Working Paper No. CDS/03/2019

Rental Markets of Farm Capital Goods: A Study of its Forms, Determinants of Participation and Impact on Agriculture

Anup Kumar Das

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Centre for Development Studies
Department of Economics
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PREFACE

The Centre for Development Studies (CDS) was set up as a research adjunct at the Department of Economics, Rajiv Gandhi University (RGU), Itanagar, Arunachal Pradesh, with a generous grant from the Ministry of Finance (Department of Economic Affairs), Government of India. The objectives of the Centre include the creation of high-quality research infrastructure for students and researchers and faculty members, in addition to sponsoring and coordinating research on various developmental issues having policy implications both at the regional and national level. Publishing working/policy papers on the research outcome of the Centre, monographs and edited volumes areamong the key activities of the Centre. The present working paper by Dr. Anup K Das, titled, '***Rental Markets of Farm Capital Goods: A Study of its Forms, Determinants of Participation and Impact on Agriculture'***, is the research outcome of a project funded by the CDS. It is the *third* in the series of working paper published by the Centre for Development Studies.

The working paper discusses the forms of rental markets, the factors affecting the participation in such markets and its impact on agricultural production and productivity enhancing practices. Rental markets of agricultural machinery, especially which are expensive in nature, can play an important role in farm operation. It can facilitate farm mechanization even by small and marginal farmers for whom heavy machinery like tractor, power tiller etc. are not affordable. Rental markets of machinery can enhance farm mechanization further by increasing incentives to invest in such capital goods. In the presence of rental markets of farm machinery, owner farmers with insufficient land for fuller utilization of machine's capacity can reduce the underutilization by renting-out the machinery. This adds to the return of owner farmers from their investment in such machinery. The study further emphasises that rental markets of agricultural machinery can also be effective in helping farmers to cope with the changing circumstances, such as difficulty of rearing the draught animals due to lack of grazing land, frequent flood, man power shortage etc. The author concludes on a positive note that the rental markets of farm machinery can contribute significantly to farm operations.

This working paper, with its focus on the rental markets of farm capital goods will be of interest and use to policy planners, academics, researchers and students. I congratulate the author for the excellent time bound work.

Date: July, 2019

Vandana Upadhyay
Coordinator, Centre for Development Studies
Department of Economics, Rajiv Gandhi University

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Anup Kumar Das
Rajiv Gandhi University, Itanagar
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SUMMARY

Rental markets of agricultural machinery, especially which are expensive in nature, can play an important role in farm operation. It can facilitate farm mechanization even by small and marginal farmers for whom heavy machinery like tractor, power tiller etc. are not affordable. Rental markets of machinery can enhance farm mechanization further by increasing incentives to invest in such capital goods. In the presence of rental markets of farm machinery owner farmers with insufficient land for fuller utilization of machine's capacity can reduce the underutilization by renting-out of such machinery. This adds to the return of owner farmers from their investment in such machinery. Rental markets of agricultural machinery can also be effective in helping farmers to cope with the changing circumstances, such as difficulty of rearing the draught animals due to lack of grazing land, frequent flood, man power shortage etc. While rental markets of farm machinery can contribute significantly to farm operation, there are some issues which need a comprehensive study. On this background, the present paper discussed the forms of rental markets, factors affecting the participation in such markets and its impact on agricultural production and productivity enhancing practices.

In the first chapter of the paper, the research problem, objectives, research question and methodology adopted in the investigation are discussed.

The review of literature related to factors markets in agriculture and its significance in farm operation has been stated in chapter 2. The discussion in this chapter focuses on rental markets of farm capital goods.

In chapter 3, backgrounds of the Assam, its economy, state of agriculture and use of agricultural capital goods are discussed in the light of secondary data. Discussion in this chapter depicts that in Assam, agriculture is still an important component of the economy. However, growth of agriculture in Assam is fluctuating. Heavy agricultural machinery like tractor, power tiller, pump set etc. are in use in the state.

Chapter 4 start with discussion on the procedure of sample selection and overview of field study locations. In the subsequent part of the chapter, based on field study inputs, the extent of rental markets, its role in farm operation and forms of such markets are discussed. In the study area, rental market of ploughing machinery are functioning in three forms and contributing significantly in farm operation. The area based form of rental markets is the dominant one.

The discussion in chapter 5 includes the purposes of rental market participations, factors affecting the hiring of ploughing machinery and impact of such markets on cropping intensity, crop diversification and yield. Realization of benefits of farm mechanization is the prime motive of participation in rental markets of ploughing machinery. In hiring of ploughing machinery, ownership of both draught animals and ploughing machinery plays a negative role. It is found that the rental markets of ploughing machinery have no direct role in increasing cropping intensity, crop diversification and yield realization of paddy.

In the final chapter, principal findings of the study, broad conclusions and policy implications thereof have been stated.

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CHAPTER 1
INTRODUCTION

1.1 Background of the Study

Rental markets of agricultural machinery especially which are expensive in nature can enhance farm mechanization at least in two ways: a) by increasing incentives to invest in such capital goods. In the presence of rental markets of farm machinery, return from such investment can be increased. Because, besides the return from the use of machinery in own farm, owners with excess machinery capacity can earn return from their investment by hiring-out the services of such machinery. b) With the well-functioning of rental markets for farm machinery, poor farmers for whom agricultural machinery are not affordable can still mechanize their farm operation by hiring-in the services of such machinery. Thus, the problem of non-divisibility of farm machinery will no longer persist if the rental markets for such machinery are functioning. In fact, the rental markets of farm machinery can play the same role as other factor markets like water markets (Saleth, 1996, Shah et al., 1997, Easter et al., 1999, Mukherji, 2004 and 2008, Dutta, 2011 and Tamuli, 2014), land lease markets (Goswami, 2012 and Ray, 2011) etc. in increasing agricultural production and productivity. Rental markets of agricultural machinery can also be effective in helping farmers to cope with the changing environment such as difficulty of rearing the draught animals due to lack of grazing land, frequent occurrence of flood, man power shortage etc. In this context, Rath (2015) pointed out that with the difficulty to maintain even a single bullock; small farmers tend to hire bullock and ploughs or increasingly tractors for ploughing work.

Assam is a predominantly agriculture based state of India. However, like the country as a whole, the average size of farms is very small. As per data provided by Agriculture Census, Assam, 2010-11, average size of operational holdings of Assam is only 1.10 hectare. Among the operational holdings, 67.32 percent and 18.25 percent are below one hectare and one to two hectares respectively. Given the average size of operational holdings and also the extent of small and marginal farmers in the state, it was thought that rental markets of farm machinery can play an important role in augmenting agricultural mechanization and thus the overall development of the sector. The functioning and impact of rental markets of farm capital goods in Assam have been studied by Das (2015). The study by Das (2015) covered various aspects of

rental markets of agricultural capital goods like the extent of such markets, impactsof such markets on mechanization, production and productivity of agriculture, rental rate structure and its determinants, impact of credit on such markets in his study. But some aspects of rental markets of farm capital goods like the forms of these markets and determinants of participation in such markets etc. were not covered. Moreover, the impact of rental markets of ploughing and irrigating machinery on agricultural production and productivity have been investigated without considering the intensity of use (number of rounds) of such machinery while the intensity of use of machinery may have important role in adoption of land productivity utilization practices. Thus, there is still a research gap on the rental markets of farm capital goods.

Hence, to fulfill the research gap, the present study aims to see the forms of rental markets, factors affecting the participation in such markets and the impact of them on agricultural production and productivity enhancing practices considering the intensity of use in the Brahmaputra Valley of Assam[1].

The present study focuses on the ploughing machinery as these are the most expensive farm capital goods. Of course, harvesters, irrigating machinery are also expensive. But as combined harvesters are hardly in use in study location (Input Survey, Assam, 2006-07), such machinery are not considered for the present study. Moreover, irrigating machinery are not so movable and their rental markets are likely to be less extensive. The traditional farm implements are affordable for most of the farmers as they are not so expensive. Hence, the rental markets for traditional farm implements are supposed to be non-exitance or even if exist, such markets will not be so extensive.

1.2 Objectives and Research Question

(i) To document the forms of rental markets of farm capital goods.

(ii) To identify the factors affecting participation in rental markets of farm capital goods.

(iii) To examine the impact of rental markets of farm capital goods on production and productivity enhancing practices of agriculture.

[1] The Brahmaputra Valley covers around 72 per cent and 85 per cent of its geographical area and population respectively.

The study will also pursue the research question whether rental markets of ploughing machinery constitute largely the extension of mechanization process or merely the substitution of markets of traditional ploughing units.

1.3 Materials and Methods

1.3.1 Materials

Inputs from secondary sources were used for preparing the statistical background of study location, role of agriculture in state economy, status of agriculture and the intensity of use of farm machinery. The sources of secondary data are like Agriculture Census of Assam for periods 2005-06 and 2010-11, Input Survey of Assam, 2006-07, Economic Survey of Assam, 2011-12 and 2014-15, Statistical Hand Book of Assam, 2013 and 2014, Directorate of Economic and Statistics, Assam etc.

But the core of the analysis is based on field study data collected by using the multi-sage sampling technique. First, on the basis of available secondary data, three districts from the Brahmaputra Valley were selected considering the fact that farm capital goods in question are used there. From each district, two villages were selected in random. Finally, from each selected village farm households[2]not less than 6.79 percent of the total farm households of the village and around 9.35 percent of farm households of all studied villages were surveyed as final sample unit. A total of 121 households were surveyed for the present investigation.

1.3.2 Methods

While secondary information gave a brief overview of agriculture in the state and intensity of use of ploughing machinery particularly those are costly, all the objectives and research question have been fulfilled using inputs from fields. Besides using the simple statistical tools like bar diagram, table, percentages etc. for documentation and analysis, appropriate econometric techniques have also been used wherever necessary to address the set objectives and research question.

As per the first objective of the present study, forms of rental markets have been examined in terms of nature of contract. Here, whether leasing is time based or area based has been checked. Moreover, in case of time based, duration of leasing in a round has also been checked.

[2] A household has been considered as farm household if at least one member of the family is engaged in cultivation either in own land or in leased in land during the reference year.

The identification of factors affecting the decision to participate in rental markets has been done using TOBIT models. However, due to technical difficulty, determinants in rental markets of ploughing machinery have been studied from demand side only.

The third objective of the study has been fulfilled using TOBIT and Log-linear regressions. Here, the impact of ploughing by hired-in machinery on cropping intensity, crop diversification and yield of paddy were analyzed.

The research question has been answered by analyzing the contribution of rental markets in mechanization of ploughing operation.

1.4 Outline of the Paper

The research problem, objectives, research question and methodology adopted in the investigation have been stated in chapter-1. The chapter-2 includes a review of literature related to factors markets in agriculture with the focus on rental markets of farm capital goods. The backgrounds of study area, its economy, state of agriculture and use of agricultural capital goods have been incorporated in chapter-3. The procedure of sample selection, brief overview of field study locations in relation to agricultural facilities have been stated in chapter-4. This chapter also includes the extent of rental markets, its role in farm operation and forms of such markets. Purposes of rental market participations, factors affecting hiring-in of ploughing machinery and impact of such markets on cropping intensity, crop diversification and yield have been discussed in chapter-5. In the final chapter principal findings, broad conclusions and policy implications thereof have been stated.

CHAPTER 2

FACTOR MARKETS AND ITS ROLE IN FARM OPERATION: A REVIEW OF LITERATURE

2.1 Factor Markets in Agriculture

The various farm inputs are possessed disproportionately by the most of the farm units. The different factor markets in agriculture like land markets particularly the lease markets, labour markets, credit markets, water markets, rental markets of agricultural capital goods etc. helps in correcting the unequal distribution of agricultural inputs. For instance, land market helps to allocate the land from land rich farm units with scarcity of other inputs to the farm units rich in inputs other than land. Here, role of land lease market is more significant. Because in the presence of land lease markets, a land poor farm unit for whom expansion of farm size through purchase of land is not feasible can still manage it by leasing-in the land. On the other hand, land surplus household, for whom own cultivation is not possible, can lease-out the land and get some agricultural output. Adjustment of land through land markets help to become smaller farm unit to be of viable size for mechanization. This ultimately increases production and productivity of agriculture by allowing the mechanize cultivation.

Labour market, another factor market in agriculture, has also an important role in enhancing agricultural development. This type of factor market helps to distribute labour from surplus households to scarce households. With the functioning of such market, agriculture sector gained in different forms. This type of markets allows efficient utilization of cultivable land by distributing labour force to farm units possessing insufficient labour force. Moreover, in the presence of such market, extent of mechanization can be enhanced by facilitating manpower to the cultivators who can invest in farm machinery but constrained by inadequate manpower. Above all, labour market helps in increasing agricultural productivity by reducing disguised unemployment.

Credit markets are other important factor markets in agriculture. Credit is the most liquid farm inputs. Credit markets have a very significant role in agricultural development. With a perfectly functioning credit market, resources can be allocated very effectively even if other input markets are not functioning. If credit market

functions, farmers will be able to take the advances of mechanization for those credit is the constraint in its adoption. It also contributes to agriculture by making possible to adopt improved farm practices by credit constrained farmers. In this context, Junankar (1976) mentioned that due to lack of credits small farmers had to work with inferior production function than the larger farmers. Swamy (1980) stated about the significance of institutional credit in extending technological changes in agriculture. Credit markets can be formal or informal. Problems of credit market are inability and unwillingness to repay by the borrowers.

Water market is another agricultural factor market. Increasing scarcity of water and energy, bottlenecks for private investment in irrigation assets, and the expansion of public/state tube wells and cooperative lift schemes have all contributed to the emergence of irrigation pump set rental. Such markets help in increasing cropping intensity, adoption of HYV seeds, introduction of new crops, productivity etc. particularly by the poor farmers.

Traditional Agricultural factor markets like land, labour, credit markets, which have important bearing on the agricultural development, have got the full attention of the researchers. For instance, there are studies on land market by Bardhan (1980), Nabi (1985), Kumar (1991), Sarap (1998), Yao (2000), Kuri (2003), Sharmaet al (2003), Murty (2004), Vranken et al (2006), Lermanet al (2006), Deininger et al(2008), Ray(2011), Goswami et al (2013) etc. Regarding labour markets investigation was done by researchers like Nabi (1985), Kuri (2003), Sharma et al(2003), Ray (2011) etc. Again, about the credit markets studies carried out by Junankar (1976), Swamy (1980), Ray (2011) etc. are available. In last few decades, with the dynamic changes of the agriculture sector brings by the factors like population pressure, uses of new technology, introduction of HYV seeds etc. led to the emergence of new agricultural factor markets such as water market and rental markets agricultural capital goods. While on water market some studies have been made by Saleth (1996), Easter et al (1999), Dutta (2007), Tamuli (2014) etc., the rental markets of agricultural capital goods are yet to get the attention of the researchers.

2.2 Rental Markets and Farm Operations

The adoption and use of farm machinery have great role in farm operations and in deriving higher productivity and production. Several works carried out by the researchers had shown that the agriculture sector gains by its mechanization in different forms. Mechanization of agriculture helps in timely cultivation, in raising productivity of land and labour, in minimizing cultivation costs, in maintenance of quality of operation etc. (Singh, 2006 and Singh, 2011). Mechanization of agriculture

make possible to reduce unhygienic farm operation and the drudgery of human labour (Singh, 2011). Agarwal's (1984) discussion on impact of tractor and tube well on cropping intensity reveal that use of such machinery result higher cropping intensity than the use of traditional ploughing mode and canal irrigation. Positive impacts of use of tractor in agriculture on cropping intensity were found in the study carried out by Roy et al (1978). Regarding the impact of ploughing machinery on productivity, as per an investigation made by ITES, Madras in 1975, it was found that the productivity increase on tractor owning and hiring farms is 4.1 to 54.8 percent (cited in Verma, 2014). Study also reveals that increase of gross income of tractor users. As for example, gross income per hectare of land derived by the farms owned tractor was 63 percent higher than the bullock owned farms (cited in Verma, 2014).

Thus, there are empirical evidences of the fact that mechanization of agriculture specifically uses of ploughing and irrigating machinery benefits agriculture by increasing cropping intensity, productivity, gross income etc. Of course, there is a debate about the impact of tractorization of agriculture on employment generation. Quite often it is said that use of tractor in farm operation cost employment opportunities. But different studies have revealed that displacement of labour due to tractorization is nominal and insignificant (Verma, 2014). In fact, such adverse effect is more than compensated by employment opportunities open ups because of higher intensity of cultivation, necessity of complementary non-farm services (manufacturing, repair etc.) etc. In this context, Roy et al (1978) mentioned that besides the higher output, increased employment can also be achieved through tractorization.

