(c) also depicts a rough correspondence between rental market participation and intensity of irrigation.
From the above discussion it is found that agricultural machinery would have been used by only a small proportion of farmers in absence of rental markets as around 82 percent of ploughing machinery users and around 61 percent of irrigating machinery users are pure hiring-in users. In fact, proportion of actual farmers use agricultural machinery without rental markets would have been even lesser than calculated one as in the absence of opportunity to lease-out, many of owners of equipments may not have been felt rational to purchase machinery only for self-use at the cost of underutilization of capacity of those machineries. Again, while functioning of rental markets of agricultural capital goods helps in mechanization of agriculture as a whole, its
impact on the small and marginal farmers is relatively more significant than the larger size group farmers. Further, intensity of mechanized ploughing and intensity of irrigation is not significantly different between owner users and hiring users. Moreover, it is found that extent of participation in rental markets and intensive use of both ploughing and irrigating machineries are positively related.

6.3 Impact of Rental Markets of Agricultural Capital Goods on Agriculture

6.3.1 Adoption Production and Productivity Enhancing Practices

The impact of rental markets of agricultural capital goods on agricultural production and productivity has been studied in terms of the following three indicators - a) cropping intensity b) crop diversification and c) productivity of paddy.

6.3.1(I) Cropping Intensity

Cropping intensity measures the number of times a cultivable land is cultivated during a year. Cropping intensity is defined as-

\[
\text{Cropping intensity} = \left( \frac{\text{Gross Cropped Area}}{\text{Net Sown Area}} \right) \times 100.
\]

The minimum value of cropping intensity is 100 which mean that the land has been cultivated only for one time during a year.

Sample farmers have been classified in to three groups by use status of machinery. In classifying the farmers by use status of machinery by them, users of owned machinery and users of owned machinery cum hirer have been assumed as owner users. That means pure hiring-in users are exclusively borrower users. Explanation for classification of users in this manner is same as already stated above.

Comparison of weighted average cropping intensities reveal that both pure hiring-in users and owner users of ploughing machinery are associated with higher cropping intensity as compared to nonusers as depicted by figure-6.11(a). Further it is found that the owner users grow crop more frequently than the hiring-in users. Same pattern has been observed in case of irrigating machinery also which is clear from figure-6.11(b). In fact, the differences of cropping intensities among the three
farmer groups are higher in case of irrigating machinery than in ploughing machinery particularly between nonusers and user groups. The observation that owner user’s cropping intensity is more than that of pure hiring-in users and irrigating machinery users have more impact on cropping intensity than that of the ploughing machinery users is more or less in conformity with the findings of Agarwal13 (1984). Thus the impression we have derived is that rental markets of agricultural capital goods contribute in increasing cropping intensity. Let us rely on econometric tools to confirm the derived impression.

**Independent variables**

*Users of Ploughing Machinery:* PHU=1 for pure hiring-in users, 0 otherwise, OWNR=1 for owner users, 0 otherwise, assuming nonusers as base category.

*Users of Irrigating Machinery:* PHU=1 for pure hiring-in users, 0 otherwise, OWNR=1 for owner users, 0 otherwise, assuming nonusers as base category.

**Control variables**

*Extent of Tenancy (TEN):* Extent of tenancy has been measured as the proportion of lease in area to the total operational holdings. Tenants as

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13 As per Agarwal’s observation, effects of tube wells on cropping intensity are substantially higher than that of the tractors.
a whole have lack of incentives for intensive cultivation as pure tenants particularly share croppers cultivated land less frequently compared to the owner operators (Goswami, 2012). Again, since higher extent of tenancy implies larger proportion of operational holdings is hired in, incentive for intensive cultivation again reduces as extent of tenancy increases. Therefore we can expect a negative sign of this variable. However, in the present study tenants consists of all types of tenants.

**Farm Size (FS):** It has been measured in terms of size of operational holdings. With large size of operational holdings, a farmer is expected to grow crop less frequently due to scarcity of labour. But, with abandon availability of other inputs of farm operation, reverse may also happen. Therefore, a-priori, a specific sign of the variable can never be expected.

**Pure Cultivator (PCUL):** PCUL is a dummy with 1 for pure cultivator, 0 otherwise. Households earning income only through cultivation have been treated as pure cultivators and rest are as cultivator cum other income earners. Cropping intensity is likely to be higher for the pure cultivators than the cultivator cum income earner from other sources as they have no alternative sources of income. Therefore, positive sign of variable can be expected.

**Access to Finance (ATF):** ATF is a dummy with 1 for borrowers, 0 otherwise. As most of the farmers are small and marginal with poor economic conditions, access to borrowing can expected to be a significant accelerator of intensive cultivation. Hence, a positive sign of the variable can be expected.

**Extent of Irrigation (IRR):** It has been measured as a ratio of Gross Irrigated Area\(^{14}\) (without considering the number of rounds irrigated) to Gross Cropped Area. Farmers with more irrigation may cultivate land more intensively. So a positive sign of the variable can be anticipated.

