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Overcoming farm size induced constraints through endogenous institutional innovations: findings from a field study in Assam plains, India

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Abstract

The existing studies on the farm size-productivity relationship call for government interventions in some form or another so as to make the farm size induced constraints non-binding. None of these studies explores the potential of the institution of rental markets in helping the farmers in overcoming these constraints. The present study delves into this hitherto unexplored issue. Using survey data, the paper first analyses whether farm size has any impact on productivity and value added and finds none. The insignificance of farm size has been explained in terms of endogenous innovations in the institutions of rental markets.

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1. INTRODUCTION

The debate on the relationship between farm size and productivity brings to the fore the issue of farm size induced constraints faced by the farmers. The earliest studies found an inverse relation between farm size and productivity which was explained in terms of the lower opportunity and transaction costs owing to the use of family labour by the small farms (Sen, 1962; Jha et al., 2000; Mazumdar, 1965; Bardhan, 1973; Chadha, 1978; Ghose, 1979; Carter, 1984; Taslim, 1989; Heltberg, 1998; Cornia, 1985 and Banerjee, 1985). T**he inverse relationship between farm size and productivity also implies that the big farms, who do not have sufficient family labour relative to their land holdings, would be at a disadvantageous position as they may confront the 'principal-agent' problem since they have to depend on hired labour.**

On the other hand, some studies found that bigger farms were more productive and vice versa (Rao 1975, Swamy 1998). The higher productivity of the bigger farms has been explained by these studies in terms of the adoption of superior technology by their owners. **However, as far as the small farmers are concerned, due to imperfection in the credit market they cannot afford to adopt modern technology which is required for purchasing better quality inputs and therefore remain less productive**. **Thus, inability to use modern technology and capital goods or machinery is the constraint that the small farms face.**

From the discussion above what can be concluded is the fact that irrespective of the size of the farm, the farmers are subject to farm size induced resource constraints. The existing literature though brings to light the farm size induced constraints, it does not provide much clue as to how to overcome them except the obvious ones that follow from the debate. All the policy measures suggested by the existing studies in this context call for government interventions in some form or other. Notwithstanding the importance of government interventions, it must be admitted that the success of government interventions depends on government's willingness and ability to implement them as well as intended beneficiaries' willingness and capability to accept and adapt to these policy initiatives. Contrary to government intervention, if a solution induced by conditions prevailing within the agrarian set-up emerges, it may be self-fulfilling and self-sustaining. In this context, the role of the institution of rental markets for the services of agricultural inputs in helping farmers overcome these constraints can be examined in the light of the induced institutional innovation hypothesis as formulated by Hayami and Ruttan (1985) and North (1990). The induced institutional innovation hypothesis suggests that appropriate institutions are innovated so as to organize people effectively in order to take advantage of unexploited profitable opportunities. Factor (rental) markets are one of the most important institutional innovations (Lin, 1995). When distribution of factors of production across households is not equal, rental markets for these factors may emerge as an equilibrating institution. These markets will improve the access of the farmers to these factors which otherwise they cannot or do not own and thereby help them to overcome the constraints they face.

It is surprising to observe that the existing literature exploring farm size induced constraints totally ignores the potential of market institution for overcoming these constraints. **However, the present study explores a scenario wherein such markets have emerged as a response to mis-match in resource (factor) endowments across farm households and is also functioning well. The paper, using data generated through a primary survey from the plains of Assam, first shows that farm size does not have any impact on land productivity and value addition by the farmers[1]. It then elaborates on how endogenous**

[1]For operational focus of the study, the primary data has been collected from the state of Assam in northeast India. Assam has an economy wherein agriculture still contributes a substantial proportion (24.44% in 2009-10) of the gross state domestic product (GSDP) and more than 50 per cent of its workforce is engaged in agriculture

(and indigenous too) innovations in (rental market) institutions made the farm size induced constraints non-binding.