Thus, from the above discussion, considering all the positive and negative effects of mechanization on agriculture, it can be said that the use of farm machinery contributes to the sector to a great extent.

Due to the inelastic supply of land and also population pressure, feasibility of increase of agricultural output through expansion of cultivable area is declining. Under such circumstances, the importance of adoption and use of machinery in agriculture is increasing to achieve higher production and productivity. While farm mechanization seems to be indispensable for higher agricultural production and productivity, machinery especially use for ploughing purpose are not affordable for poor farmers. In fact, owning such machinery is also not efficient for farmers having cultivable land less than the capacity of machinery. Under such circumstances rental markets of such machinery is one way out. Discussing the production relations in agriculture, Binswanger et al (1986) pointed out the different possible forms of farm

machinery rental markets along with possible constraints in their functioning. Literature on rental markets of such machinery and also on other farm capital goods is few and far between. Agricultural factor markets have been discussed by Ray (2011) to a great extent but it was not specific to rental markets of ploughing machinery. Another study carried out by Agarwal (1984) in Punjab about the impact of use of tractor and tube well on cropping intensity had shown the functioning of rental markets of ploughing machinery. That study was also not dealt specifically with the rental markets of ploughing machinery. Presence of rental markets of tractor has also been mentioned in research works carried out by Roy et al (1978), Jodha (1974) etc. But these studies have not covered the various important aspects of such markets.

In a study by Das (2015), functioning and impact of rental markets of ploughing and irrigating machinery in Assam has been studied. The study basically dealt with the extent of such markets (extent of participation in such markets and their spatial extent), socio-economic characteristics of participants, rental rate structure and determinants of rental rates, impact of such markets on better farm practices (impact on mechanization, cropping intensity, crop diversification, productivity and production) and impact of credit on rental markets. But the other aspects like determinants of participation in rental markets, forms of such markets etc. have not been covered. Moreover, in examining the impact of rental markets of ploughing machinery on farm production and productivity enhancing practices, the intensity of participation in such markets have not be considered. But consideration of the intensity of participation in such markets seems to be important for better analysis of the impact of rental markets of ploughing machinery on agriculture.

2.3 Conclusion

It is found that various factor markets have great role in agricultural development especially in a situation of unbalance possession of farm resources. These markets are not only correcting the unequal distribution of resources but also benefiting agriculture in different forms. However, such markets are not free from problems. The above discussion reveals that while lots of studies have been carried out on factors markets like land, labour, credit and water markets, studies on rental markets of farm capital goods particularly of machinery are rather thin whereas such markets can play the same role as the other factor markets. Although rental markets of agricultural capital goods were studied, some of the important aspects of such markets are yet to get the attention of the researchers. Hence, in the subsequent chapters of the present study, such untapped issues of rental markets of farm capital goods will be addressed.

CHAPTER 3

AGRARIAN ECONOMY OF ASSAM AND USE OF FARM MACHINERY: AN OVERVIEW FROM SECONDARY INPUTS

3.1 Background of the Study Location

3.1.1 Location

Assam, one of the North-Eastern states of India, is located between the latitudes of $24^0 08'$ N and $27^0 09'$N and the longitudes of $89^0 42'$E and $96^0 10'$E. A large portion of the state is surrounded by hilly areas. She shares a part of its north boundary with Bhutan and the rest with Arunachal Pradesh. Assam shares the east boundary with Nagaland, Manipur and a part of it with Arunachal Pradesh and the south boundary with Mizoram. To the south-west, Tripura, Meghalaya and Bangladesh are situated and to the west the state West Bengal is situated.

Brahmaputra Valley, Barak Valley and the Hills are the three natural divisions of Assam. The largest valley is the Brahmaputra Valley which covers 72 percent of the geographical area and around 85 percent of population of the state. The Barak Valley and the Hills Valley comprise around 9 percent and 19 percent of the geographical area respectively while they comprise about 12 percent and 3 percent of the total population respectively.

Agro-climatic zone-wise Assam has been divided in to six climatic zones namely- North Bank Plain (NBP), Upper Brahmaputra Valley (UBV), Central Brahmaputra Valley (CBV), Lower Brahmaputra Valley (LBV), Barak Valley (BV) and Hill zone. The first four agro-climatic zones belong to Brahmaputra Valley.

3.1.2 Climate

Assam's climate comprises both wet summer and sunny winter seasons. From early June monsoon rain starts which continues to October. Heavy pre-monsoon rain is there in late April and May. In the state temperature varies from 25^0 Celsius to 40^0 Celsius during the summer generally. Normally climate is dry during winter in the state.

Table-3.1 presents the rainfall pattern in Assam in 2013. In the reference period actual rainfall in the state was less than normal rainfall. There was a deficiency of rainfall of 26.15 percent in the year 2013. Season-wise also in all the seasons actual rainfall was less than the normal. Deviation of actual rainfall from normal rainfall was highest in winter season (-78.22 percent) and lowest in summer (-18.98 percent).

Table 3.1: Rainfall Pattern in Assam in 2013

Season	Actual (mm)	Normal (mm)	Deviation (%)
Winter (Jan.-Feb.)	10.5	48.2	(-)78.22
Summer (March-May)	449.8	555.2	(-) 18.98
Monsoon (June-Sept.)	1127.6	1539.2	(-) 26.74
Post Monsoon (Oct.-Dec.)	118.9	168.5	(-) 29.44
All Seasons	1706.8	2311.1	(-) 26.15

Source: Statistical Hand Book, Assam, 2014

3.1.3 Demography

As per data provided by Census, 2011, Government of India, 71.64 percent of the area of the state is covered by the Brahmaputra Valley. Rural area comprises 98.39 and 98.03 percent of the total area of Assam and Brahmaputra Valley respectively. Brahmaputra Valley consists of 84.63 percent population of Assam. Out of the total population 85.90 percent in Assam and 85.80 percent in Brahmaputra Valley are rural. In terms of household also a large proportion of them are rural both in the state (84.62 percent) and in Brahmaputra Valley (84.37 percent). Sex ratios in Assam as well as in Brahmaputra Valley are same (958 per thousand). However, population density in Brahmaputra Valley (470 per sq. Km) is quite higher than in the state as a whole (398 per sq. Km).

Table 3.2: Demographic Profile as per Census, 2011

		Brahmaputra Valley*	Non-Brahmaputra Valley*	Assam
Area (sq. km.)	Total	56194	22244	78438
	Rural	55087.73	22090.39	77178.12
	Urban	1106.27	153.61	1259.88
Population	Total	26410562	4795014	31205576
	Rural	22660779	4146255	26807034
	Urban	3749783	648759	4398542
	Male	13488436	2451007	15939443

	Female	12922126	2344007	15266133
Households	Total	5415554	990917	6406471
	Rural	4569227	851650	5420877
	Urban	846327	139267	985594
Sex ratio		958	956	958
Population density (per sq. km)		470	216	398
Decadal growth rate of population in 2001-11		16.56	19.96	17.07
Literacy rate				72.19
Birth rate (per thousand)				22.4
Death rate (per thousand)				7.8
Infant mortality rate (per thousand)				54

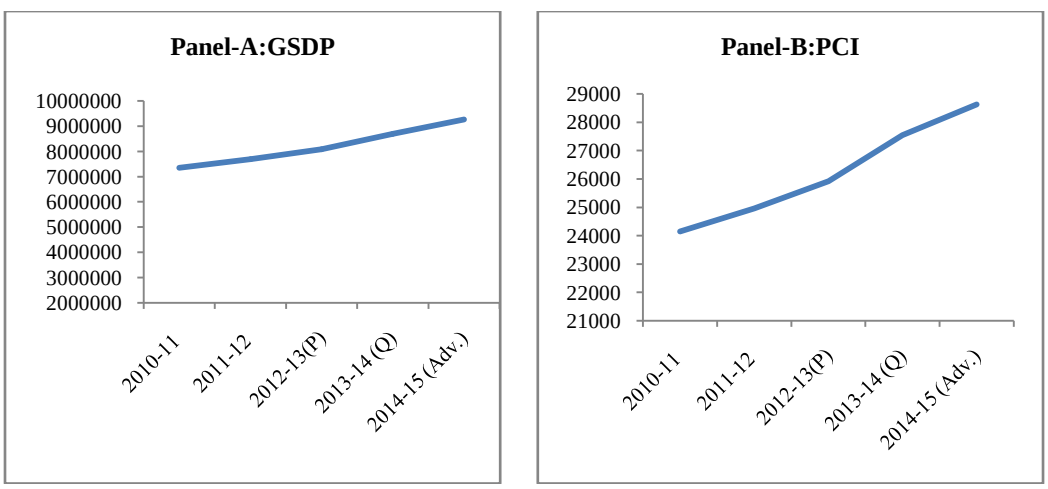
Source: Compiled and calculated from Statistical Hand Book, Assam, 2014 and Economic Survey, Assam, 2014-15

*Author's own calculation

3.1.4 Economy

As per data provided by the Economic Survey of Assam, 2014-15, both GSDP and PCI of Assam have been increasing in last few years (refer figure-3.1). The GSDP of the state increased from Rs.7344442.00 in 2010-11 to Rs.9257303.00 in 2014-15(adv.). During the same period PCI increased from Rs.24149.00 to Rs.28625.00.

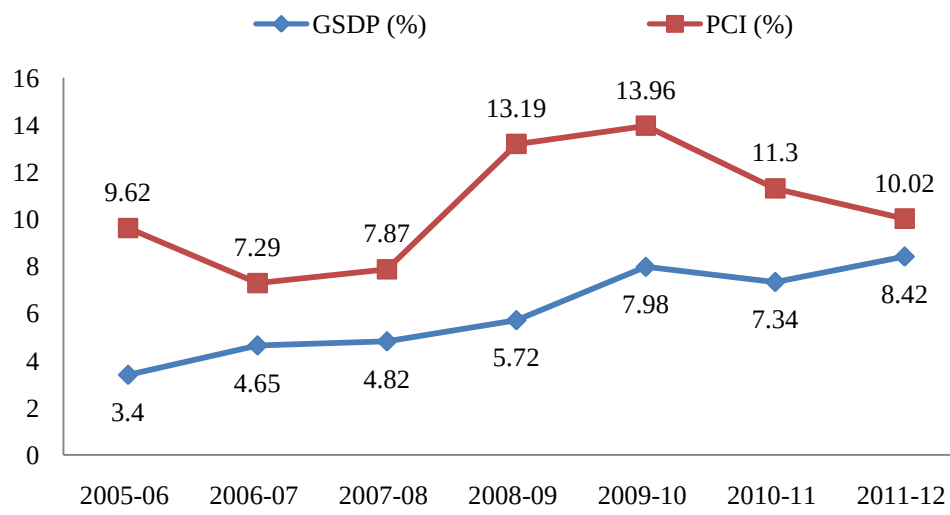
Figure 3.1: Trend of GSDP and PCI in Assam in Last Few Years (in Rs.)



Source: Economic Survey, Assam, 2014-15

Looking into the growth of GSDP and PCI of Assam, it has been observed that the rate of growth of both increased during the period 2005-12. Of course, the rate of growth of PCI is more that of theGSDP. However, while growth rate of GSDP has been continuously increasing from 3.40 percent in 2005-06 to 8.42 percent in 2011-12 except in 2010-11, rate of growth of PCIhas been fluctuating.

Figure 3.2: Trend of Growth of GSDP and PCI of Assam

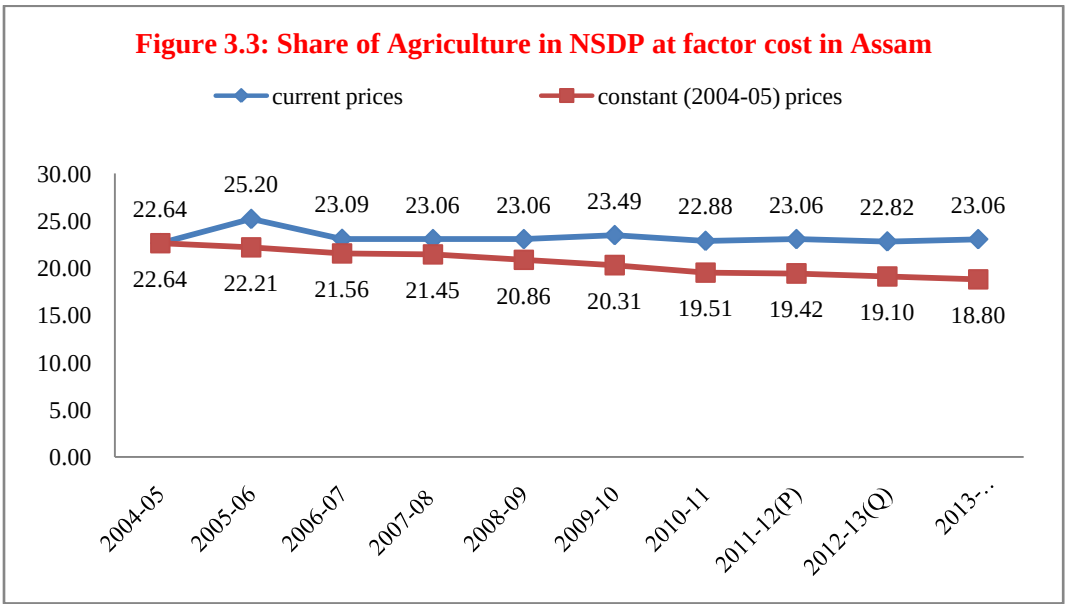


Source: Economic Survey, Assam, 2011-12

3.2 Agrarian Scenario

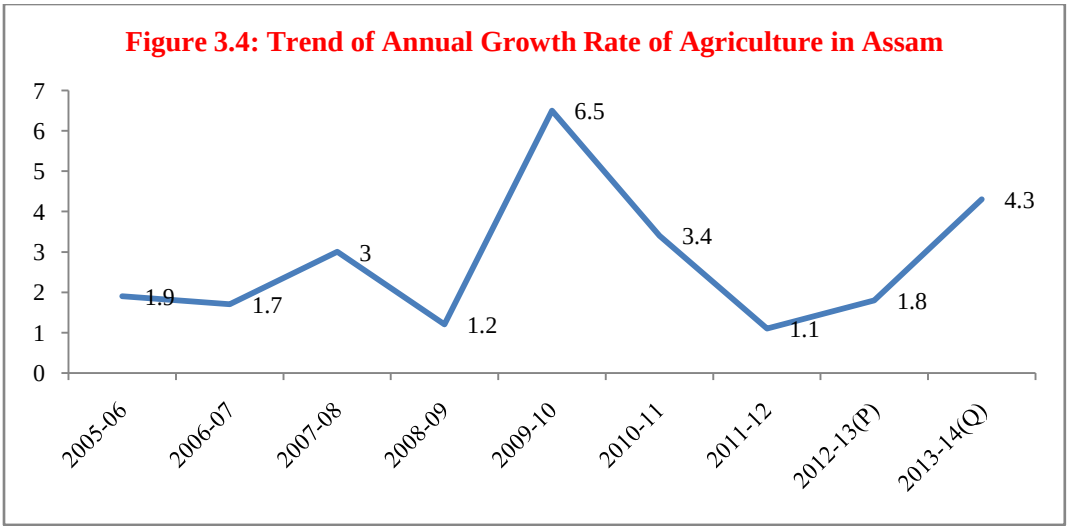
3.2.1 Role of Agriculture in the Economy

Agriculture has been still playing a major role in the state economy. As per data provided by the Directorate of Economic and Statistics, Assam, the share of agriculture in NSDP at factor cost at current prices and at constant (2004-04) prices were 23.06percent and 18.80 percent respectively in 2013-14 (Adv.). However, contribution by the agriculture sector to the state economy in terms of NSDP at factor cost is declining.



Source: Calculated from Directorate of Economics and Statistics, Assam accessed from http://ecostatassam.nic.in on 24/11/2015

Although agriculture is one of the major components of the economy of Assam, growth of this sector is not remarkable. The rate of growth of agriculture in 2005-06 was 1.9 percent which increased to 4.3 percent in 2013-14(Q). Throughout the period of study, the rate of growth of agriculture in Assam was erratic.



Source: Economic Survey, Assam, 2014-15

3.2.2 Land Use Pattern

Table-3.3 presents the land use pattern of Assam. In the state, 96.96 percent of operated area is net sown area. Land not available for cultivation constitutes 1.97 percent of the total operated area. The shares of othertype of land in the total operated area are less than one percent. The land use patterns in Brahmaputra Valley region and Non-Brahmaputra Valley region of the State are also similar to the overall land use pattern.