\(^{14}\) GIA represents area irrigated using machinery and/or traditional method in section 6.3
**Extent of Mechanized Ploughing (EMP):** It has been measured as the ratio of Gross Mechanically Ploughed Area (without considering the number of rounds ploughed) to Gross Cropped Area. Easier and less time consuming ploughing through machinery may result in more cropping intensity. So, we can expect a positive sign of this variable.

**Access to Extension Services (ATE):** It is a dummy with 1 if consulted with extension workers, 0 otherwise. A farmer has been considered as the beneficiary of extension services if he/she has consulted with extension workers.

Extension services are likely to help in increasing cropping intensity through spread of knowledge and awareness about the better crop varieties, new technologies and improved method of cultivation. So, we can expect a positive sign of this variable.

**Area under High Yielding Varieties (AHYV):** Percentage of area under boro paddy to the total paddy acreage has been used as the indicator of HYV adoption. As HYVs get matured in relatively short duration, its impacts on cropping intensity can be expected to be positive.

**Location Characteristics:** Location of the present study covers three districts. Agricultural practices, due to location advantages or disadvantages say in terms of soil condition, occurrences of flood etc., may vary across locations and so the cropping intensity too. Therefore, two dummies, $L_1$ and $L_2$ have been used taking North Lakhimpur as base category where, $L_1=1$ for Morigaon, 0 otherwise and $L_2=1$ for Kamrup, 0 otherwise.

Taking Cropping Intensity ($Y$) as dependent variable, two formulations for two types of machines have been modeled.

**Formulation-1**

For ploughing machinery

$$Y = F(\text{PHU}, \text{OWNR}, \text{TEN}, \text{FS}, \text{IRR}, \text{ATF}, \text{ATE}, \text{AHYV}, \text{PCUL}, L_1, L_2)\ldots$$

........................................................................................................................................6.01
Formulation-2

For irrigating machinery

\[ Y = F(\text{PHU}, \text{OWNR}, \text{TEN}, \text{FS}, \text{EMP}, \text{ATF}, \text{ATE}, \text{AHYV}, \text{PCUL}, L_1, L_2) \ldots \]

------------------------------------------6.02

**Functional Specification of the Model**

The minimum value of cropping intensity is 100 without any limit on maximum value of it. Further, in our data set we have a cluster of 122 observations at 100. So, a Tobit regression model with left censoring will be appropriate than a simple linear regression model. Accordingly, with the help of latent variable \( Y_i^* \), following formulations have been constructed for ploughing and irrigating machinery respectively.

\[
Y_i^* = \beta_0 + \beta_1 \text{PHU}_i + \beta_2 \text{OWNR}_i + \beta_3 \text{TEN}_i + \beta_4 \text{FS}_i + \beta_5 \text{IRR}_i + \beta_6 \text{ATF}_i + \beta_7 \text{ATE}_i + \beta_8 \text{AHYV}_i + \beta_9 \text{PCUL}_i + \beta_{10} \text{L}_1 + \beta_{11} \text{L}_2 + U_i \]

\[
Y_i = 100 \quad \text{for} \quad Y_i^* < 100
\]

\[
Y_i = Y_i^* \quad \text{for} \quad Y_i^* \geq 100
\]

Where \( Y_i = 100 \) for \( Y_i^* \) less than 100

\[ U_i \text{'s are the disturbance terms.} \]

Before estimating the parameters, violation of the assumption of homoscedasticity has been examined by applying Breusch- Pagan test as data set is come from cross section sample. Results obtained using STATA 11 reveals the presence of heteroscedasticity with respect to both types of machineries. Subsequently the problem of heteroscedasticity has been corrected by estimating robust standard errors.

Using STATA 11 maximum likelihood estimates of parameters have been obtained which are presented by table-6.2. Regarding ploughing machinery, variables PHU and OWNR are found to be insignificant, whereas they are highly and positively significant with respect to irrigating machinery. Thus, though use of ploughing machinery has no significant bearing on cropping intensity, use of irrigating machinery either own or through hiring-in is found to be crucial in enhancing
cropping intensity. This reveals that pure hiring-in users of some agricultural capital goods are able to increase their cropping intensity significantly compared to the nonusers of such capital goods. Now use of such machineries without having ownership on them is possible for the pure hiring-in users because of the functioning of rental markets of concerned machineries. Of course through use of machinery, by purchasing them rather than by hiring-in, one can cultivate more intensively than the nonusers. Owner users can derive higher cropping intensity than the pure hiring-in users has been shown by the present study. But purchase of machineries like tractor, power tiller and pumpsets are not always viable due to smallness of land holdings and also not affordable for the poor farmers. Under such circumstances, if rental markets of concerned machineries functions, farmer without having ownership on such machineries can cultivate intensively by using those machineries through hiring-in. Functioning of rental markets may again increase the use of such machineries by increasing ownership due to opening up of opportunity to renting out them which will contribute to the income of the owner. The increase use of machineries due to increased ownership will ultimately add to the gross cropped area and so to the agricultural production. This shows the role of rental markets of agricultural capital goods in agricultural development.