The present paper has been organised into six sections. Section 2 elaborates on materials and methods used in the study. A brief profile of the sample has been presented in section 3. Section 4 analyses whether farm size influences productivity and value added. Section 5 explains as to how the organizational changes or innovations in institutions helped the farmers overcome farm size induced resource constraints. Section 6 concludes.

2. MATERIALS AND METHODS

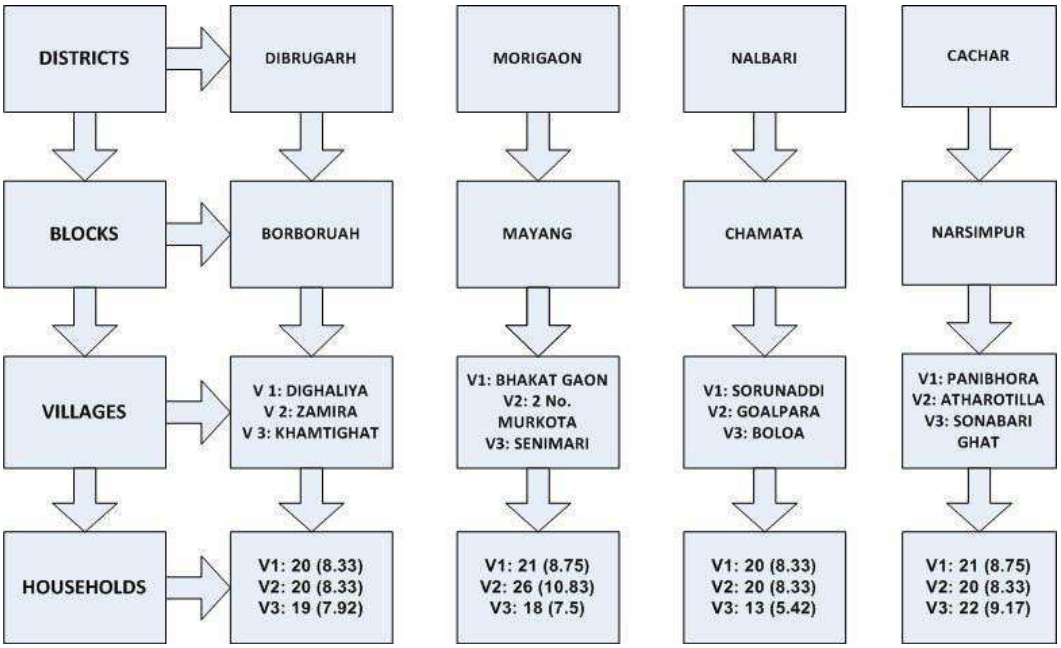
2. 1. Source of Data

The present study is based on primary data collected during 2011-12 from the plains of Assam. Assam comprises of Brahmaputra valley, Barak valley and a hill region. The hills constitute only 19 per cent of geographical area of the state whereas the remaining 81 per cent of the geographical area is plain. The plains constituting of the valleys differ distinctively from the hills in terms of the agricultural system, institution and climate. While the shifting cultivation is still widely prevalent in the hills, settled cultivation is practiced in the plains. The transition to individual ownership of land from community ownership is yet not complete in the hills. On the other hand, people have individual ownership of land in the plains. In terms of climate, the major difference between the hills and the plains or even within the plains is in case of rainfall received. The hills receive fairly less amount of rainfall as compared to the plains. While the Barak valley receives more rainfall as compared to the Brahmaputra valley, the variations in the normal rainfall received in different zones within the Brahmaputra valley are not substantial. On the whole, the two valleys, however, are considerably similar in terms of agrarian institutions and types of agricultural production. Hence, the present study confines to only the plains of the state of Assam.