Table 3.3: Pattern of Land Use (area in hectare)

Region	Net Area Sown	Area Under Current Fallows	Other Uncultivated Land Excluding Fallow Land	Fallow Land Other than Current Fallows	Culturable Waste Land	Land Not Available for Cultivation	Operated Area
Non-Brahmaputra Valley*	341114 (96.03)	840 (0.24)	5843 (1.64)	403 (0.11)	35 (0.01)	6979 (1.96)	355214 (100.00)
Brahmaputra Valley *	2566741 (97.08)	2224 (0.08)	21053 (0.80)	1389 (0.05)	411 (0.02)	52039 (1.97)	2643856 (100.00)
Assam	2907855 (96.96)	3064 (0.10)	26896 (0.90)	1792 (0.06)	446 (0.01)	59018 (1.97)	2999070 (100.00)

Source: Agriculture Census, Assam, 2010-11 accessed from http://agcensus.nic.in/ on 27/11/15

In ( ) percentage to the total operated area

*Author's own calculation

3.2.3 Land Holding

Land holdings in the state are mostly of smaller size. Around 67 percent of the holdings are marginal followed by small holdings (18.26 percent). In terms of operated area, major size class is semi-medium (27.27 percent) followed by marginal (25.84 percent) and small (22.91 percent) groups respectively. Structural distribution of operational holdings and area across various size groups in Brahmaputra Valley is similar to that of the state as a whole. Again, in 2010-11, there is decline of

operational holdings and area of all size classes other than marginal size class compared to 2005-06 both in the state as a whole and in the Brahmaputra Valley.

Table 3.4: Operational Holdings and Area as per Agriculture Census, 2010-11 (in hectare)

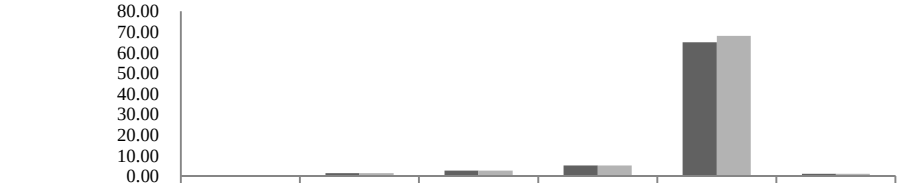
Size classes (in hectare)	Assam				Brahmaputra Valley*			
	Holdings (percent of all size)	Area (percent of all size)	% variation in 2010-11 over 2005-06		Holdings (percent of all size)	Area (percent of all size) holdings	% variation in 2010-11 over 2005-06	
			holdings	area			holdings	area
Marginal (<1.00)	1831115 *(67.31)*	774797 *(25.84)*	4.46	1.93	1639456 *(67.88)*	692087 *(26.18)*	5.09	3.91
Small (1.00-2.00)	496574 *(18.26)*	687156 *(22.91)*	-16.04	-4.34	427915 *(17.72)*	593994 *(22.47)*	-13.25	-1.48
Semi medium (2.00-4.00)	303528 *(11.16)*	817982 *(27.27)*	-4.50	-3.31	266991 *(11.05)*	720847 *(27.27)*	-5.67	-4.58
Medium (4.00-10.00)	84869 *(3.12)*	437372 *(14.58)*	2.33	2.81	77558 *(3.21)*	399258 *(15.10)*	0.72	1.16
Large (10& above)	4137 *(0.15)*	281763 *(9.40)*	-15.60	-5.64	3662 *(0.15)*	237668 *(8.99)*	-16.07	-1.38
All size	2720223 *(100)*	2999070 *(100)*	-1.08	-1.62	2415282 *(100)*	2643856 *(100)*	-0.10	-0.61

Source: Agriculture Census, Assam, 2005-06 and 2010-11

*Author's own calculation

N.B.: during the calculation, it has been found that number of marginal operational holdings of Assam as per Agriculture census, 2010-11 is given as 1830815 in the district-wise table (table-4 of annexure-iv) whereas it is given as 1831115 in table-7(i) of the same report. However, second value has been considered in the present analysis as in that case the sum of operational holdings of all size groups is equal to the total operational holdings for the state in that time period. In the same report, in case of N.C. Hills, operational holdings of all sizes are given as 17494 (table-4 of annexure-iv) but the sum of the operational holdings (17194) is not tally with it as per the information by the same source. However, the value 17494 has been considered as in that case the total operational holdings of Assam tally with the sum of operational holdings of all districts. Again, operated area of all size groups (119285) is not equal to sum of operated areas of all size groups (119286) of Cachar district as per Agriculture Census, 2005-06, Assam. For the present study operated area of all size groups (119285) is considered arbitrarily.

Figure 3.5:Average Size of Operational Holdings as per Agriculture Census, 2010-11 (area in hectare)



	Marginal	Small	Semi-medium	Medium	Large	All size
Brahmaputra Valley	0.42	1.39	2.70	5.15	64.90	1.10
Assam	0.42	1.38	2.69	5.15	68.1	1.1

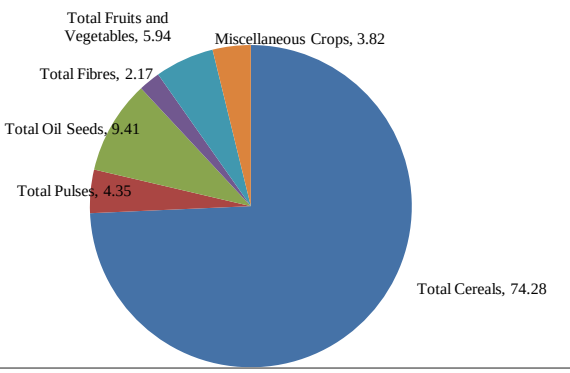
Source: Agriculture Census, Assam, 2010-11

Average size of operational holdings in Assam is 1.10 hectare and it is same for Brahmaputra Valley too as per Agricultural Census, Assam, 2010-11 (refer figure-3.5). Size group-wise the average size of operational holdings of Assam and the Brahmaputra Valley is almost same except in case of large holdings. The average size of large holdings of the state is 68.10 hectare against 64.90 hectare in the Brahmaputra Valley.

3.2.4 Cropping Pattern

Cereals are the predominant crops of the state (74.28 percent of the total cropped area). Oil seeds are cultivated in 9.41 percent of gross cropped area followed by fruits and vegetables (5.94 percent). The shares of pulses, fibres and miscellaneous crops in gross cropped area are 4.35, 2.17 and 3.82 percent respectively.

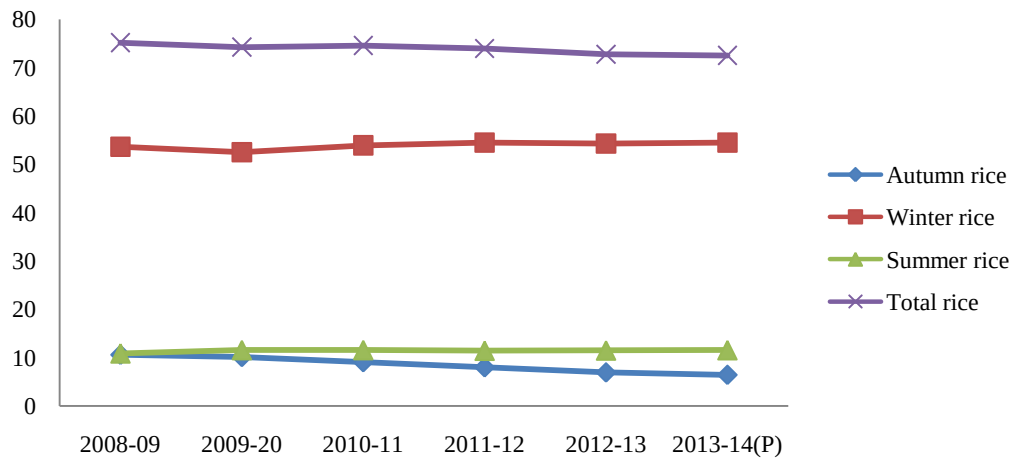
Figure 3.6: Percentage Distribution of Area Under Different Crops in Assam in 2013-14 (P)



Source: Statistical Hand Book, Assam, 2014

While rice is the dominant crop in the state, its share in the gross cropped area has declined in 2013-14 (P) compared to in 2008-09 (refer figure-3.7). During the study period, among the three types of rice, share of area under the winter rice is increasing. On the contrary, area under the autumn rice is declining while it is remained same for summer rice.

Figure 3.7: Trend of Percentage of Area Under Rice to the GCA in Assam



Source: Statistical Hand Book, Assam, 2013 and 2014

N.B.: as per the Statistical Hand Book, Assam of 2013 and 2014, in 2011-12 the area under the total rice is given as 2646 thousand hectares whereas the sum of area under the different types of rice is 2546 thousand hectares as per same sources. However, for the present study, area under the total rice has been taken as 2546 thousand hectares as in that case it tallies with other figures such as GCA, area under the total food grains etc.

3.2.5 Cropping Intensity

As per the data provided by the Statistical Hand Book of Assam, 2013, Directorate of Economics and Statistics, Assam, the cropping intensity in the state was 148.01 percent in 2010-11. Region-wise, cropping intensity in the same period was 147.60 percent for Brahmaputra Valley and 150.52 percent for Non-Brahmaputra Valley. In contrast Agriculture Census, Assam, 2010-11 gives a different picture. The values of cropping intensity for the state as a whole and also region-wise as per the latter source significantly lower. Moreover, while cropping intensity is more in Non-Brahmaputra Valley than that in Brahmaputra Valley as per Statistical Hand Book of Assam, it is just reverse as per Agriculture Census of Assam.

Table 3.5: Cropping Intensity in Assam (area in hectare) During 2010-11

	As per Statistical Hand Book, Assam	As per Agriculture Census, Assam
Non-Brahmaputra Valley*	150.52	108.85
Brahmaputra Valley*	147.60	113.25
Assam	148.01	112.74

Source: Agriculture Census, Assam, 2010-11 accessed from http://agcensus.nic.in/ on 27/11/15 & Statistical Hand Book, Assam, 2013

*Author's own calculation

3.2.6 Irrigation Status

The value of the gross irrigation ratio for the state is 4.98 percent revealing the lower extent of irrigation. Across regions, the extent of irrigation in Brahmaputra Valley (5.40 percent) is higher than in Non-Brahmaputra Valley (1.67 percent). Again, intensity of irrigated cropping in Assam is 101.28 percent which is quite low. Region-wise, similar to gross irrigation ratio, the value of the intensity of irrigated cropping is 101.32 percent for Brahmaputra Valley and 100.02 percent for Non-Brahmaputra Valley.

Table 3.6: Irrigated Areas, Extent and Intensity of Irrigation

(area in hectare)

	Net irrigated area	Gross irrigated area	Gross cropped area	Gross irrigation ratio	Intensity of irrigated cropping
Non-Brahmaputra Valley*	6200	6201	371319	1.67	100.02
Brahmaputra Valley*	155035	157077	2906882	5.40	101.32
Assam	161235	163278	3278201	4.98	101.28

Source: Agriculture Census, Assam, 2010-11 accessed from on 27/11/15

*Author's own calculation

3.3 Extent of Use of Agricultural Machinery

Table-3.7 presents the extent of use of some important farm machinery particularly those are heavy in nature and also costly. As per the data provided by Input Survey,

Assam, 2006-07 the parentage of operational holdings using machinery to the total operational holdings is highest for power tiller (3.67 percent) among the ploughing machinery considered. The 'Tractors used for agricultural purposes' is the second highest extensively used ploughing machinery (in 1.35 percent of operational holdings) in the state followed by the 'tractor drawn leveller'. Again 'diesel engine pump set' is the most extensively used irrigating machinery. 'Diesel engine pump set' has been found to be used in 3.24 percent of operational holdings followed by 'electric pump set' in 0.93 percent of operational holdings.

Across size groups, the extent of operational holdings using those machinery is lower for smaller groups compared to larger groups. Thus, the relationship between the extent of use of farm machinery and the size of operational holdings is found to be inverse one in general.

Table 3.7: Operational Holdings Using Some Selected Ploughing and Irrigating Machinery in Assam

Size groups (area in hectare)		Diesel engine pump set	Electric pump set	Power tiller	Tractors used for agri. purposes/wheel tractors	Tractor drawn mould board plough	Tractor drawn disc harrow	Tractor drawn leveller
Marginal (below 1.0)	No.	20265	5158	49127	7672	1724	1441	4629
	%	1.16	0.29	2.80	0.44	0.10	0.08	0.26
Small (1.0 - 1.99)	No.	31345	7266	20960	12353	1896	158	3974
	%	5.30	1.23	3.55	2.09	0.32	0.03	0.67
Semi-medium (2.0 - 3.99)	No.	26881	8930	19787	11604	3158	845	3195
	%	8.47	2.81	6.23	3.65	0.99	0.27	1.01
Medium (4.0 - 9.99)	No.	9927	4008	10206	5318	1543	862	1442
	%	12.03	4.86	12.36	6.44	1.87	1.04	1.75
Large (10 and above)	No.	408	131	584	154	66	34	103
	%	17.19	5.52	24.60	6.49	2.78	1.43	4.34
All groups	No.	88826	25493	100664	37101	8387	3340	13343
	%	3.24	0.93	3.67	1.35	0.31	0.12	0.49

Source: Input Survey, Assam, 2006-07

Region-wise the extent of use of 'electric pump set' is more in Brahmaputra Valley than in Non-Brahmaputra Valley. Other machinery like 'diesel engine pump set', 'power tiller', 'tractors used for agri. purposes', 'tractor drawn mould board plough' and 'tractor drawn disc harrow' are used less extensively in Brahmaputra Valley than in Non-Brahmaputra Valley. However, 'tractor drawn leveller' is found to be used only in Brahmaputra Valley. Across districts, in Chirang, in highest proportion (17.62 percent) of operational holdings 'diesel engine pump set' has been used followed by in Dhubri (13.47 percent). In terms of proportion of operational holdings, 'electric pump set' is highest extensively used in Dibrugrah. While Bongaigaon is at the first position in respect of the extent of use of power tiller (23.08 percent), 'tractors used for agri. purposes' has been found to be used in highest proportion of operational holdings in Darrang. 'Tractor drawn mould board plough', 'tractor drawn disc harrow' and 'tractor drawn leveller' have been found to be used more extensively in Cachar (4.59 percent), Dibrugarh (1.26 percent) and Nalbari (3.47 percent) respectively.