Among the control variables, with respect to both types of agricultural capital goods, farm size is negatively significant and access to finance and pure cultivator are positively significant. Thus, while smaller size group farmers cultivate more frequently than larger size group farmers, access to finance helps in increasing cropping intensity. Further, pure cultivators cultivate land more frequently than cultivator cum other income earners. In case of ploughing machinery IRR is found to be positively significant at 10 percent level of significance which shows the importance of irrigation in promoting cropping intensity. The variable EMP, considered in case of irrigating machinery, is found to be insignificant in influencing cropping intensity. Extent of tenancy, access
to extension services and area under HYVs are found to be insignificant with respect to both types of machineries which show that they have no impact on cropping intensity. Further, no significant variation of cropping intensities across locations has been found with respect to both types of machineries.

<table>
<thead>
<tr>
<th>PHU</th>
<th>0.02(0.09)</th>
<th>0.48(0.09)**</th>
</tr>
</thead>
<tbody>
<tr>
<td>OWNR</td>
<td>0.06(0.12)</td>
<td>0.64(0.10)**</td>
</tr>
<tr>
<td>TEN</td>
<td>-0.03(0.12)</td>
<td>-0.05(0.11)</td>
</tr>
<tr>
<td>FS</td>
<td>-0.08(0.04)*</td>
<td>-0.10(0.04)**</td>
</tr>
<tr>
<td>IRR</td>
<td>0.30(0.16)*</td>
<td>--</td>
</tr>
<tr>
<td>EMP</td>
<td>--</td>
<td>-0.07(0.09)</td>
</tr>
<tr>
<td>ATF</td>
<td>0.20(0.08)**</td>
<td>0.14(0.08)*</td>
</tr>
<tr>
<td>ATE</td>
<td>0.12(0.10)</td>
<td>0.08(0.10)</td>
</tr>
<tr>
<td>AHYV</td>
<td>0.003(0.002)</td>
<td>0.001(0.001)</td>
</tr>
<tr>
<td>PCUL</td>
<td>0.16(0.08)**</td>
<td>0.14(0.07)*</td>
</tr>
<tr>
<td>L1</td>
<td>0.02(0.12)</td>
<td>0.001(0.11)</td>
</tr>
<tr>
<td>L2</td>
<td>-0.11(0.10)</td>
<td>-0.12(0.09)</td>
</tr>
<tr>
<td>Constant</td>
<td>0.79(0.12)***</td>
<td>0.78(0.11)***</td>
</tr>
<tr>
<td>F{11,221}</td>
<td>3.88***</td>
<td>9.88***</td>
</tr>
<tr>
<td>Pseudo R²</td>
<td>0.14</td>
<td>0.26</td>
</tr>
</tbody>
</table>

* ** and *** represents significant at 10%, 5% and 1% respectively
In () and {} figures are robust standard error and degrees of freedom respectively

However, results of the studies about the impact of tractorization on cropping intensity are not similar. Motilal (1973) found cropping intensity of tractor users and nonusers are not significantly differing which is similar to what have been found in the present study. As opposed to Motilal's findings and to the present study, Agarwal's (1984) study reveals that tractor farm's cropping intensity is
significantly higher than that of bullock farms\textsuperscript{15}. The variation of results could be due to methodological variations along with other factors. For instance, in the study made by Agarwal, information was collected by the full time researchers residing in the study areas while for the present study; enumerator had relied on recall method for collection of information. Secondly, in Agarwal’s study regression model fitted for studying the impact of tractor use on cropping intensity is linear while it is Tobit model with left censoring in the present study. Thirdly, Agarwal’s study areas were mainly wheat-growing areas while paddy is the principal crop in case of the present study. Furthermore, differences in soil conditions, status of agriculture etc. can be crucial.

6.3.1(II) Crop Diversification

In the present study, crop diversification has been defined as the allocation of cultivable land in terms of number of crops grown along with the proportion of such land allocated to each type of crops. Distribution of cultivable land to more diverse crops portfolio and with more equality among the crops indicates higher crop diversification. Here, Herfindahl Index has been used to measure the extent of crop diversification. Herfindahl index is given by-

\[ H = \frac{\sum_{i=1}^{n} s_i^2}{\sum_{i=1}^{n} s_i}, \]

Where \( s_i \) is the share of the \( i \)-th crop in the Gross Cropped Area. The range of the Herfindahl index is \( 0 \leq H \leq 1 \). Higher value of Herfindahl index implies more concentration. However, in the present study, for convenience of the interpretation, we have used \( (1-H) \) where the range of values is still same as in case of Herfindahl index. But contrary to the \( H \), higher value of \( (1-H) \) will indicate more diversified cultivation.