Table 3.8: Percentage of Operational Holding using Implements to the Total Operational Holdings

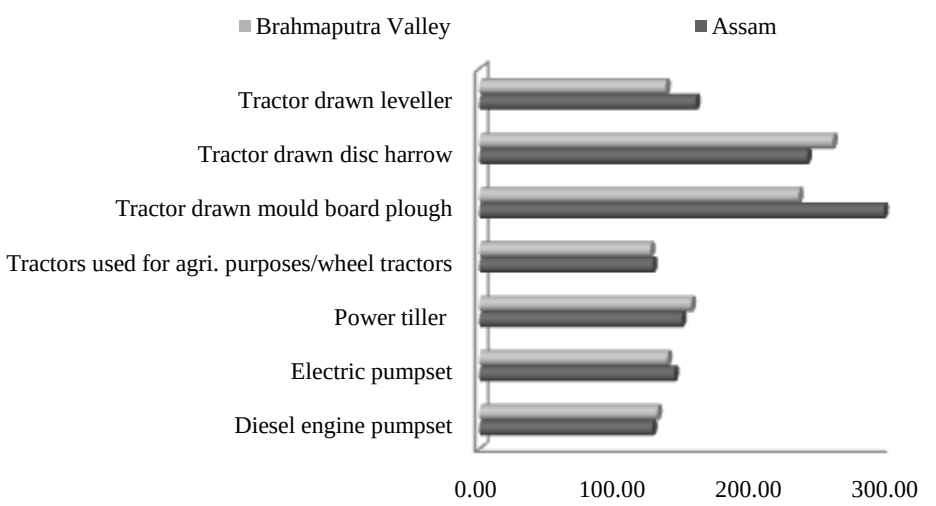
	Diesel engine pump set	Electric pump set	Power tiller	Tractors used for agri. purposes/wheel tractors	Tractor drawn mould board plough	Tractor drawn disc harrow	Tractor drawn leveller
Kokrajhar	5.10	0.30	0.25	0.09	0.01	0.23	0.08
Dhubri	13.47	3.33	2.43	0.40	0.03	0.08	0.73
Goalpara	1.31	0.15	0.56	0.09	0.00	0.00	0.10
Bongaigaon	10.50	2.74	23.08	3.83	0.00	0.00	1.55
Barpeta	2.01	0.02	1.52	0.05	0.00	0.00	0.35
Kamrup	1.15	0.12	1.91	0.60	0.27	0.17	0.95
Nalbari	0.62	2.25	12.89	4.23	0.00	0.00	3.47
Darrang	0.10	0.68	0.71	5.58	0.54	0.54	1.35
Morigaon	3.85	0.82	1.60	0.15	0.09	0.07	0.92
Nagaon	4.09	0.71	1.58	0.04	0.00	0.00	0.00
Sonitpur	0.63	0.75	7.68	3.90	0.09	0.00	1.03
Lakhimpur	2.76	0.29	1.34	0.44	0.22	0.00	0.00
Dhemaji	8.95	1.34	1.36	0.00	0.00	0.00	1.30

Tinsukia	0.00	0.03	0.48	0.03	0.03	0.03	0.41
Dibrugarh	5.43	6.70	4.49	3.96	1.68	1.26	0.34
Sibsagar	2.56	1.25	3.18	0.70	0.02	0.02	0.01
Jorhat	0.07	0.03	0.59	1.07	0.13	0.03	0.00
Golaghat	0.08	0.07	0.26	0.02	0.00	0.00	0.00
Continued table-3.8							
Kamrup (Metro)	0.04	0.54	1.13	0.74	0.37	0.00	0.18
Baska	0.36	0.85	0.11	2.89	0.00	0.00	0.00
Chirang	17.62	1.57	10.68	2.82	0.00	0.00	0.43
Odalguri	0.99	0.19	0.94	0.08	0.00	0.00	0.00
Karbi-Anglong	9.19	0.30	2.56	1.94	0.27	0.11	0.00
N. C. Hills	0.00	0.01	0.00	0.00	0.00	0.00	0.00
Cachar	0.03	0.00	7.24	4.29	4.59	0.00	0.00
Karimganj	7.06	1.65	2.44	0.06	0.06	0.00	0.00
Hailakandi	1.44	0.55	21.52	0.00	0.00	1.10	0.00
Assam	3.24	0.93	3.67	1.35	0.31	0.12	0.49
Brahmaputra Valley	3.16	0.99	3.02	1.29	0.14	0.10	0.55
Non-Brahmaputra Valley	3.81	0.51	8.37	1.80	1.50	0.28	0.00

Source: Input Survey, Assam, 2006-07 accessed from http://agcensus.nic.in/ on 22/11/2015

The extent of use of farm machinery under consideration is different in various district of the state (refer figure-3.8). Among the machinery, 'tractor drawn disc harrow' and 'tractor drawn mould plough' are the implements which extent of use is more varied .The variation of percentage of operational holdings using such machinery is highest for 'tractor drawn mould plough' with respect to Assam while it is the 'tractor drawn disc harrow' for the Brahmaputra Valley.

Figure 3.8: Coefficient of Variation of the Extent of Use of Machinery



Source: Same as cited in table-8

3.4 Conclusion

Above discussion make the following points clear-

(i) Agriculture is playing a crucial role in the economy of the state and also in the study area. However, its contribution to the economy is declining.

(ii) The growth of agriculture in the state was fluctuating in last few years.

(iii) Agricultural implements particularly the heavy machinery like tractors, power tillers etc. have been found to be used by the cultivators in Assam. It is observed that the percentage of operational holdings using such machinery is lower for the small and marginal size groups than the larger size groups.

(iv) In all the districts, all types of machinery under consideration are not been used. The extents of use of those machinery are found to be varied across districts.

CHAPTER 4

FIELD STUDY BACKGROUND, INCIDENCE AND FORMS OF RENTAL MARKETS

4.1 Background of Field Study

Previous chapter, based on secondary data, has given an overall picture of agriculture in Assam in general and Brahmaputra Valley in particular. The discussion in that chapter has shown the importance of agriculture in the economy of Assam, present state of the sector, the extent of use of farm machinery particularly those are heavy in nature. Now the main questions to be addressed in the present investigation are- what are the forms of rental markets? What affect the decision to participate in rental markets? To fulfill these objectives, we need information about socio-economic characteristics of farm households, resource possession, participation status in the rental markets of concerned implements, access to credit, access to extension services, rental rates paid by them, different cropped areas etc. These types of information are not available in various relevant secondary sources. Hence, to collect the necessary information, a primary survey of farm households was carried out during January-February, 2016.

As the survey was carried out to fulfill the above mentioned objectives, information was mainly collected about the extent of participation in rental markets, the extent of use of machinery, determinants of the decision to participates in rental markets, impact of rental markets on agriculture, rental rate structure etc.

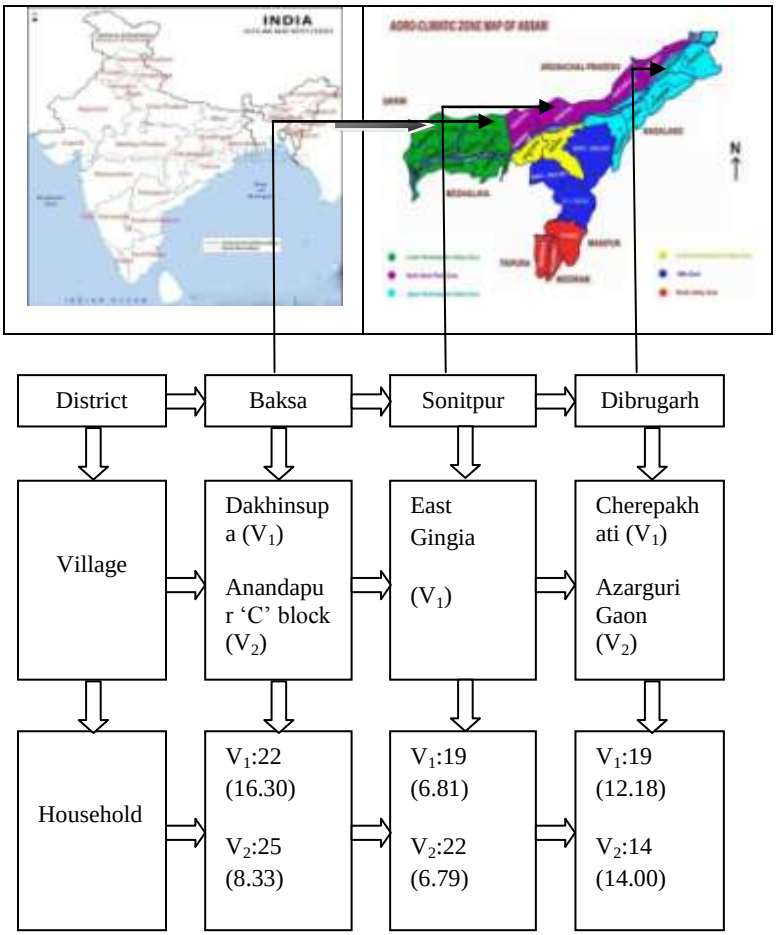
4.2 Methodology of Field Study

4.2.1 Procedure of Sample Selection

The multistage sampling method was followed in the present study in order to make the field investigation representative. First, three districts of the Brahmaputra Valley were selected purposively. Based on the secondary data provided by Input Survey, Assam, 2006-07, districts were selected considering the fact that tractors and power tillers were used there in. The selected districts were Sonitpur, Baksa and Dibrugarh. Sonitpur is in the North Bank Plain Zone and Baksa is in Lower Brahmaputra Valley Zone. Dibrugarh is in the Upper Brahmaputra Valley Zone. At the next stage, two villages from each selected district were selected in random. Thus, a total of six

villages from three districts were selected. Finally, from each village, around 9.35 percent but not less than 6.79 percent ofthe total farm households were surveyed. The size of the sample is 121.

Chart 4.1 Sampling Design



In ( ) percentage of surveyed households to the total households of the village

4.2.2 Collection of Data

Data from the primary survey were collected at village level and at household level. Mainly the information on size of farm land, irrigation sources, input prices, incidence of flood, farmer's organization, stock of agricultural capital goods, major crops, availability of other facilities related to agriculture such as retailers for

fertilizers, pesticides etc. were collected using the village schedule. For this purpose, interaction was done with the Gaonburah (village headman) of respective villages. At the household level, data related to farm operation were collected through the interaction with a senior family member (preferably the head of the household). The collected information includes cropped area, area lease in/out, status of use of farm machinery and its frequency, nature of seeds, fertilizer application, incidence and extent of irrigation, production and productivity, access to credit, access to extension services, participation status in rental markets, rental rates etc.

4.3 Basic Infrastructure and Agrarian Set-up of Surveyed Areas

Table 4.1 gives a bird eye view of the basic infrastructure facilities related to agriculture. Pucca road is passes within all the villages except in Cherepakhati. State/national highway is passing within only two surveyed villages while the maximum distance to it is 17 km in case of other villages. Public bus stand, Commercial bank branch and Retail outlet for fertilizers, pesticides etc. are available within West Gingia and East Gingia villages. For weekly haat (market place) and retail outlet for farm fuel, all the survey villagers have to go outside the village.

Table 4.1: Basic Infrastructure

Village	Pucca road	State/ national highway	Public bus stand	Weekly haat	Commercial bank branch	Retail outlet for fertilizers, pesticides etc.	Retail outlet for farm fuel
Azarguri Gaon	Within village	1.5	1.5	1.5	1.5	1.5	3
Cherepakhati	2	2	2	4	3	3	4
West Gingia	Within village	Within village	Within village	4	Within village	Within village	3
East Gingia	Within village	Within village	Within village	4	Within village	Within village	3
Dakhinsupa	Within village	15	1.5	1.5	6	1.5	6
Anandapur 'B' block	Within village	17	2	1	8	3	9

Source: Village headman of respective village
N.B: If not available within village, distance (in km) to the nearest one

As per the information provided by the Gaonburahs of respective villages, around 86.79 percent of the total households in the surveyed villages are farm households (refer table-4.2). Dependent on agriculture is highest in Cherepakhati village (100

percent) and lowest in Azarguri Gaon village (71.43 percent). Thus, it is found that majority of households in all the surveyed villages are dependent on agriculture. In other words, all the surveyed villages are basically agriculture based.

Table 4.2: Extent of Households Dependent on Agriculture

Village	Total Households	Total Farm Households	% of Farm households to the Total Households
Azarguri Gaon	140	100	71.43
Cherepakhati	156	156	100.00
West Gingia	360	324	90.00
East Gingia	310	279	90.00
Dakhinsupa	150	135	90.00
Anandapur 'B' block	375	300	80.00
Total	1491	1294	86.79

Source: Village headman of respective village

Different ploughing implements and pump set are available almost in all the surveyed villages. As a whole there are 545 ploughing inputs are available out of which 62 are machinery and 483 are bullock pairs which indicates that farmers have used both machinery and traditional ploughing unit. Table-4.3 has shown that the possession of bullock pair per FHH is 0.37 and ploughing machinery is 0.05. However, lesser possession of ploughing machinery per FHH compared to bullock does not necessarily mean the lower extent of use of the former. Because, ploughing machinery has more capacity to plough than that of the bullock pair.

Table 4.3: Ownership of Farm Capital Goods in Surveyed Villages

Village	Bullock pair (i)	Power tiller (ii)	Tractor (iii)	Ploughing machinery(ii+iii)	Ploughing input (i+ii+iii)	Pump set
Azarguri Gaon	50	6	0	6	56	1
Cherepakhati	120	1	2	3	123	4
West Gingia	60	0	18	18	78	500
East Gingia	190	1	19	20	210	450
Dakhinsupa	50	7	2	9	59	NA
Anandapur 'B' block	13	4	2	6	19	25
Total	483	19	43	62	545	980
Available per FHH	0.37	0.02	0.03	0.05	0.42	0.76

Source: Village headman of respective village

N.B.: FHH-Farm Household, NA-information not available, ploughing machinery includes both tractor and power tiller

The principal crops cultivated in surveyed villages are mainly paddy, potato, rape and mustered and winter vegetables. While paddy is major crops in all the studied villages, potato is major crop in East Gingia, West Gingia and in Anandapur 'C' Block. Again, rape and mustered is the major crops in Dakhinsupa and Anandapur 'C' Block, i.e., in Baksa. Winter vegetables are principal crops in Cherepakhati.

Table 4.4: Major Crops in Surveyed Villages

Village	**Crops**
Azarguri Gaon	Paddy
Cherepakhati	Paddy, winter vegetables
West Gingia	Potato, paddy
East Gingia	Potato, paddy
Dakhinsupa	Paddy, rape and mustard
Anandapur 'B' block	Paddy, rape and mustard, potato

Source: Village headman of respective village

4.4 Incidence of Rental Markets

The extent of participation in rental markets has been measured in terms of Market Participation Rate (MPR). The MPR has been defined as the percentage of farm households participated in rental markets to the total farm households. The overall MPR for ploughing machinery is 100 percent. It implies that all the sample farm households are participating in rental market of ploughing machinery. However, individually this participation rate is less than 100 percent. Highest participation is found to be in case of ploughing tractor[3] (66.94 percent) followed by ploughing cum leveller tractor[4] (65.29 percent) and power tiller (29.75 percent) respectively (refer table-4.5). Moreover, along with the functioning of rental markets of ploughing machinery, presence of draught animal rental for ploughing purpose has also been found. However, rental markets of draught animal areless extensive in terms of MPR. Regarding the nature of market participants, it is found that some of them have participated as both supplier and demander too. It is true even in case same type of implement but those are special cases. In case of individual implement, participation as both supplier and demander by same household is due to the fact that they purchased their implements during the reference period and before purchasing they use such machinery by hiring-in.

[3] Tractor used only for ploughing purpose.

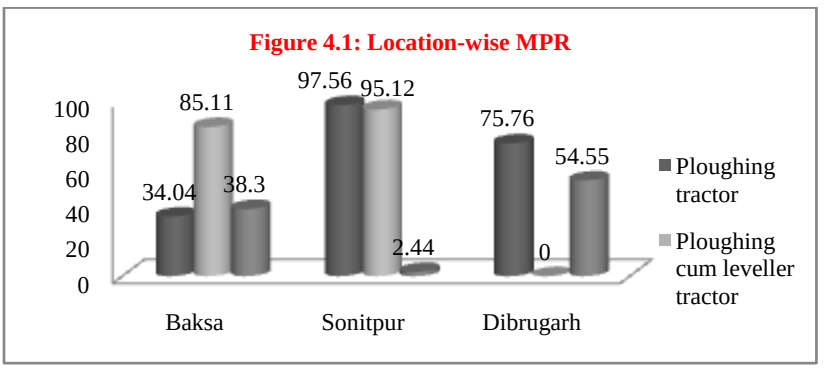
[4] Tractor used for both ploughing and levelling of cropped land

Table 4.5: Extent of Participation in Rental Markets of Ploughing Inputs

Sl No.	Implement		Participant				Non-participant	MPR
			Demander[5]	Supplier[6]	Both	Total		
1	1.a	Ploughing tractor	76	04	01	81	40	**66.94**
	1.b	Ploughing cum leveller tractor	74	03	02	79	42	**65.29**
	1.c	Power tiller	26	10	00	36	85	**29.75**
2	Draught animal		08	02	00	10	111	**08.26**
3	Ploughing machinery (1.a+1.b+1.c)		103	07	11	121	00	**100.00**

Location-wise, the MPR of various implements are varied. The MPRs in rental market of ploughing tractor is highest in Sonitpur (97.56 percent) followed by in Dibrugarh (75.76 percent) and Baksa (34.04 percent) respectively. The MPRs for ploughing cum leveller tractor are 85.11 percent, 95.12 percent and zero percent and for power tiller are 38.30 percent, 2.44 percent and 54.55 percent respectively in Baksa, Sonitpur and Dibrugarh. During the field survey, larger size of operational holdings[7] was reported as the main cause of lower use and so lower participation in rental markets of power tiller in Sonitpur. On the other hand, lack of awareness about the ploughing cum leveller tractor was reported as the basic cause of non-use and so non-participation in rental markets of this implement in Dibrugarh.

Figure 4.1: Location-wise MPR



[5] Demander represents those participated in rental markets of concerned implement(s) only as demander and at the same time they may use own implement(s) but without leasing-out.

[6] Supplier represents those participated in rental markets of concerned implement(s) only as supplier and at the same time they may also use it in own operation but without leasing-in.

[7] Average size of operational holdings of households of surveyed villages in Sonitpur is 1.47 hectare against 1.14 hectare and 0.80 hectare in Baksa and Dibrugarh respectively as per information collected from the village headman.