Figure-6.12(a) depicts that the values of crop diversification index of nonusers, pure hiring-in users and owner users of ploughing machinery are 0.32\%, 0.45\% and 0.46\% respectively. With respect to irrigating

\textsuperscript{15} Agarwal has considered a farm household as a bullock farm household that exclusively depends on bullock for ploughing and a farm household use tractors for ploughing, may not be for all the rounds of ploughings, as tractor farm household which is similar to the present study.
machinery, crop diversification indices are 0.18%, 0.56% and 0.69% for nonusers, pure hiring-in users and owner users respectively as shown by figure-6.12(b). Thus, in case of both types of machineries it is found that users of machinery are more diversified crops grower than the nonusers. Moreover, between owner users and pure hiring-in users, crop diversification is more in case of former than the latter. This may be due to the fact that as owner of machinery have a better control over the timeliness and extent of use of it, they can add more crops to their crop portfolio which require large scale use of machineries. As per preliminarily investigation, a positive role of rental markets of agricultural capital goods on crop diversification is observed. To validate the impression given by above discussion, let us rely on the econometric techniques.

Independent variables

Users of Ploughing Machinery: PHU=1 for pure hiring-in users, 0 otherwise, OWNR=1 for owner users, 0 otherwise, assuming nonusers as base category.

Users of Irrigating Machinery: PHU=1 for pure hiring-in users, 0 otherwise, OWNR=1 for owner users, 0 otherwise, assuming nonusers as base category.

Control variables

Extent of Tenancy (TEN): Extent of tenancy has been measured as a proportion of lease in area to the total operational holding. In general, a
tenant particularly if he/she is share cropper, incentive for diversified cultivation is less as compared to owner operators (Goswami, 2012). With higher extent of tenancy, extent of crop diversification again reduces. Therefore we can expect a negative sign of this variable. However, in the present study tenants consists of all types of tenants.

**Farm Size (FS):** It has been measured in terms of size of operational holdings. A priori, it is difficult to predict the nature of relationship between farm size and extent of diversified cropping. This is because, while a small farmer with overwhelming labour power may diversify and cultivate many crops, financial constraints may prevent the extent of diversification (Goswami, 2012). Again, while large farmer may grow one specific crop if economics of scale is present in such operation, in absence of economics of scale and if he/she is risk averter, he/she may cultivate with more diversification.

**Pure Cultivator (PCUL):** PCUL is a dummy with 1 for pure cultivator, 0 otherwise. Households earning income only from cultivation has been treated as pure cultivators and rest are as cultivator cum income earner from other sources. Crop diversification is likely to be high for the pure cultivators than the cultivator cum income earner from other sources as their cropping intensity is generally high which increase the scope for more diversification. Therefore, a positive sign of the variable can be expected.

**Access to Finance (ATF):** ATF is a dummy with 1 for borrowers, 0 otherwise.

As most of the small and marginal farmers have financial constraints, access to borrowing can be significant in increasing volume of cultivation and hence in enhancing crop diversification. So, a positive sign of this variable can be expected.

**Extent of Irrigation (IRR):** It has been measured as the ratio of Gross Irrigated Area (without considering the number of rounds irrigated) to Gross Cropped Area. Farmers with more irrigation may grow more
diversified crops as better access to irrigation increases cropping intensity as well as helps in cultivating crops those are more dependent on timely water. Therefore, a positive sign of the variable can be expected.

Access to Extension Services (ATE): ATE is a dummy with 1 if consulted with extension workers, 0 otherwise. A farmer has been considered as the beneficiary of extension services if he/she has consulted with extension workers.

Extension services, through spread of knowledge and awareness, can expect to be contributed positively towards crop diversification.

Location Characteristics: Location of the present study covers three districts. Agricultural practices, due to location advantages or disadvantages say in terms of soil condition, occurrences of flood etc., may vary across locations and so the crop diversification too. Therefore, two dummies, \( L_1 \) and \( L_2 \) have been used taking North Lakhimpur as base category where, \( L_1=1 \) for Morigaon, 0 otherwise and \( L_2=1 \) for Kamrup, 0 otherwise.

Taking crop diversification (Y) as dependent variable, two formulations for two types of machineries have been modeled.

Formulation-1
For ploughing machinery

\[ Y = F(\text{PHU,OWNR,TEN,FS,IRR,ATF,ATE,PCUL,}L_1,L_2) \] ... 6.05

Formulation-2
For irrigating machinery

\[ Y = F(\text{PHU,OWNR,TEN,FS,ATF,ATE,PCUL,}L_1,L_2) \] ............ 6.06

Functional Specification of the Model
Since the range of the dependent variable is \( 0 \leq Y \leq 1 \), a linear regression model will not be appropriate. This is because the predicted values will not necessarily be confined between 0 and 1. Further, in our data set we have a cluster of 100 observations which take the value 0 in the
lower end. So, a Tobit regression model with left censoring will be appropriate than a simple linear regression model. Accordingly, with the help of a latent variable $Y^*_i$, following formulations have been constructed for ploughing and irrigating machinery respectively.

\[
Y^*_i = \beta_0 + \beta_1 \text{PHU}_i + \beta_2 \text{OWNR}_i + \beta_3 \text{TEN}_i + \beta_4 \text{FS}_i + \beta_5 \text{IRR}_i + \beta_6 \text{ATF}_i + \beta_7 \text{ATE}_i + \beta_8 \text{PCUL}_i + \beta_9 L_1 + \beta_{10} L_2 + U_i \]
\[\text{………………..………………..6.07}\]

\[
Y^*_i = \beta_0 + \beta_1 \text{PHU}_i + \beta_2 \text{OWNR}_i + \beta_3 \text{TEN}_i + \beta_4 \text{FS}_i + \beta_5 \text{ATF}_i + \beta_6 \text{ATE}_i + \beta_7 \text{PCUL}_i + \beta_8 L_1 + \beta_9 L_2 + U_i \]
\[\text{………………..………………..6.08}\]

Where $Y_i = 0$ for $Y^*_i < 0$

$= Y^*_i$ for $0 \leq Y^*_i \leq 1$

and $U_i$ s are the disturbance terms.

Before proceeding to the estimation of the parameters, presence of problem of heteroscedasticity has been examined by applying Breusch- Pagan test as data set come from cross section sample. Results obtained using STATA 11 reveals that the problem of heteroscedasticity is present with respect to ploughing machinery. Since, the problem of heteroscedasticity is present in case of ploughing machinery; it has been corrected by estimating white’s heteroscedasticity consistent robust standard errors.

Summary of the maximum likelihood estimates of parameters, obtained using STATA 11, are shown by table-6.3. The variables PHU and OWNR are not significant with respect to ploughing machinery while they are positively significant at 1 percent with respect to irrigating machinery. Thus similar to cropping intensity, mechanization of ploughing has no role in augmenting diversified cropping too but access to irrigation facilities, i.e., irrigation through either own machinery or hiring-in of machinery times plays an important role in crop diversification. Significantly more crop diversification by pure hiring-in users compared to nonusers reveals the role of rental markets of agricultural capital goods in enhancing agricultural productivity enhancing practice as discussed above in case of cropping intensity.
With regard to control variables, access to finance is found to be positively significant at 1 percent in case of both the formulations and access to extension services is positively significant only with respect to ploughing machinery. Again, extent of irrigation is positively significant with respect to ploughing machinery depicting its contribution in enhancing extent of crop diversification. Other variables such as extent of tenancy, farm size and pure cultivator are found to be insignificant with respect to both types of machineries which reveal no role of those factors in determining the extent of crop diversification. Location dummy $L_1$ is positively significant with respect to both types of machineries indicating crop diversification is more in Morigaon compared to North Lakhimpur. On the other hand $L_2$ is not significant in case of both types of machineries which means that there is no significant difference of extent of crop diversification between North Lakhimpur and Kamrup.

<table>
<thead>
<tr>
<th></th>
<th>With Respect to Ploughing Machinery</th>
<th>With Respect to Irrigating Machinery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breusch-Pagan test for heteroscedasticity</td>
<td>Breusch-Pagan test for heteroscedasticity</td>
<td></td>
</tr>
<tr>
<td>Chi$^2{1}$ = 12.87</td>
<td>Chi$^2{1}$ = 0.84</td>
<td></td>
</tr>
<tr>
<td>Probability = 0.0003</td>
<td>Probability = 0.3583</td>
<td></td>
</tr>
<tr>
<td>Result= Presence of heteroscedasticity</td>
<td>Result= No heteroscedasticity</td>
<td></td>
</tr>
<tr>
<td>PHU</td>
<td>-0.10 (0.06)</td>
<td>0.29 [0.05]***</td>
</tr>
<tr>
<td>OWNR</td>
<td>-0.11 (0.08)</td>
<td>0.44 [0.06]***</td>
</tr>
<tr>
<td>TEN</td>
<td>-0.05 (0.07)</td>
<td>-0.04 [0.06]</td>
</tr>
<tr>
<td>FS</td>
<td>0.02 (0.02)</td>
<td>0.003 [0.02]</td>
</tr>
<tr>
<td>IRR</td>
<td>0.30 (0.08)***</td>
<td>--</td>
</tr>
<tr>
<td>ATF</td>
<td>0.18 (0.05)***</td>
<td>0.13 [0.04]***</td>
</tr>
<tr>
<td>ATE</td>
<td>0.11(0.05)*</td>
<td>0.06 [0.05]</td>
</tr>
<tr>
<td>PCUL</td>
<td>0.07 (0.05)</td>
<td>0.05 [0.04]</td>
</tr>
<tr>
<td>$L_1$</td>
<td>0.22(0.06)***</td>
<td>0.11 [0.05]**</td>
</tr>
<tr>
<td>$L_2$</td>
<td>0.06 (0.07)</td>
<td>0.01 [0.05]</td>
</tr>
<tr>
<td>Constant</td>
<td>-0.13 (0.07)**</td>
<td>-0.16 [0.06]***</td>
</tr>
<tr>
<td>F${10,222}$</td>
<td>7.37***</td>
<td>--</td>
</tr>
<tr>
<td>LR chi$^2{9}$</td>
<td>--</td>
<td>111.69***</td>
</tr>
<tr>
<td>Pseudo $R^2$</td>
<td>0.22</td>
<td>0.41</td>
</tr>
</tbody>
</table>

* *** and **** represents significant at 10%, 5% and 1% respectively
In (), [], and {} figures are robust standard error, standard error and degrees of freedom respectively.
6.3.1(III) Productivity

Although there are different concepts of productivity, concept of land productivity has been used in the present study. It has been defined as the production of a crop per unit of land. Here we have measured land productivity in terms of production of paddy in kilogram per hectare of paddy acreage. Paddy is taken for the study since almost all the sample households (96.12 percent) have grown this crop.