In terms of rounds, the intensity of use of own / hired-in has been defined as the percentage of round of use of own/hired-inploughing input to the total rounds of ploughing by the implement (either by own or by hired-in). The overall intensity of use of hired-inploughing inputsis found to be 69.46 percent. In case of use of ploughing machinery, 80.82 percent of the total round used is by hiring-in them. Across implements, the intensity of use of hired-in ploughing inputs is more for ploughing tractor (89.34 percent) followed by ploughing cum leveller tractor (88.38 percent), power tiller (33.85 percent) and draught animal (13.16 percent) respectively.

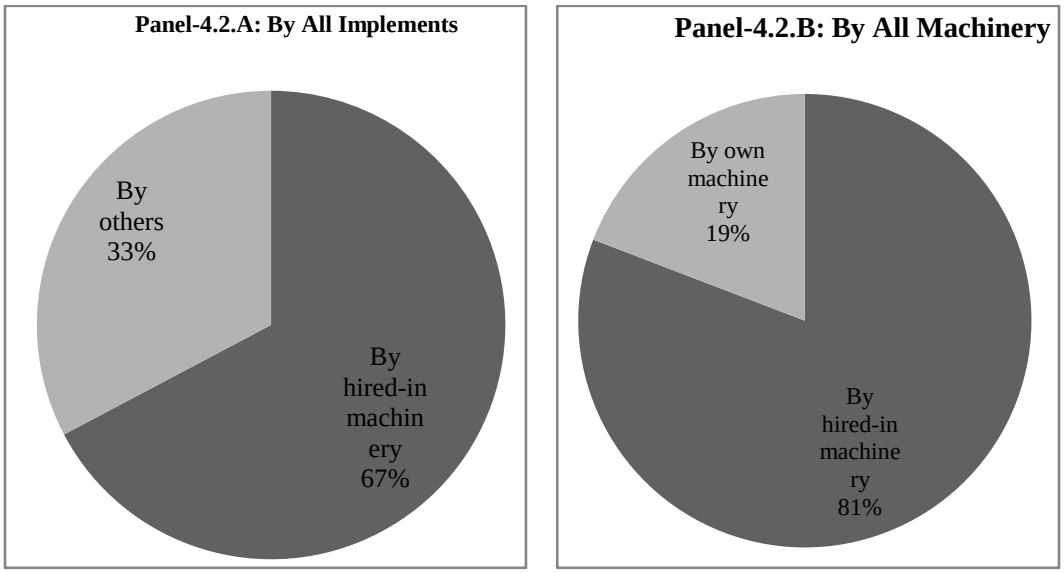
Table 4.6: Intensity of Use of Own/Hired-in Ploughing Inputs

Sl No.	Capital goods		By own implement		By hiring in implements		Total round ploughed	
			No.	%	No.	%	No.	%
1	1.a	Ploughing tractor	073	*10.66*	612	*89.34*	0685	*100*
	1.b	Ploughing cum leveller tractor	051	*11.62*	388	*88.38*	0439	*100*
	1.c	Power tiller	129	*66.15*	066	*33.85*	0195	*100*
2	Draught animal		231	*86.84*	035	*13.16*	0266	*100*
3	Ploughing machinery (1.a+1.b+1.c)		253	*19.18*	1066	*80.82*	1319	*100*
4	**Total (1+2)**		**484**	***30.54***	**1101**	***69.46***	**1585**	***100***

Figure-4.2 shows that the use of machinery by hiring-in has played a significant role in overall ploughing activity. Out of the total round of ploughing by all implements a total of 67 percent round is by hired-in machinery and in case of the total rounds of ploughing by machinery, 81 percent is by hired-in machinery.

Thus, it is found that the intensity of use of hired-in implements has as ignificant role in overall ploughing operation. The intensity of use of hired-in implements is significantly more in case of machinery (81 percent) than the draught animal (13 percent). Moreover, while the use of ploughing machinery is found to be mainly by hiring-in, use of draught animal by hiring-in is very less. Further, ploughing by hired-in machinery is found to be contributing significantly in the overall ploughing operation in terms of round of use.

Figure 4.2: Percentage Distribution of Round of Ploughing by Type of Implements



In terms of area, the intensity of ploughing by own/hired-in implement(s) has been defined as the percentage of Gross Ploughed Area considering round of ploughing {GPA(R)} by own/hiring-in of implement(s) to the GPA(R) by implement(s) either by own or by hired-in. As per table-4.7, 67.01 percent of GPA(R) has been ploughed through hired-in implements. The percentage of GPA(R) by hired-in ploughing machinery in the GPA(R) by all machinery is 71.36 percent while only 4.43 percent of GPA(R) by draught animal is by hired-in of it. Across implements, the intensity of GPA(R) by hired-in is more for ploughing tractor (78.20 percent) followed by ploughing cum leveller tractor (64.12 percent), power tiller (39.04 percent) and draught animal (4.43 percent) respectively. Thus, the intensity of ploughing by hiring-in is significant and it is at a larger scale in case of machinery. Moreover, while a very large proportion of GPA(R) by ploughing machinery is by hired-in machinery, GPA(R) by hired-in draught animal constitutes only a small proportion of GPA(R) by draught animals.

Table 4.7: Intensity of Ploughing by Own/Hired-in Implements

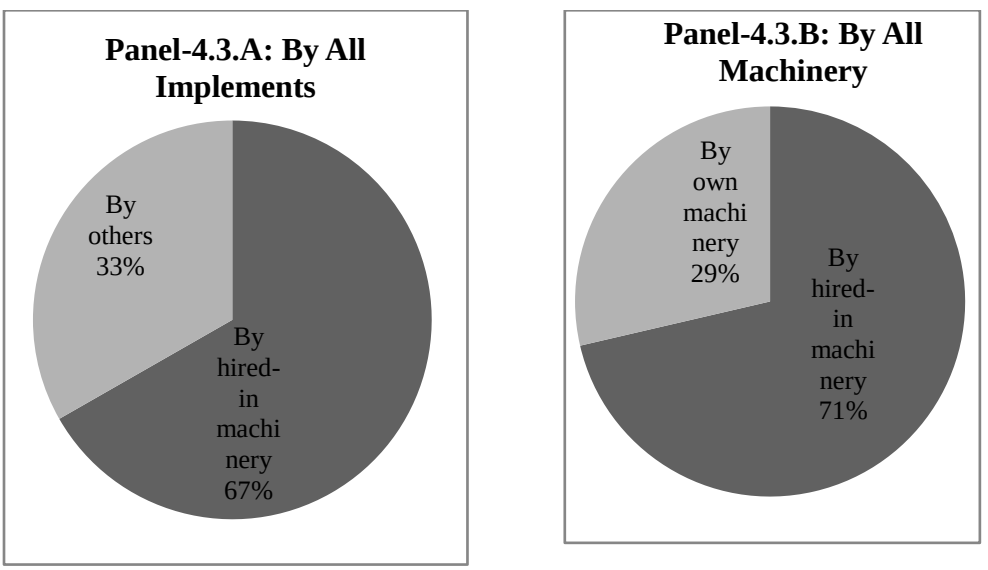
(area in hectare)

Sl No.	Capital goods		GPA (R) by own implement		GPA (R) by hiring-in implements		Total GPA(R)	
			Area	**%**	**Area**	**%**	**Area**	**%**
1	1.a	Ploughing tractor	439.76	*21.80*	1577.20	*78.20*	2016.96	*100*
	1.b	Ploughing cum leveller tractor	368.14	*35.88*	657.90	*64.12*	1026.04	*100*
	1.c	Power tiller	119.69	*60.96*	76.64	*39.04*	196.33	*100*
2	Draught animal		215.21	*95.57*	09.97	*04.43*	225.18	*100*
3	Ploughing Machinery (1.a+1.b+1.c)		927.59	*28.64*	2311.74	*71.36*	3239.33	*100*
4	**Total (1+2)**		**1142.80**	***32.99***	**2321.71**	***67.01***	**3464.51**	***100***

N.B.: GPA(R)-Gross Ploughed Area considering number of rounds ploughed

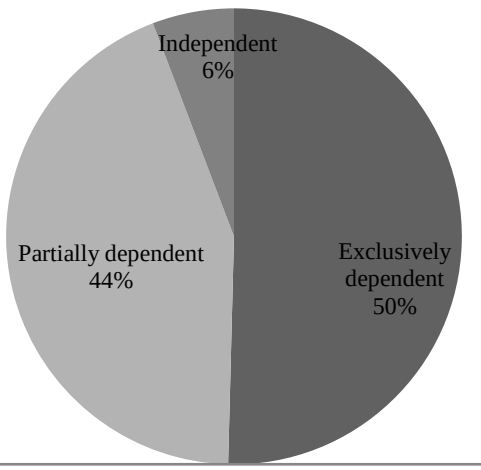
Regarding the contribution of hired-in ploughing machinery in GPA(R) by all implements and GPA(R) by all machinery, it is found that a very large proportion of them are by the hired-in ploughing machinery (refer figure-4.3). The GPA(R) by hired-in ploughing machinery constitutes 67 percent and 71 percent of GPA(R) by all implements and by all ploughing machinery respectively.

Figure 4.3: Percentage Distribution of GPA(R) by Type of Implements



To see the dependency on the rental markets in terms of hiring-in, all the users of ploughing machinery have been classified into three groups-Exclusively dependent, Partially dependent and Independent (owner users). Exclusively dependent are those who have ploughed their land completely by hiring-in the services of ploughing machinery. Partially dependent includes farmers ploughing partly by hired-in ploughing machinery and party by using own machinery or by draught animal (own and/or hired-in). Independent farmers include those ploughed completely by using own machinery or both by own machinery and draught animal (own and/or hired-in).While all the sample households are found to be using ploughing machinery, 94 percent are dependent on hired-in machinery for ploughing. Again, 50 percent of sample farmers (53.51 percent of the total hiring-in users) are cultivating by depending exclusively on hired-in ploughing machinery and 44 percent (46.49 percent of the total hirers) by depending partially on such machinery.

Figure 4.4: Percentage Distribution of Households by the Extent of Dependency on Hired-in Ploughing Machinery



From the discussion in the present section, it is found that rental markets of all types of ploughing inputs are functioning in study area. The extent of participation is more in machinery rental than in draught animal rental. The significantly large proportion of the total rounds of ploughing by all implements and by ploughing machinery is found to be contributed by hired-in machinery. Similarly, out of GPA(R) by all implements and by ploughing machinery, a large percentage is ploughed by hired-in ploughing machinery. Moreover, a large majority of farm households are completely dependent on rental markets of ploughing machinery for conducting their ploughing

operation. It may happen that in the absence of such markets, some of these cultivators (those exclusively dependent on hired-in ploughing machinery)withdraw themselves from farming activity and the intensity of cropping isalso low. Thus, rental markets of ploughing machinery have been found to be playing a great role in farm operation in general and in mechanizing it in particular. Therefore, it can be said that rental markets of ploughing machinery contributing in enlarging the extent and intensity of farm mechanization besides substituting the draught animal rental markets.

4.5 Forms of Rental Markets

The form of rental markets of ploughing machinery has been viewed from demander side. In other words, only the demanders (market participants either as pure demander or as both demander and supplier) are considered for this purpose. This is because, it is difficult to get information from the suppliers about the total number of times the machinery is hired-out, the number of times hired-out in different form in the reference period etc.On the basis of the information collected from field, rental markets of ploughing machinerycan be broadly classified into two forms-

A) Time based rental market and

B) Area based rental market

Under the form 'A', hiring in/out of services of ploughing machinery is taken place on the basis of duration of use for a specific rental rate. Time based rental arrangements can be again classified into two types- a) Daily rental market and b) Hourly rental market. In case of daily rental, rental rate is fixed for whole day and in case of hourly rental, it is fixed per hour. Under the form 'B', rental arrangement is area based, i.e., in the study locations it is paid per bigha-wise.

In the present study, form of rental markets has been captured in two ways. One way it is studied in terms of hiring-in household and another way it is studied in terms of frequency of hiring-in. Here, if a household participated in more than one form of markets, they have been counted as hirer in all the forms participated. Hence, the sum of hirers in different forms may not be equal to the total hirers. Table-4.8 reveals that in the study area, household hires-in ploughing machinery from three forms of rental markets. Among the three forms, area based is the predominant (68.42 percent of total hiring-in households) in terms of hiring-in households followed by hourly based (28.95 percent) and daily based (18.42 percent) respectively. The percentage of households hiring-in from time based rental market is 33.33 percent. However, some households are found to be hiring-in from more

than one form of rental markets. Implement-wise, rental markets of ploughing and ploughing cum leveller tractors are found to be functioning in all the three forms while power tiller rental is functioning only in the area based form.

Table 4.8: Type of Rental Markets of Farm Capital Goods in Terms of Households

Implements	Time based			Area based	Total hirers
	Daily	Hourly	Total	Bigha[8]	
Ploughing tractor	21(27.27)	19(24.68)	36(46.75)	41(53.25)	77
Ploughing cum leveller tractor	03(03.95)	33(43.42)	36(47.37)	40(52.63)	76
Power tiller	00(00.00)	00(00.00)	00(00.00)	26(100.00)	26
Ploughing machinery	21(18.42)	33(28.95)	38(33.33)	78(68.42)	114

In ( ) percentage to the total

In terms of hiring-in frequency too, major form of rental markets of ploughing machinery is area based (55.63 percent of total round of hiring-in) followed by hourly based (26.17 percent) and daily base (18.20 percent) respectively. Again, time based form of ploughing machinery rental constitutes 44.37 percent of the market.

Table 4.9: Type of Rental Markets of Farm Capital Goods in Terms of Hiring-in Frequency

Implements	Time based			Area based	Total round of hiring-in
	Daily	Hourly	Total	Bigha	
Ploughing tractor	186(30.39)	141(23.04)	327(53.43)	285(46.57)	612
Ploughing cum leveller tractor	008(02.06)	138(35.57)	146(37.63)	242(62.37)	388
Power tiller	000(00.00)	000(00.00)	000(00.00)	066(100.00)	066
Ploughing machinery	194(18.20)	279(26.17)	473(44.37)	593(55.63)	1066

In ( ) percentage to the total

Looking into the form of rental markets across locations, it has been found that rental markets in all the three form are present only in Sonitpur in case ploughing machinery (refer table-4.10). In Baksa and Dibrugarh, rental markets of all the

[8] Bigha is a common unit of land measurement used in Assam and one Bigha is equal to 0.13387 hectare

ploughing machinery under study are found to be functioning only in area based form.

Table 4.10: Location-wise Forms of Rental Markets of Ploughing Machinery

Location	Time based						Area based		Total	
	Daily		Hourly		Total		Bigha			
	HH	F	HH	F	HH	F	HH	F	HH	F
Ploughing Tractor										
Baksa	00	000	00	000	00	000	15	054	15	054
Sonitpur	21	186	19	141	36	327	01	006	37	333
Dibrugarh	00	000	00	000	00	000	25	225	25	225
Overall	21	186	19	141	36	327	41	285	77	612
Ploughing cum Leveller Tractor										
Baksa	00	00	00	000	00	000	40	242	40	242
Sonitpur	03	08	33	137	36	145	01	001	36	146
Dibrugarh	00	00	00	000	00	000	00	000	00	000
Overall	03	08	33	137	36	145	41	243	76	388
Power Tiller										
Baksa	00	00	00	00	00	00	10	14	10	14
Sonitpur	00	00	00	00	00	00	01	03	01	03
Dibrugarh	00	00	00	00	00	00	15	49	15	49
Overall	00	00	00	00	00	00	26	66	26	66

N.B.: HH-hiring-in household and F-frequency of hiring-in

Thus, it is found that rental markets of ploughing machinery are functioning in three forms. However, area based is the predominant form of such markets both in terms of households hiring-in and in terms of frequency of hiring-in. While all the three forms of rental markets are present and functioning in Sonitpur, only area based is present and functioning in other two locations.

4.6 Socio-Economic Characteristics of Sample Households

In terms of operational holdings, 34.71 percent of surveyed households are marginal followed by the small farmers which account 23.97 percent (refer table-4.11). Semi-medium, medium and large farmers constitute 19.01 percent, 18.18 percent and 4.13 percent respectively. Thus, major portion of the surveyed farmers are of smaller size groups. Regarding the intensity of ploughing by hired-in machinery[9], it is found to

[9] It has been defined as the percentage of gross area ploughed using hired-in machinery considering round of ploughing to the gross area ploughed using all implements considering round of ploughing.

be highest for small farmers and lowest for large farmers. The intensity of ploughing by hired-in machinery of small and marginal farmersis more than the larger farmers.

Table 4.11: Distribution of Sample Households by Operational Holdings

Size class	Households	Intensity of ploughing by hired-in machinery
Marginal (<1.00)	42(34.71)	77.67
Small (1.00-2.00)	29(23.97)	78.02
Semi medium (2.00-4.00)	23(19.01)	71.28
Medium (4.00-10.00)	22(18.18)	74.84
Large (10& above)	05(04.13)	46.57
All size	121(100.00)	66.73

In ( ) percentage to the total

By ownership holdings of cultivable land, marginal farmers comprise 63.64 percent of sample households followed by small (17.36 percent) as per table-4.12. The shares of semi-medium, medium and large groups in the total sample farmers are 14.05 percent, 4.13 percent and 0.83 percent respectively. The intensity of ploughing by hired-in machinery is more for smaller size groups compared to the large size groups by ownership holdings of cultivable land.

Table 4.12: Distribution of Sample Households by Ownership Holdings of Cultivable Land (area in hectare)

Size class	Households	Intensity of ploughing by hired-in machinery
Marginal (<1.00)	77(63.64)	71.06
Small (1.00-2.00)	21(17.36)	78.63
Semi medium (2.00-4.00)	17(14.05)	68.25
Medium (4.00-10.00)	05(04.13)	59.15
Large (10& above)	01(00.83)	00.00
All size	121(100.00)	66.73

In ( ) percentage to the total

The largest percentage of the head of the households (HOHs) has the education of level P to HS (45.45 percent) followed by M to G (33.06 percent). The percentage of HOHs having education of G & above, M to G and BP are 6.61 percent, 33.06 percent and 3.31 percent respectively. Intensity of ploughing by hired-in machinery is highest for illiterate HOHs.

Table 4.13: Distribution of Households by Educational Attainment of Head of the Households

Education	Households	Intensity of ploughing by hired-in machinery
Illiterate (NL)	14(11.57)	78.07
Below primary (BP)	04(03.31)	53.63
Primary to high school (P to HS)	55(45.45)	73.89
Matriculates to graduate (M to G)	40(33.06)	63.76
Graduate and above (G & above)	08(06.61)	35.04
Total	121(100.00)	66.73

In ( ) percentage to the total

4.7 Conclusion

The main findings from the discussion in this chapter can be sum-up as follows-

(i) Farmers are using both machinery and draught animals for ploughing purposes and ploughing machinery are found as the predominant among them. The dependent of draught animal for ploughing operation is quite less.

(ii) Rental markets of ploughing inputs are functioning in all the studied locations. All the sample households are found to be participated in rental markets of ploughing machinery whereas only a small proportion of sample households are involved in draught animal rental.

(iii) Rental markets of ploughing machinery are found to be contributing significantly in farm operation (ploughing operation) in general and in mechanization of ploughing operation in particular. This gives the answer of the research question of the study that rental markets of ploughing machinery are not just substituting the markets of traditional ploughing units but significantly contributing in enhancing the extent of mechanization.

(iv) In three forms rental markets of ploughing machinery are found to be functioning. However, area based form is the major form and present in all the three locations while daily base and hourly base are found only in Sonitpur.

(v) The intensity of ploughing by hired-in machinery is relatively more by small and marginal farmers compared to large farmers.

CHAPTER 5

DETERMINANTS OF RENTAL MARKET PARTICIPATION AND ITS IMPACT ON AGRICULTURE

Discussion in the previous chapter confirmed the functioning of rental markets of ploughing machinery in various forms. In fact, same percent participation by the sample households in such markets has been found. Now the question arises are - why do farmers participate in such markets either as demander or as supplier? What are the determinants of participation in rental markets? Do these markets benefit agriculture? Whether such markets are functioning perfectly? etc. In the present chapter attempt has been made to give the answer of such questions.

5.1 Factors Affecting Participation in Rental Markets

5.1.1 Purpose of Rental Market Participation

To know the basic purpose of rental market participation, during the survey one question was asked to the respondents about the motivation behind their participation in such markets. Options given to the participants in rental market of ploughing machinery are-

A) To increase return from agriculture through mechanization.
B) To adjust with changing environment[10].
C) To earn return from investment.
D) Others[11].

While all the four options were given to the suppliers, for the demanders options-A, B, and D were given as option C is not relevant for them. For the suppliers option A, B and C actually represent the main objective of purchasing the machinery as they are participating in rental markets to get something by renting out the excess capacity in addition to use of such machinery in own field. On the other hand, option C of suppliers represent that their main target is to earn income by renting-out its

[10] This option covers the maintenance difficulty of draught animal due to reduction of grazing land, frequent flood etc.
[11] It covers the problems like higher price of bullock, engagement in non-farm activity, man power shortage, small size of holdings etc.

services. Among the participants in rental markets of ploughing machinery, 67.54 percent of demanders have hired-in the machinery time mainly to avail the benefits of mechanization. Followed by it the main purpose of hiring in of ploughing machinery is to adjust with the changing environment (21.93 percent). The rest 10.53 percent demanders of ploughing machinery hired-in such services for other purposes. Similar to the demanders, majority of suppliers (77.78 percent) participate in such markets to gain through mechanization of cultivation followed by to adjust with the changing environment (22.22 percent). However, participation in rental markets of concerned machinery either as demander or as supplier is guided by multiple purposes for most of the surveyed households. Overall it is found that while there are several reasons to participate in the rental markets of ploughing machinery, gained through mechanization of agriculture is the predominant one. Of course, a significant portion of participants are found to be participated in such markets mainly to adjust with the changing environment. This finding of the present study is in conformity of the point mentioned by Rath (2015) on increasing use of tractors and power tillers.

Table 5.1: Distribution of Market Participants by Purpose (main) of Participation

Purpose	Demander[12]	Supplier[13]
To increase return from agriculture through mechanization	77 (67.54)	14 (77.78)
To adjust with changing environment	25 (21.93)	04 (22.22)
To earn return from investment	NA	00 (00.00)
Others	12 (10.53)	00 (00.00)
Total	114 (100.00)	18 (100.00)

In ( ) percentage to the total

N.B: NA-Not Applicable

5.1.2 Characteristics of Hiring-in Users of Ploughing Machinery

Characteristics of hiring-in users of ploughing machinery have been studied by classifying them as exclusively hirers and partially hirers. Exclusively hirers represent the farmers ploughing their land completely by hired-in machinery. On the other hand, partially hirers include hiring-in users other than exclusively hirers. In terms of size of holding it is found that the size of operational holdings of exclusively hirers is found to be 2.57 hectare against the 2.94 hectare of partially hirers (refer

[12] Any household hired-in ploughing machinery time.

[13] Any household hired-out ploughing machinery time.

table-5.2). Similarly, the size of ownership holdings of exclusively hirers is 1.07 hectare while it is 1.08 hectare for partially hirers. Thus, it is found that on an average exclusively hirers farmers are of smaller size group than the partially hirers farmers. In this regard, two probable causes can be pointed out- firstly, as exclusively hiring-in farmers have land of smaller size; they may feel that ploughing completely by hiring-in machinery will be less expensive and more convenient than by own ploughing inputs as their requirements is less. Secondly, generally farm size and economic condition of farmers goes in same direction. Thus, smaller is the size of land holding of farmers, more is the financial constraint and hence they prefer to plough by hired-in machinery.

Table 5.2: Size of Holdings by Hirers Type (area in hectare)

Type of hirer	Operational holdings	Ownership holdings of cultivable land
Exclusively hirers	2.57	1.07
Partially hirers	2.94	1.08
Total hirers[14]	2.74	1.07
Non-hirers	5.50	3.24
Overall HH	2.90	1.20

In terms of educational attainment of head of the households, it is found that exclusively hirers are having the education of matriculation and above (49.18 percent) more than the partially hirers (24.53 percent) as per table-5.3. Relatively more exclusively hirers having education of matriculation or above may be due to comparatively more engagement in services.

Table 5.3: Percentage Distribution of Hiring-in HOHs by Educational Attainment

Type of hirers	NL	BP	P to HS	M to G	G & above	Overall
Exclusively hirers	8.20	3.28	39.34	42.62	06.56	100.00
Partially hirers	15.09	3.77	56.60	18.87	05.66	100.00
Total hirers	11.40	3.51	47.37	31.58	06.14	100.00
Non-hirers	14.29	0.00	14.29	57.14	14.29	100.00
Overall HH	11.57	3.31	45.45	33.06	06.61	100.00

[14] Total hirers include both exclusively and partially hiring-in users.

Classifying the hiring-in users of ploughing machinery as pure cultivator (those households earning only from own agriculture) and as others (households earning at least some part of their income from activities other than from own cultivation), it is found that others constitute 57.38 percent of exclusively hirers farmers against 54.72 percent of partially hirers farmers. Thus, the engagement in activities other than in owns farm is relatively more for exclusively hirers than partially hirers.

Table 5.4: Percentage Distribution of Hiring-in Households by Type of Occupation

Type of hirer	Pure cultivator	Others	Total
Exclusively hirers	42.62	57.38	100.00
Partially hirers	45.28	54.72	100.00
Total hirers	43.86	56.14	100.00
Non-hirers	71.43	28.57	100.00
Overall HH	45.45	54.55	100.00

In terms of size of workforce, exclusive hirers have on an average lesser number of working population (1.89 person) compared to the partially hirers (2.19 percent). It implies that exclusively hirers possess lesser number of working population than partially hirers. This may be to some extent due to more requirement of manpower to operate and maintenance of own implements.

Table 5.5: Size of Workforce

Type of hirer	Average size
Exclusively hirers	1.89
Partially hirers	2.19
Total hirers	2.03
Non-hirers	2.00
Overall HH	2.02

5.1.3 Determinants of Leasing-inof Ploughing Machinery

In the present study, all the sample households are found to be participated in rental markets of ploughing machinery. Hence, the examination of factors affecting the decision to participate in such markets is difficult. So, attempt has been made to see the factors affecting hiring-in of ploughing machinery as hirers are the predominant

group of participants in such markets (94.21 percent) and they are also the main beneficiary group[15]. Of course, suppliers are also benefited from functioning of such markets but they constitute only a small proportion of total market participants (5.79 percent). The determinants of hiring-in of ploughing machinery have been examined in terms of the intensity of ploughing by hired-in of such machinery as it represents the intensity of participation in such markets by demanders. We have defined the intensity of ploughing by hired-in machinery as the percentage of GPA(R) by hired-in ploughing machinery to the GPA(R) by all implements (own and hired-in).

Independent Variables:

Ownership of Ploughing Machinery (PM): it is a dummy variable with 1 for owner and 0 otherwise.

With the ownership of one or more ploughing machinery, necessity to hiring-in machineryfor same activity is nil or less. So, we can expect a negative sign for this variable.

Ownership of Draught Animal (DA): It is a dummy variable with 1 for owner and 0 otherwise.

With the ownership of draught animal, necessity to hiring-in of ploughing machinery is less as they are substitute in nature. So, we can expect a negative sign for this variable.

Farm Size (FS):It has been measured in terms of size of operational holding.

With smaller size of operational holdings, a farmer may prefer to use ploughing machinery rather than by purchasing the machinery if land size is less than the capacity of the machinery. On the other hand, smaller farmer may hire-in machinery less as they can also plough it within time using draught animal. Thus a priori, we cannot expect any specific sign.

Extent of Tenancy (TEN): It has been measured as a ratio of leased-in land to the operational land.

As a tenant has to share a part of the total production especially under share cropping without cost sharing, he/she may have less incentive to mechanized

[15] Because in the absence of rental markets of ploughing machinery, owner users can still mechanize their ploughing operation, use of ploughing machinery would have not possible for hiring-in users in such case.

cultivation by hiring-in ploughing machinery. So, we can expect a negative sign for this variable.

Size of Working Population (WOKP): It is the number of working populations in the households.

As maintenance of draught animal and operation of machinery requires more persons, with small size of working population, a farm household may prefer more to hire-in ploughing machinery. So, a negative sign can be anticipated

Education of head of households (EDU): This is a categorical variable with 0 for illiterate, 1 for below primary, 2 for primary to high school, 3 for matriculation to undergraduate and 4 for graduate and above.

Education spreads knowledge and increases awareness about the improved methods of cultivation and thus promotes mechanization of farm operation. In this context, Kuri (2003) mentioned that with spread of education, new generation in the farm households is becoming less willing to take up the backbreaking work of manual agriculture. Hence we can expect that among the hiring-in users of ploughing machinery, education of the head of the households will positively work. Therefore, a positive sign of this variable can be anticipated

Access to Finance: ATNS is equal to 1 if money borrowed from non-institutional sources and 0 otherwise. ATIS is equal to 1 if money borrowed from institutional sources and 0 otherwise. Here non-borrowers are the base category.

If a household borrow money from both institutional and non-institutional sources, such household has been treated as institutional borrower as he/she avail the same advantages as a pure institutional borrower. While access to fund can increase mechanization of ploughing and hence the intensity of hiring-in of ploughing machinery, access to non-institutional fund may promote hiring-in of ploughing machinery more and institutional fund may promote ownership of it more. This is because the requirement of money is instant in hiring-in which is generally possible in case of non-institutional sources. Moreover, amount needed is also less. However, in case of purchase of ploughing machinery, requirement of fund is more and such investment is generally preplanned. As the interest burden is relatively lower in case of institutional credit, such credit is likely to encourage relatively more the ownership of machinery. Thus, for both the variables, positive sign can be anticipated.

Pure Cultivator (PCL): PCL which is a dummy with 1 for the household earning only from own cultivation and 0 otherwise.

A household engage in activity other than own cultivation may found more difficult to maintain and operate own ploughing inputs than a pure cultivator. So, households other than pure cultivators may prefer more the hiring-in of ploughing machinery. So, a negative of this variable can be expected.

Location Characteristics: L_1=1 for Baksa and 0 otherwise. L_2= 1 for Sonitpur and 0 otherwise assuming Dibrugarh as base location.

Location of the present study includes three districts. Agricultural practices in terms of soil condition, occurrences of flood etc. may vary across locations and so the intensity of hiring-in of ploughing machinery too. So, location dummies L_1 and L_2 are used to capture the location characteristics.

Assuming intensity (I) of ploughing by hired-in machinery as the dependent variables, regression model has been constructed as follows-

$$I=F(PM, DA, FS, TEN, WOKP, EDU, ATNS, ATIS, PCL, L_1, L_2)$$

Specification of the Model

As the range of dependent variable is 0 to 100, linear regression will not be suitable. We have also clusters of 7 observations at 0 and 61 observations at 100. Hence, a both sides censored TOBIT regression will be appropriate in this case which has been formulated as follows-

$$I_i^*=\beta_0+\beta_1 PM_i+\beta_2 DA_i+\beta_3 FS_i+\beta_4 TEN_i+\beta_5 WOKP_i+\beta_6 EDU_i+\beta_7 ATNS_i$$
$$+\beta_8 ATIS_i+\beta_9 PCL_i+\beta_{10} L1_i+\beta_{11} L2_i+U_i$$

Where I_i=100 for I_i^* greater than 100

$=I_i^*$ for $0\leq I_i^*\leq 100$

= 0 for I_i^*less than 0and U_i s are the disturbance terms

As dataset comes from cross section sample, problem of heteroskedasticity has been checked using Breusch-Pagan test. Presence of heteroskedasticity has been detectedand subsequently corrected by estimating White heteroskedasticity consistent robust standard error. Moreover, the value of VIF confirmed that there is no problem of multicollinearity.

Using STATA.13, maximum likelihood estimates of parameters have been obtained. Results show that the coefficient of variables PM and DA are negatively significant at 1 percent. Thus, ownership of ploughing machinery and draught animals reduce the intensity of ploughing by hired-in machinery which is natural. This is because use of ploughing machinery by hiring-in is substitute to the use of own ploughing inputs. Other variables like FS, TEN, WOKP, EDU, ATNS, ATIS and PCL are found to be insignificant. Insignificance of location dummies reveals that the intensity of ploughing by hired-in is not varied across locations. Constant is found to be significant at 1 percent.