Figure-6.13(a) depicts that the productivity of paddy of pure hiring-in users and owner users of ploughing machinery are higher than that of nonusers. Again, between owner users and pure hiring-in users, former group is at a better position as compared to the latter group. In case of irrigating machinery, productivity of paddy is considerably varied among the farmer groups by use status as shown by figure-6.13(b). It is found that the productivity of paddy of nonusers, pure hiring-in users and owner users of irrigating machinery are 3069.85, 4038.52 and 4517.99 kg/hectare respectively. Thus the impression given by the analysis is that while productivity of paddy of users of machinery is more than that of nonusers, owner users are at better position than the pure hiring-in users. For confirmation of the idea derived, let us proceed to the next step that based on econometric techniques.
Independent variables

*Users of Ploughing Machinery:* PHU=1 for pure hiring-in users, 0 otherwise, OWNR=1 for owner users, 0 otherwise, assuming nonusers as base category.

*Users of Irrigating Machinery:* PHU=1 for pure hiring-in users, 0 otherwise, OWNR=1 for owner users, 0 otherwise, assuming nonusers as base category.

Control variables

*Extent of Tenancy (TEN):* Extent of tenancy has been measured as the proportion of lease in area to the total operational holdings. Productivity of crops is lower for the tenants than the own land cultivators (Junankar, 1976). Again, land productivity may be even less for share croppers due to lack of incentive to take care of crops as the total amount produced has to be shared with land lord without cost sharing. Again, with the higher extent of tenancy, productivity may fall. Therefore we can expect a negative sign of this variable.

*Farm Size (FS):* It has been measured in terms of size of operational holdings. In general, it is believed that farm size and productivity is more or less inversely related. But, results of the study by both Rao et al (1981) and Dorward (1999) have shown that in some circumstances larger size holdings and higher productivity can positively related. So, a priori, it is difficult to expect a specific sign of this variable.

*Access to Finance (ATF):* ATF is a dummy with 1 for borrowers, 0 otherwise.

As most of the small and marginal farmers are poor, access to borrowing is seemed instrumental in enhancing productivity through adequate uses of fertilizers, pesticides, improved seeds, irrigation etc. Hence, a positive sign of this variable can be expected.

*Extent of Irrigation (IRR):* It has been measured as the ratio of Gross Irrigated Area (without considering the number of rounds irrigated) to Gross Cropped Area. Extent of irrigation is likely to be positively related to the productivity as sufficient water at appropriate time is crucial in
enhancing productivity. So, we can expect a positive sign of this variable.

Access to Extension Services (ATE): ATE is a dummy with 1 if consulted with extension workers, 0 otherwise. A farmer has been considered as the beneficiary of extension services if he/she had consulted with extension workers. Extension services, through spread of knowledge and awareness, can be expected to contribute positively towards productivity.

Area under High Yielding Varieties (AHYV): Percentage of area under boro paddy to the total paddy acreage has been used as the indicator of HYV adoption. As HYVs are more productive than traditional varieties, average productivity will be increased with increased proportion of area under HYVs. So, a positive sign of the variable can be anticipated.

Fertilizer Consumption (FER): It has been measured in terms of application of NPK (in kg)/hectare of paddy. As fertilizer application improves productivity, a positive sign can be expected for this variable.

Location Characteristics: Location of the present study covers three districts. Agricultural practices, due to location advantages or disadvantages say in terms of soil condition, occurrences of flood etc., may vary across locations and so the productivity too. Therefore, two dummies, L1 and L2 have been used taking North Lakhimpur as base category where, L1=1 for Morigaon, 0 otherwise and L2=1 for Kamrup, 0 otherwise.

Taking Productivity (P) as dependent variable, two formulations for two types of machineries have been modeled.

Formulation-1
For ploughing machinery

\[ P = F(\text{PHU}, \text{OWNR}, \text{TEN}, \text{FS}, \text{IRR}, \text{ATF}, \text{ATE}, \text{AHYV}, \text{FER}, L_1, L_2) \] . 6.09

Formulation-2
For irrigating machinery
P=F(PHU,OWNR,TEN,FS,ATF,ATE,AHYV,FER,L1,L2)…… 6.10

Functional Specification of the Model
Since dependent variable can takes only positive values, an exponential specification of the models will be more suitable. So, following formulations of functions 6.09 and 6.10 have been constructed respectively.

\[ P=\exp(\beta_0+\beta_1PHU_i+\beta_2OWNR_i+\beta_3TEN_i+\beta_4FS_i+\beta_5IRR_i+\beta_6ATF_i+\beta_7ATE_i+\beta_8AHYV_i+\beta_9FER+\beta_{10}L1_i+\beta_{11}L2_i+U_i) \] …………...……...….6.11

\[ P=\exp (\beta_0+\beta_1PHU_i+\beta_2OWNR_i+\beta_3TEN_i+\beta_4FS_i+\beta_5ATF_i+\beta_6ATE_i+\beta_7AHYV_i+\beta_8FER+\beta_9L1_i+\beta_{10}L2_i+U_i) \] …………...……...….6.12