Table 5.6: Results of TOBIT Model for Determinants of Intensity of Hiring of Ploughing Machinery

Variables	**Breusch-Pagan test for heteroskedasticity** **$chi^2(1)$ = 13.23** **Prob > chi^2 = 0.0003** **Result: Presence of heteroskedasticity**		
	Coefficient	**Robust S.E.**	**p-value**
PM	-1.003***	0.131	0.000
DA	-0.668***	0.078	0.000
FS	0.017	0.013	0.213
TEN	-0.022	0.100	0.825
WOKP	-0.005	0.037	0.893
EDU	0.007	0.037	0.857
ATNS	0.085	0.095	0.374
ATIS	-0.084	0.075	0.263
PCL	-0.002	0.061	0.969
Baksa(L_1)	-0.022	0.087	0.804
Sonitpur(L_2)	-0.014	0.109	0.898
Constant	1.279***	0.161	0.000
F	11.96 (11, 110)***		
Pseudo R^2	0.6314		
VIF	Individual maximum is 2.23 and average is1.62		

In ( ) degrees of freedom

***, and * represents significant at 1% and 10% respectively

5.2 Impact of Rental Markets of Ploughing Machinery on Agriculture

The impact of rental markets of farm capital goods on crop diversification, cropping intensity and land productivity has been investigated by Das (2015). In that study role of rental markets has been captured in terms of impact on pure hiring-in[16] users compared to non-users as hiring-in users are the main beneficiaries as well as predominant group of market participants. Result of study reveals that although pure hiring-in users and owner users[17] were at better position with respect to all the above mentioned indicators than the non-users, such advantages were statistically significant in case of irrigation machinery but not for ploughing machinery. Thus, while rental markets of irrigation machinery werefound to be playing a significant positive role in promoting productivity enhancing practices, it was no so for ploughing machinery rental. In that study role of rental markets was studied without considering the intensity of participation in the markets. It is felt that investigation of impact of rental markets considering the intensity of market participation on productivity enhancing practices may give a different picture especially in case of ploughing machinery. Generally, just one round of ploughing is not sufficient for cultivation of different crops and hence the round of ploughing is matter in the study of productivity enhancing practices of agriculture. Under such circumstances, a pure hiring-in user who use hired-in machinery for ploughing for all the rounds and in whole gross cropped area will naturally have more advantages than a pure hiring-in user who use hired-in machinery only for one round and/or only in a small part of the gross cropped area. Hence, in the present study, impact of rental markets of ploughing machinery of utilization of land productivity has been studied considering the intensity of ploughing by hired-in machinery.

5.2.1 Cropping Intensity

Cropping intensity has been defined as the percentage of gross cropped area to the net sown area.

Independent Variable

Intensity of Hiring-in(INT): It has been defined as the ratio of gross area ploughed using hired-in machinery considering round of ploughing to the gross area ploughed using all implements considering round of ploughing

[16] Pure hiring-in users are the users of concerned capital goods only through hiring-in.

[17] Owner users are all the users of concerned capital goods other than pure hiring-in users of such capital goods.

Control Variables

Farm size (FS): it has been measured in terms of size of operational holdings.

Due to scarcity of labour generally it is expected that with larger size of operational holdings, a farm household cultivated land less frequently. But reverse may also happen provided other farm inputs are available abundantly. Hence, a specific sign of this variable cannot be anticipated a-priori.

Extent of Tenancy (TEN): it has been measured as ratio of leased in area to the total operational holding.

Pure tenants especially share croppers cultivate less intensively compared to owner operators (Goswami, 2012). This intensity of cultivation can be even less with increase extent of tenancy. So, a negative sign can be expected for this variable.

Access to Finance (ATF): it is a dummy variable with 1 for money borrowers and 0 otherwise.

As most of the farmers have poor economic condition, access to credit can help intensive cultivation by enabling them to procure required farm inputs. Therefore, a positive sign of this variable can be expected.

Pure Cultivator (PCL): if the whole income of the family is from own agriculture, households is treated as pure cultivator. So, this is also a dummy with 1 for pure cultivator and 0 otherwise.

As cultivation is the only source of income, such households are like to cultivate more frequently. Hence, a positive sign can be expected.

Extent of Irrigation (IRR): it has been defined as the percentage of gross irrigated area to the gross cropped area.

With the availability of irrigation, a farmer may cultivate more frequently. In this context, the study by Agarwal (1984) has shown the positive impact of irrigation on cropping intensity.

Adoption of High Yielding Varieties (HYV):it has been measured as a ratio of HYV paddy acreage to the total paddy acreage.

As HYVs required shorter duration to get matured, the impact of adoption of it can be expected to be positive.

Location characteristics: cropping intensity may vary across locations due to the variation in location characteristics such as soil condition, incidence of flood etc. Hence to capture such location advantages or disadvantages two location dummies have been used. L_1 is 1 if location is Baksa, 0 otherwise. L_2 is 1 if location is Sonitpur, 0 otherwise. Dibrugarh is the reference location.

Assuming cropping intensity (CI) as the dependent variable following models have been formulated-

$$CI=F\ (INT, FS, TEN, ATF, PCL, IRR, HYV, L_1, L_2)$$

Specification of the Models

The value of dependent variable (cropping intensity) is such that the lower value it can take is 100 without any limit on the upper value. In our dataset, we have a cluster at minimum value of 45 observations. A TOBIT regression with left censoring will be more appropriate than a simple linear regression in such case. Hence left censored TOBIT regression has been formulated as follows-

$$CI_i^*=\beta_0+\beta_1 INT_i+\beta_2 FS_i+\beta_3 TEN_i+\beta_4 ATF_i+\beta_5 PCL_i+\beta_6 IRR_i+\beta_7 HYV_i+\beta_8 L_{1i}+\beta_9 L_{2i}+U_i$$

Where $CI_i=100$ for CI_i^* less than 100

$=CI_i^*$ for CI_i^* greater than equal to 100

and U_is are the usual disturbances

The problem of heteroskedasticity has been checked before proceeding to the estimations of parameters as data set is coming from cross section sample. Breusch-Pagan test depicts the presence of heteroskedasticity which has been corrected by estimating robust standard error. However, there is no such problem of multicollinearity.

Results of regression show that the coefficient of INT is not significant. It reveals the absence of any role of intensity of ploughing by hired-in machinery in raising intensive cultivation. Thus, rental markets of ploughing machinery have no direct impact on cropping intensity. Among the control variables, the coefficient of TEN has been found to be negatively at 10 percent and coefficients of PCL and HYV have been found to be positively significant at same level of significance. Thus, it is found that while the extent of tenancy reduces intensive cultivation, pure cultivators cultivate more frequently. Moreover, adoption of HYVs has also increases cropping

intensity. Other variables like farm size, access to finance and extent of irrigation are found to be insignificant revealing their no role in determining cropping intensity. Insignificant location dummies make it clear that across locations intensity of cropping is same.

Table 5.7: Result of left Censored TOBIT Regressionfor Impact of Rental Markets on Cropping Intensity

Variables	Breusch-Pagan test for heteroskedasticity $chi^2(1)$ = 253.66 Prob > chi^2 = 0.0000 Result: Presence of heteroskedasticity		
	Coefficient	Robust S.E.	p-value
INT	-0.445	0.637	0.487
FS	0.044	0.033	0.196
TEN	-0.982*	0.586	0.097
ATF	0.579	0.494	0.244
PCL	0.387*	0.206	0.063
IRR	-0.004	0.004	0.341
HYV	0.517*	0.287	0.075
Baksa(L_1)	0.233	0.360	0.520
Sonitpur(L_2)	-0.116	0.335	0.729
Constant	0.795	0.731	0.279
F	2.07(9, 112)**		
Pseudo R^2	0.0379		
VIF	Individual maximum is 2.14 and average is1.54		

In ( ) degrees of freedom

** and * represents significant at 5% and 10% respectively

5.2.2 Crop Diversification

The crop diversification has been measured using Herfindahl Index which is given by-

$$H=\sum_{i=1}^{n} s_i^2,$$

Where s_i represents the share of *i*-th crop in gross cropped area. The value of this index ranges from 0 to 1. Higher is the value of H, lesser is the diversified cropping. For convenient of interpretation we have calculated (1-H) where range of values is

same as in case of H. But higher value of (1-H) will represent more diversified cropping.

Independent Variable

Intensity of Hiring-in (INT): as defined in section 5.2.1 above.

Control Variables

Farm Size (FS): as defined in section 5.2.1 above

The exact type of relation between diversified cropping and farm size is not predictable. With large scale availability of manpower, a small farmer may diversify more provided no financial constraint is there. But subject to financial constraint it may be just reverse. Similarly, in the presence of economics of scale in operation, larger farmers may diversify less while in absence of it, things may be opposite. Hence, a-priori, a specific sign of this variable cannot be anticipated.

Extent of Tenancy (TEN): as defined in section 5.2.1 above.

Diversified cultivation by pure tenants especially share croppers is less relative to owner operators (Goswami, 2012). Crop diversification may be even less with increase of extent of tenancy. But Dutta (2011) found the reverse of what had been revealed by Goswami (2012). Therefore, we cannot expect a specific sign for this variable.

Access to Finance (ATF): as defined in section 5.2.1 above.

Access to credit can encourage diversified cultivation especially by credit constraint farmers mainly towards costly crops. So, a positive sign of this variable can be anticipated.

Pure Cultivator (PCL): as defined in section 5.2.1 above.

As pure cultivators earn income only from own agriculture, such households are like to cultivate more frequently and hence the extent of diversified cultivation may also increase. So, the sign of this variable can be expected to be positive.

Extent of Irrigation (IRR): as defined in section 5.2.1 above.

Availability of irrigation can facilitate cultivation of crops dependent very much on it. This can increase the numbers of crops cultivated by farmers having irrigation

facility. So, the impact of extent of irrigation on crop diversification can be expected to be positive.

Working Population (WOKP): it has been measured in terms of working persons of family.

The number of crops cultivated also depends on availability of labour services. So, with more availability of working population a family can devote more services to agriculture and hence diversification of cultivation may increase. Here, the sign of the variable can be expected to be positive.

Access to Extension Services (ATE): it is a dummy with 1 if consulted with the extension workers, 0 otherwise.

As access to extension services increases awareness about new crops and techniques of cultivation, a positive sign of this variable can be anticipated.

Location characteristics: diversified cultivation may vary across locations due to location characteristics such as soil condition, incidence of flood etc. So, using dummy variables such location advantages or disadvantages have been captured. As the study location of the present investigation is three, two location dummies have been used. L_1 is 1 if location is Baksa, 0 otherwise. L_2 is 1 if location is Sonitpur, 0 otherwise. Dibrugarh is the reference location.

Assuming crop diversification (CD) as the dependent variable following models have been formulated-

CD=F (INT, FS, TEN, ATF, PCL, IRR, ATE, WOKP, L_1, L_2)

Specification of the Model

While the value of dependent variable (1-H) ranges from 0 to 1, in our dataset, there is a cluster of 29 observations at the lower end. Hence a left censored TOBIT regression has been constructed as follows-

$$CD_i^*=\beta_0+\beta_1INT_i+\beta_2FS_i+\beta_3TEN_i+\beta_4ATF_i+\beta_5PCL_i+\beta_6IRR_i+\beta_7ATE_i+\beta_8WOKP_i+\beta_9L_{1i}+\beta_{10}L_{2i}U_i$$

Where $CD_i=0$ for CD_i^* less than 0

$=CD_i^*$ for CD_i^* $0\leq CD_i^*\leq 1$

and U_is are the usual disturbances

Results of heteroskedasticity and multicollinearity depicts that both the problems are not present in the regression for crop diversification.

The coefficient of variable INT has been found to be insignificant. It means intensity of hiring-in of ploughing machinery has no role in enhancing diversified cropping.Thus, rental markets of ploughing machinery have no role in enhancing diversified cropping. Among the control variables, coefficient of farm size is positively at 5 percent and the coefficients of variables ATF and PCL are positively at 5 percent. Thus, crop diversification increases with farm size, access to finance and it also more for a pure cultivator than a cultivator who also earns a part of income from sources other than own cultivation.

Table 5.8: Result of left Censored TOBIT Regression for Impact of Rental Markets on Crop Diversification

Variables	Breusch-Pagan test for heteroskedasticity $chi^2(1)$ = 0.49 Prob > chi^2 = 0.4822 Result: No heteroskedasticity		
	Coefficient	S.E.	p-value
INT	-0.060	0.086	0.483
FS	0.024**	0.010	0.013
TEN	-0.101	0.083	0.223
WOKP	0.015	0.030	0.604
ATF	0.143**	0.061	0.021
PCL	0.158**	0.065	0.017
IRR	0.0001	0.001	0.934
ATE	0.094	0.074	0.210
Baksa (L_1)	0.189**	0.077	0.016
Sonitpur (L_2)	-0.157*	0.084	0.066
Constant	0.122	0.124	0.328
LR chi^2	31.51(10)*		
Pseudo R^2	0.2798		
VIF	Individual maximum is 2.26 and average is1.61		

In ( ) degrees of freedom

***, ** and * represents significant at 1%, 5% and 10% respectively

5.2.3 Yield

The impact of rental markets of ploughing machinery on yield has been investigated in terms of yield of paddy in the present study. Paddy has been considered here as it is the largest growing crop by the sample households (82.64 percent)[18]. The yield of paddy has been defined as the output in kg per hectare of land.

Independent Variable

Intensity of Hiring-in (INT):it has been defined as gross paddy cultivated area ploughed by hired-in machineryconsidering round to the gross paddy cultivated area ploughed by all inputs considering round.

Control Variables

Farm Size (FS): as defined in section 5.2.1 above

Regarding the relationship between farm size and yield, it is difficult to have a clear view. While the study by Hossain et al (1977) depicts a negative relation between farm size and land productivity, as per (Khan, 1979, Rao et al, 1981 and Dorward, 1999), under some circumstances,farm size and productivity may relate positively. So, a-priori, a specific sign of this variable cannot be anticipated.

Extent of Tenancy (TEN): as defined in section 5.2.1 above.

The extent of tenancy has adverse impact on output (Junankar, 1976). However, there is also evidence of positive relation between land productivity and tenancy (Hossain et al, 1977). Therefore, a specific sign cannot be expected for this variable.

Access to Finance (ATF): as defined in section 5.2.1 above.

Access to credit can increase yield for credit constraint farmers by enabling cultivation of crops with higher input cost. So, we can expect a positive sign of this variable.

Extent of Irrigation (IRR):it has been measured in terms of gross paddy cultivated area irrigated to the gross paddy cultivated area.

[18] However, for the analysis of yield, 82 paddy grower households (67.77 percent of sample households) have been considered. This is because in Cherepakhati village of Dibrugarh, due to flood paddy was affected and so no output had been received by those households.

Availability of irrigation is very much important especially for dry season cultivation for higher productivity. In this context, Dayal (1984) found a positive relation between land productivity of agriculture and irrigation. So,the sign of this variable can be expected to be positive.

Adoption of High Yielding Varieties (HYV): as defined in section 5.2.1 above.

As the HYVs are more productive than ordinary vitiates, overall productivity increase with increase area under such varieties. So, a positive sign of sign can be anticipated for it.

Fertilizer Application (NPK): it has been measured in terms of application of NPK in kg per hectare of paddy.

Fertilizer application increases the productivity of land. So, with more application of fertilizer, output and hence yield is likely to rise. Therefore, the sign for this variable can be expected to be positive.

Location Characteristics: Yield of paddy depends on location characteristics such as soil condition, climatic condition etc. So, dummy variables have been used to examine the presence of variation of such location characteristics. As the study location of the present investigation is three, two location dummies have been used. L_1 is 1 if location is Baksa, 0 otherwise. L_2 is 1 if location is Sonitpur, 0 otherwise. Dibrugarh is the reference location.

Assuming yield (Y) as the dependent variable following models have been formulated-

$$Y=F\ (INT, FS, TEN, ATF, HYV, IRR, NPK, L_1, L_2)$$

Specification of the Model

The dependent variable here can take only positive values. In such case an exponential specification of regression will be better than a simple linear regression. Accordingly, following Log-linear regression has been constructed.

$$Y=\exp(\beta_0+\beta_1 INT_i+\beta_2 FS_i+\beta_3 TEN_i+\beta_4 ATF_i+\beta_5 HYV_i+\beta_6 IRR_i+\beta_7 NPK_i+\beta_8 L_{1i}+\beta_9 L_{2i}+U_i)$$

Where $U_i$sare the usual disturbances

However, as the above regression is non-linear, it has been made linear by taking log on both sides as follows-

$$LnY=\beta_0+\beta_1INT_i+\beta_2FS_i+\beta_3TEN_i+\beta_4ATF_i+\beta_5HYV_i+\beta_6IRR_i+\beta_7NPK_i+\beta_8L_{1i}+\beta_9L_{2i}+U_i$$

The problems of multicollinearity and heteroskedasticity have been used before proceeding to the estimation of parameters. Using Breusch-Pagan test, it is found that problem of heteroskedasticy is not present. The value VIF has also confirmed the absence of problem of multicollinearity.

Table-5.9 presents the results of Log-linear regression for yield of paddy. The coefficient of the independent variable INT is found to be insignificant. It depicts that in increasing yield, intensity of ploughing by hired-in machinery has no role. Thus, it is found that rental markets of ploughing machinery have no impact on yield of agriculture. Regarding the control variables, coefficient of only HYV is found to significant positively at 5 percent. Thus, adoption of HYVs contributes in raising yield. Other, variables like IRR, NPK, FS, TEN and ATF are found to insignificant showing that yield is not get influence by them. Moreover, insignificant location variables depict that across locations, yield of paddy in same.