Since formulations 6.11 and 6.12 are non-linear, let us make them linear by taking log on both sides of equations as follows-

\[ \ln P=\beta_0+\beta_1PHU_i+\beta_2OWNR_i+\beta_3TEN_i+\beta_4FS_i+\beta_5IRR_i+\beta_6ATF_i+\beta_7ATE_i+\beta_8AHYV_i+\beta_9FER+\beta_{10}L1_i+\beta_{11}L2_i+U_i \] …………...……...….6.13

\[ \ln P=\beta_0+\beta_1PHU_i+\beta_2OWNR_i+\beta_3TEN_i+\beta_4FS_i+\beta_5ATF_i+\beta_6ATE_i+\beta_7AHYV_i+\beta_8FER+\beta_9L1_i+\beta_{10}L2_i+U_i \] …………...……...….6.14

Where, \( U_i \)s are the disturbance terms.

As data set come from cross section sample, there is the possibility that disturbance term is not homoscedastic. Hence, estimation of the models has been done after checking the problem of heteroscedasticity by applying Breusch- Pagan test. Results obtained using STATA 11 reveals that the problem of heteroscedasticity is not present with respect to both types of machineries.

Ordinary Least Square estimates of the log-linear regression models are obtained using STATA 11. Table-6.4 shows that the productivity of paddy is not significantly varied across three types of farmers by use status of ploughing machinery. Contrast to ploughing machinery, owner users and pure hiring-in users of irrigating machinery are associated with significantly higher productivity of paddy than the nonusers of such machinery. In other words, farmers without having ownership holding on irrigating machinery can still irrigate their crops by hiring-in the times of such machinery and derive significantly higher productivity.
Extraction of higher productivity by pure hiring-in users indeed reveals the role of rental markets as discussed in details in case of cropping intensity above. Thus rental markets of some agricultural capital goods are found to be playing an important role in enhancing agricultural productivity.

Among the control variables, area under HYVs and fertilizer consumption are positively significant at 5 percent with respect to both types of machineries reflecting their contribution in enhancing productivity of paddy. Further, extent of irrigation and access to finance are also found to be important contributors to the productivity of paddy with respect to ploughing machinery. However, extent of tenancy, access to extension services and farm size has no effect on agricultural productivity. Across locations, productivity is found to be lower in Morigaon than in North Lakhimpur with respect to both types of machineries but they are not varied significantly between Kamrup and North Lakhimpur.

Table-6.4: Results of Log-linear Regression Models for Productivity

<table>
<thead>
<tr>
<th></th>
<th>With Respect to Ploughing Machinery</th>
<th>With Respect to Irrigating Machinery</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Breusch-Pagan test for heteroscedasticity</td>
<td>Breusch-Pagan test for heteroscedasticity</td>
</tr>
<tr>
<td></td>
<td>Ch$^2$(1) = 0.37</td>
<td>Ch$^2$(1) = 1.36</td>
</tr>
<tr>
<td></td>
<td>Probability = 0.5453</td>
<td>Probability = 0.2443</td>
</tr>
<tr>
<td>Result= No heteroscedasticity</td>
<td>Result= No heteroscedasticity</td>
<td></td>
</tr>
<tr>
<td>PHU</td>
<td>-0.02 (0.06)</td>
<td>0.23 (0.05)***</td>
</tr>
<tr>
<td>OWNR</td>
<td>0.06 (0.08)</td>
<td>0.21 (0.06)***</td>
</tr>
<tr>
<td>TEN</td>
<td>0.05 (0.06)</td>
<td>0.03 (0.06)</td>
</tr>
<tr>
<td>FS</td>
<td>-0.02 (0.02)</td>
<td>-0.01 (0.02)</td>
</tr>
<tr>
<td>IRR</td>
<td>0.15 (0.09)*</td>
<td>--</td>
</tr>
<tr>
<td>ATF</td>
<td>0.09 (0.05)**</td>
<td>0.07 (0.04)</td>
</tr>
<tr>
<td>ATE</td>
<td>0.07 (0.05)</td>
<td>0.07 (0.05)</td>
</tr>
<tr>
<td>AHYV</td>
<td>0.003 (0.001)**</td>
<td>0.003 (0.001)**</td>
</tr>
<tr>
<td>FER</td>
<td>0.001(0.001)**</td>
<td>0.001 (0.001)**</td>
</tr>
<tr>
<td>L$_1$</td>
<td>-0.16 (0.07)**</td>
<td>-0.18 (0.07)**</td>
</tr>
<tr>
<td>L$_2$</td>
<td>-0.03 (0.06)</td>
<td>-0.04 (0.05)</td>
</tr>
<tr>
<td>Constant</td>
<td>8.01 (0.06)***</td>
<td>7.97 (0.05)***</td>
</tr>
<tr>
<td>F</td>
<td>10.75**(11,211)</td>
<td>14.83**(10,212)</td>
</tr>
<tr>
<td>R$^2$</td>
<td>0.36</td>
<td>0.41</td>
</tr>
<tr>
<td>Adjusted R$^2$</td>
<td>0.33</td>
<td>0.38</td>
</tr>
</tbody>
</table>