Table 5.9: Result of Log-Linear Regression for Impact of Rental Markets on Yield of Paddy

Variables	Breusch-Pagan test for heteroskedasticity $chi^2(1)$ = 0.34 Prob > chi^2 = 0.5579 Result: No heteroskedasticity		
	Coefficient	S.E.	p-value
INT	0.072	0.099	0.466
IRR	-0.001	0.001	0.421
NPK	-0.001	0.006	0.874
FS	0.020	0.013	0.136
TEN	-0.009	0.105	0.930
ATF	-0.117	0.084	0.166
HYV	0.295**	0.120	0.016
Baksa (L_1)	-0.025	0.111	0.824
Sonitpur (L_2)	0.156	0.129	0.232
Constant	7.871***	0.149	0.000
F	2.04(9,72)**		
R^2	0.2035		
VIF	Individual maximum is 3.16 and average is1.72		

In ( ) degrees of freedom

*** and ** represents significant at 1% and 5% respectively

5.3 Summing-up

The principal findings of this chapter have been summarized below-

i) Participation in the rental markets of ploughing machineryis mainly motivated by the realization of benefits of mechanization of ploughing operation. However, maintenance difficulty of draught animals is another important factor motivating farmers to participate in such markets as pointed out by Rath (2015).

ii) Regarding, the characteristics of market participants, exclusively hiring-in users are mostly smaller size group farmers. Moreover, exclusively hiring-in users are farmers with lesser working family members and relatively less of them are pure cultivators. Again, highly educated farm families are relatively more dependent on hiring-in of ploughing machinery. That means dependency on rental markets is more by smaller farmers, farmer with lesser manpower, more education and engaged in activities other than own cultivation.

iii) Hiring-in of ploughing machinery is adversely affected by ownership of both draught animals and ploughing machinery which is quite natural as they are substitutes in nature.

iv) The rental markets of ploughing machinery have no role in increasing cropping intensity, diversified cropping and yield. Therefore, the findings Das (2015) in this regard is stand unchanged.

APPENDIX

Table A.1: Descriptive Statistics of Explanatory Variables for Determinants of Intensity of Ploughing by Hired-in Machinery

Variables	Mean	Standard Deviation
PM	0.165	0.373
DA	0.298	0.459
FS	2.902	3.608
TEN	0.418	0.399
WOKP	2.025	1.052
EDU	2.198	1.030
ATNS	0.314	0.466
ATIS	0.273	0.447
PCL	0.455	0.500
Baksa	0.388	0.489
Sonitpur	0.339	0.475
Dibrugarh	0.273	0.447

Table A.2: Descriptive Statistics of Explanatory Variables forImpact of Rental Markets on Agricultural Productivity Enhancing Practices

Variable	Cropping intensity		Crop diversification		Yield	
	Mean	SD	Mean	SD	Mean	SD
INT	0.756	0.321	0.756	0.321	0.675	0.389
FS	2.902	3.608	2.902	3.608	3.268	4.015
TEN	0.418	0.399	0.418	0.399	0.411	0.4
WOKP	--	--	2.025	1.052	--	--
ATF	0.587	0.494	0.587	0.494	0.573	0.498
PCL	0.455	0.5	0.455	0.5	--	--
IRR	25.405	35.334	25.405	35.334	12.119	30.186
ATE	0.298	0.459	0.298	0.459	--	--
HYV	0.607	0.454	--	--	0.798	0.366
NPK	--	--	--	--	4.387	6.137
Baksa	0.388	0.489	0.388	0.489	0.439	0.499
Sonitpur	0.339	0.475	0.339	0.475	0.378	0.488
Dibrugarh	0.273	0.447	0.273	0.447	0.183	0.389

CHAPTER 6

SUMMARY OF FINDINGS, CONCLUSIONS AND POLICY IMPLICATIONS

This chapter summaries the core findings of the present investigation, broad conclusions and the policy implications thereof.

6.1 Principal Findings

The findings based on both secondary and field study data in relation to fulfillment of set objectives and research question have been restated in following two heads.

6.1.1 Inferences Based on Secondary Data

- In the economy of Assam, agriculture has been playing a significant role. However, the share of agriculture in the state economy has been declining.
- While agriculture is still crucial in the state economy, the growth of this sector in last few years was erratic.
- In the state and also in Brahmaputra Valley, most of the farm machinery especially ploughing machinery, the focus of the study have been found to be used. District-wise such machinery have been found to be used in most of them but with the varying extent of use of them.

6.1.2 Inferences Based on Field Study Data

- Rental markets of ploughing machinery are functioning extensively. All the sample households are found to be participating in such markets. Some of sample households have participated both as supplier and as demanders in rental markets of even same type of ploughing machinery.
- Draught animal rental is also found to functioning but extent of participation in such markets is quite less.
- Rental markets of agricultural capital goods especially the ploughing machinery are contributing in farm operation significantly. In fact, cultivation is made possible for a large number of households by the

functioning of such markets as those farmers plough their land completely by hired-in machinery.

- The participation in rental markets is mainly motivated by mechanization of operations. However, changing environment, for instance, difficulty of rearing cattle due to reducing grazing lands, occurrence of flood etc. also motivates to rely on rental markets of ploughing machinery. There are also factors like higher cost of draught animal, manpower shortage, engagement in activities other than own cultivation etc. motivates participation as demanders in such markets.

- Among the hiring-in users of ploughing machinery, intensity of hiring-in is more for small and marginal farmers than larger size group farmers.

- A large proportion of hiring-in users are exclusively dependent on rental markets for completing their ploughing operation. Such users are smaller size group farmers than farmers which are not completely dependent of hired-in ploughing machinery. Moreover, dependency on rental markets is relatively more for farm households with less manpower, engaged in works other than in own farm and higher level education.

- Ownership of draught animals and ploughing machinery control the intensity of participation in rental markets of ploughing machinery as hirer.

- In enhancing cropping intensity, crop diversification and yield, rental markets of ploughing machinery have no role. This could be due to the fact that all the sample households ploughed mechanically and the intensity of ploughing mechanically for them is quite high (93.50 percent). Moreover, there is the substitution of intensity of hiring-in by intensity of use of own machinery to some extent. As a result, the impact of hired-in machinery may not be visible.

6.2 The Broad Conclusions and Policy Suggestions

The rental markets of ploughing machinery are functioning extensively in Assam. Such markets are functioning indifferent forms. Of course, rental markets of ploughing machinery are functioning predominantly in area based form. Agricultural operation is very much dependent on functioning of this form of factors markets. A large majority of farmers is dependent on rental markets of ploughing machinery for performing their ploughing operation. In fact, cultivation by some of the farmers is possible only because of functioning of rental markets of ploughing

machinery. The degree of dependency is even more for farmers of smaller size groups, possessing less manpower, more educated and earns income from activities other than own cultivation. The extent of area ploughed by hired-in machinery is also high. Thus, rental markets of ploughing machinery are playing a significant role in farm operation and its mechanization.

The prime motive of participation in rental markets of ploughing machinery for most of the farmers is to reap the benefits of mechanization. However, for a significant proportion of farmers overcoming the maintenance difficulty of draught animals by depending on its substitutes is the main purpose of participation in such markets.

From the facts that rental markets of ploughing machinery are contributing significantly in mechanized farming, the main purpose of participation in such markets is to gained through mechanization of agriculture for majority of the participants and in fact a large majority of the farmers relied totally on it for conducting their ploughing operation, it can be concluded that these markets are not just substituting the markets of traditional ploughing units but also contributing greatly in enhancing the extent of mechanization of agriculture.

While rental markets of ploughing machinery has a great role in farm mechanization, the benefits from such markets depends on their efficiency and equity in functioning. For instance, there may be non-availability of ploughing machinery to hire in at the more opportune time due to scarcity of suppliers which can affect the farming outcomes of hiring users. Although, problems related to efficiency and equity of such markets is not evident from the present investigation, if such problem arises, concerned authority may take initiatives to increase suppliers. In this regard, facilitation of formal credit to more farmers can be suggested as 34.78 percent of ploughing machinery have been purchased by using institutional credit.

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ANNEXURE-I

Village Schedule

1. a) Village…….

   b) District……..…

   c) Agricultural sub division……..

   d) ADO circle……...……..

2. No. of households……

3. No. of cultivating households……

4. No. of families involve in leasing of agricultural capital goods……

5. Area (total cultivable) .....……..……Bigha

6. Total irrigated area by source

Sources	Area in bigha
Tube well	
Cannel	
Others	
Total	

7. Basic infrastructure (distance from the nearest……..):

Items	Distance (in km)
Pucca road	
State/National highway	
Public bus stand	

Weekly haat	
District H.Q./ major town	
Commercial bank branch	
Retail outlet for fertilizers, pesticides etc.	
Retail outlet for farm fuel	

8. Stock of agricultural capital goods

Items	No. available	No. of owner users	No. of hiring users
Bullock			
Tractor (Small)			
Tractor (Big)			
Power tiller			
Pumpset			
Others			

9. Input price and rental rate during the reference period……

Inputs	Usual	Rabi season	Kharif season
Labour			
Bullock			
Tractor			
Power tiller			
Pumpset			
Others			

10. Incidence of flood:

Time	No. of waves
Last year	
Year before last year	
2 years before last year	
3 years before last year	
4 years before last year	

11. Major crops grown in the village

a)……

b)……..

c)……

d)……

12. a) Is there any FMC (Pothar Parichalana Samiti) or similar organization?

0-No 1-Yes ☐

b) If yes, no. of members:……..

c) No. of times they meet in a year…….

d) Is there any other farmers group such as water organization?

0-No 1-Yes ☐

13. Availability of farm inputs repairing facilities

Equipment	Number within the village	Distance from nearest available facilities#
Bullock		
Tractor		
Power tiller		
Pumpset		
Others		

#if not available within the village

ANNEXURE-II

Household Schedule

1. Village…….....

2. a) Name of the Head of the farm household……

   b) Caste: GEN-**1**, SC-**2**, ST-**3**, OBC/MOBC-**4** ☐

   c) Religion: Hindu-**1**, Muslim-**2**, Christian-**3**, Others-**4** ☐

   d) Language speck at home: Assamese-**1**, Boro-**2**, Bengali-3, Nepali-**4**, Other-**5** ☐

3. Household size ...……..

4. Details of the household members

Sl No.	Relation with HOH	Sex	Age	Educational Background *	Occupation #	
					Primary	Secondary
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						

***years of schooling**

 # Code-
0-Retired and non-worker (Including infant, old and disable)
1-Unemployed
2- Student
3-Housewife
4- Trading and self-employed
5- Service
6- Agricultural laborer
7-Other daily wage laborer,
8- Cultivator

5. Land holdings (in bigha)

Sl.No.	Items		Area in bigha	No. of plots	Location of plots#
1	Homestead				
2	Details of cultivable land				
	2.a)	Owned operated			
	2.b)	Lease in			
	2.c)	Lease out			
	2.d)	Fallow			
3	Total				

#within the village – 1, in the adjacent village – 2, beyond the adjacent village -3

6. Details of agricultural capital goods owned

Items	No. owned	Purchase price (in Rs)	Year of purchase	Use for farming activity#	Use for non-farming activity#	Financing source (loan amount)
Ploughing cum leveller tractor						
Ploughing tractor						
Power tiller						
Pump set (D/E)						
Bullock pair						
Sprayer						
Harvester						
Shallow tube well						
Others						

#own-**1**, hire out-**2**

7. Purpose (main) of participation in rental markets of farm machinery (as demander/suppliers)

Sl No.		Demander	Supplier
1	To avail the benefits of mechanization		
2	To adjust with the changing environment#		
3	To earn return from investment	NA	
4	Other		

#maintenance difficulty of TU for reduction of grazing land

NA-Not Applicable

8) Details of crops grown

Crops	Area (in bigha)	Area irrigated (in bigha)	Production	Yield (per bigha)	Fertilizer per bigha (amount in kg)					Seed*	Pesticide (cost)	Total no. of round plough ed	Bullock hired-in			Bullock owned	
					Urea	SSP	MOP	DAP	FYM				No. of times used	Rent (per bigha/ hour/day)	Source#	No. of times used	Operational cost
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Sali(T)																	
Sali(H)																	
Ahu(T)																	
Ahu(H)																	
Boro(T)																	
Boro(H)																	
Rape & mus																	
Potato																	
Pulses																	
Sug. Cane																	
Sum.Veg																	
Win veg.																	
Other																	

From the owner with in the village-**1**, from the owner of adjacent village-**2**, from the owner not of adjacent village but within the same panchayat-**3**,
Relative/friend-F, other- O
Group member-M, non-member-N
*if seed is fully subsidized-**1**, if partially subsidized-**2,** own-**3,** purchased-**4,** both-**5**

Crops	Ploughing tractor hired-in			Ploughing tractor owned		Ploughing cum leveller tractor hired-in			Ploughing cum leveller tractor owned		Power tiller hired-in			Power tiller owned		Pump set hired-in			Pump set owned	
	No. of times used	Rent (per bigha/hour/day)	Source#	No. of times used	Fuel cost	No. of times used	Rent (per bigha/hour/day)	Source#	No. of times used	Fuel cost	No. of times used	Rent (per bigha/hour/day)	Source#	No. of times used	Fuel cost	No. of times used	Rent (per bigha/hour/day)	Source#	No. of times used	Fuel cost
1	19	20	21	22	23	24	25	26	27	30	31	32	33	34	35	36	37	38	39	40
Sali(T)																				
Sali (H)																				
Ahu (T)																				
Ahu(H)																				
Boro(T)																				
Boro (H)																				
Rape & mus																				
Potato																				
Pulses																				
Sug. Cane																				
Sum. Veg																				
Win veg.																				
Other																				

From the owner with in the village-**1**, from the owner of adjacent village-**2**, from the owner not of adjacent village but within the same panchayat-**3**,

Relative/friend-F, other- O

Group member-M, non-member-N

9. Access to credit (during the reference period)

Source		Term loan (amount and rate of interest)	Short term loan (amount and rate of interest)
1. Institutional	1. a. Bank		
	1. b. Cooperative		
	1. c. Others		
2. Semi- institutional	2. a. SHGs		
	2. b. MFI		
	2. c. Others		
3.Non-institutional	3. a. Friends/relative		
	3. b. Money lender		
	3. c. Trader		
	3. d. Others		

10. Number of persons having bank account:

11. Sources of crop advice

Item	Sources#
Advice regarding crop/variety to be grown	
Dose of fertilizer application	
Pest and pest control	
Other farming matter	

#self advice-1, fellow farmers-2, extension worker/officer-3, trader-4, FMC or any other farmers' association-5and marketing agencies including contract farming-6

12. a) Do you know the village level worker/ Gram Sevak of your locality?

Yes-1 No-0 ☐

b) If yes, did you consult him during the last year?

Yes-1 No-0 ☐

c) If yes, did you follow the advice?

Yes-1 No-0 ☐

d) If yes, was the advice useful?

Yes-1 No-0

e) Did the extension worker visit your village during the last 6 months?

Yes-1 No/cannot say-0

13. Membership of farmers' association-

Association	Yes	No
Field Management committee		
Water Users Association		
SHGs		
Any other non-political association		

About the author

Anup Kumar Das is currently working as an Assistant Professor in the Rajiv Gandhi University, Itanagar, Arunachal Pradesh. He teaches economics in the Department of Economics. He has obtained his Ph.D. from Gauhati University, Guwahati, Assam. He has to his credit papers published in reputed research journals. The author has also contributed chapters to edited books published by national/international publishers. The prime thrust area of research of the author is agricultural economics.

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The Centre for Development Studies (CDS) was set up in 2013 as a research adjunct at the Department of Economics, Rajiv Gandhi University (RGU),Itanagar, Arunachal Pradesh, with a generous grant from the Ministry of Finance (Department of Economic Affairs), Government of India. The objectives of the Centre include the creation of high quality research infrastructure for students, researchers and faculty members, in addition to sponsoring and coordinating research on various developmental issues having policy implications both at the regional and national level. Sponsoring national and international scholars for delivering lectures and other academic engagements and organizing national and international seminars, workshops, symposiums at periodic intervals on relevant topics and publishing working/policy papers on the research outcome of the Centre, monographs and edited volumes are other key activities of the Centre.

Design & printing: govindsrawat@gmail.com

Centre for Development Studies
Department of Economics
School of Social Sciences
Rajiv Gandhi University
Rono Hills, Itanagar– 791 112
Arunachal Pradesh, India

Tel.: +0360-2277371 (office)
Fax: +0360-2277317
Email: cds.rgu.itanagar@gmail.com