* , ** and *** represents significant at 10%, 5% and 1% respectively
In () and {} figures are standard error and degrees of freedom respectively
6.3.2 Contribution of Rental Markets of Agricultural Capital Goods to the Total Agricultural Production

The discussion in section 4.4.4(I) shows that on an average participants in rental markets of both ploughing and irrigating machinery have higher cropping intensity than the non-participants group. The average cropping intensity of participants in rental markets of ploughing machinery is 115.25 percent against 115.00 percent of the non-participants. Again, in case of rental markets of irrigating machinery, average cropping intensity of market participants is 127.35 percent whereas it is 109.30 percent of the non-participants. This reveals the fact that, on an average, rental market participants of both machineries are in a better position compared to non-participants. Further, discussion in section 6.3.1(I) on average cropping intensity of farmer groups by use status of machinery has shown that compared to non-user group users of machinery through exclusively hiring-in (pure hiring-in group) are associated with higher cropping intensities in case of both types of machineries. In fact, this difference is significant in case of irrigating machinery. Thus it is found that farmers without owning agricultural capital goods can still use such capital goods by hiring-in if rental markets of capital goods is functioning and they can extract higher total agricultural production in terms of increased cropping intensity.

Rental markets of agricultural goods also found to be contributed to agricultural production in other form. Hariapar village and its nearby areas under Morigaon is highly flood prone where rearing of bullock is very difficult and so scope for bullock hiring-in is extremely low. In that village while a total of 96.00 percent of sample households have been found to be using machinery in ploughing operation, a total of 80.00 percent surveyed households are pure hiring-in users. Thus it is found that in a situation where dependence on traditional plough unit is very less or nil and purchase of ploughing machinery is not feasible due to monetary or non-monetary factor, cultivation is still possible by hiring-in
such machinery if rental market of it is functioning which ultimately contributes to the total agricultural production.

Regarding other better farm practices also market participants are associated with the higher values than the non-participants. For instance in case of chemical fertilizer consumption, NPK application by participants in rental markets of ploughing machinery is 67.19 kg/hectare against 55.34 kg/hectare of non-participants. Again, with respect to rental markets of irrigating machinery, NPK application by participants (81.41 kg/hectare) is larger than that of by non-participants (52.74 kg/hectare).

Thus rental markets of agricultural capital goods contribute to the increase of total agricultural production not only by augmenting gross cropped area through enhanced cropping intensity but also through facilitating wider application of farm productivity enhancing practices.

6.4 Conclusion

This chapter deals with the main research question (that includes one objective) of the study in two parts. In first part, studying the contribution of rental markets of ploughing and irrigating machinery in mechanization of agricultural operation, it is found that functioning of such markets benefit farmers in general and small and marginal farmers in particular. The present study confirms that despite the preponderance of small, marginal and fragmented holdings in Assam, the use of lumpy agricultural capital goods like power tiller, tractor and irrigating pumpset have been facilitated by the thriving rental markets of such capital goods. Thus as far as use of farm machineries is concerned, the rental markets of these machineries have obviated the need for that component of agrarian reforms which aimed to consolidate holdings.

16 According to NSS reports 491 and 492, marginal and small holdings comprised of 96% of ownership holdings and 80% of total area owned in Assam (Goswami et al, 2013) and as per data provided by Agriculture Census, Assam, 2010-11, a total of 85.57% of operational holdings and 48.75% of operated area were of small and marginal size.
Regarding the contribution to use of production and productivity enhancing practices, it is found that rental markets of irrigating machinery has significant positive impact while rental markets of ploughing machinery have not had so significant impact. However, regarding the impact of rental markets of ploughing machinery on agricultural production and productivity enhancing practices, results might have been different if intensity of use of such machinery was considered instead of considering just adoption status. Insignificant of rental markets of ploughing machinery in stimulating agricultural productivity is affected by some special circumstances. For example, in Hariapar village, one sample village of the study, participation in rental market of ploughing machinery is 96 percent. But such a high participation rate in the village is to some extent accompanied by extremely less feasibility of rearing of bullock as the area is flood prone. Under such circumstances, definitely agricultural production and productivity enhancing practices like multiple cropping is limited but cultivation by poor farmers is still possible because of functioning of rental markets of ploughing machinery which ultimately increases agricultural production.

A common finding with respect to the contribution of rental markets of agricultural capital goods on production and productivity enhancing practices is that the owner users are always in a better position than the hiring users which depicts the presence of imperfection of rental markets of agricultural capital goods. A probable source of imperfection of rental markets of agricultural capital goods is the fact that majority of suppliers of agricultural capital goods are user cum suppliers. It is conceivable that their machineries are available for hiring-in only when these are not used in his/her farm. Therefore, such capital goods may not be available for hire in at the most convenient time for the hirers. Nevertheless rental markets of agricultural capital goods have been contribute to productivity and/or production in spite of the above mentioned imperfection.