While collecting data, a multi-stage sampling design was followed in order to make the sample representative of the population and the geographical scope of the study. At the first stage, four non-contiguous districts were selected in order to capture the agro-climatic variations within the plains. The districts selected are: Dibrugarh, Morigaon, Nalbari and Cachar which fall under upper Brahmaputra valley, central Brahmaputra valley, lower Brahmaputra valley and Barak valley respectively. Since Barak valley constitutes only 9 per cent of the geographical area of the state and has only two districts, only one district was selected from this agro-climatic zone. In the second stage, in consultation with the agriculture officers of the selected districts and keeping in view the representativeness of the district in terms of cropping pattern and socio-economic variations, one development block from each of them had been selected. The third stage of the sampling involved selecting three villages (thus a total of 12 villages) at random from each block. Finally, from each selected village 10 per cent of the households operating on agricultural land were selected at random. A total of 221 households thus selected formed the final sample size covered in the survey. The selection procedure of the sample has been summarised in figure 1.

(Government of Assam, 2011-12). However, in so far as the farm size is concerned, almost all (except for the plantation crop like tea) agricultural activities are carried out on small and marginal holdings in the state. As per the National Sample Survey of India, 94.6 per cent of operational holdings in Assam were marginal and small holdings and there was no large holding in 2002-03 (Goswami, 2012). Given the perceived limited resource endowment of these marginal and small farmers, it therefore becomes important to understand whether farm size acts as a constraint on the farmers and how these constraints are overcome by them.

Figure 1: Selection Process of the Sample



Notes: 1. V1 – Village 1, V2 – Village 2 and V3 – Village 3
2. Figures within ( ) represent percentages of households in the village in the sample

2. 2. Methodology

The present paper estimates the following –

Productivity or value of output per hectare of farm land (VHAC)

Value added per hectare of farm land (VADHAC)

The definitions of VHAC and VADHAC are given below.

VHAC: gross value of output[2]/farm size in hectare.

VADHAC: (gross value of output – total costs of purchased intermediate inputs[3])/farm size in hectare.

The analysis of productivity and value added has been done at two levels. First, productivity and value added from cultivation have been analysed in terms of size classes. This exercise gives us an impression whether farm size may impact the variables of our concern. Then, to ascertain whether farm size influences the variations in productivity and value added from cultivation across farm households more rigorously, multiple regression models have been developed which includes some other control variables besides farm size. The details of the regression models framed, their estimation procedures and results obtained thereof have been elaborated in section 4.

[2] Gross value of a crop is given by the product of the total crop output and the price received by sample farmers selling the crop in their respective locality. While calculating the VHAC in overall cultivation, the gross value of total farm output is defined as the summation of the market values of all the crops produced by the household during one year.

[3] Costs of purchased intermediate inputs include expenditures on fertilizers, pesticides, seeds, fuel and irrigation charge. While calculating the value addition in overall cultivation, summation of the costs of purchased intermediate inputs used in all crops produced during one year has been deducted from the summation of the gross values of all the crops produced by the household during that year.

3. A BRIEF PROFILE OF THE SAMPLE

This section presents a brief profile of the sample in terms of the tenure status of the farmers, distribution of the farmers in terms of size classes of operational holding and tenure status wise cropping pattern. Table I shows the distribution of the sample households in terms of tenure status.

Table I
Distribution of the sample households in terms of tenure status

Tenure Status	Percentage of Sample Households
Pure Tenant	16.30
Owner Operator cum Tenant	37.10
Owner Operator	33.48
Owner Operator cum Lessor	13.12
Total	100.00

Source: author's calculation based on field survey data

As shown in Table I, there are four categories of households in the sample in terms of their tenure status. Of all, the owner operator cum tenant[4] is the predominant category (37.10 percent) followed by owner operator (33.48 percent), pure tenant (16.30 percent) and owner operator cum lessor (13.12 percent).

It has been found that the farmers prefer to lease in land under sharecropping and fixed rent tenancy contracts in the field study locations. Most of these tenancy contracts were found to be for short duration.

Table II shows the distribution of the sample farm households and areas under different size classes of operational holding.

Table II
Percentage distribution of farm households and areas under different size classes of operational holding

Operational Holdings (in Hectare)	Sample Households	Sample Areas
0-1	38.01	16.59
1-2	38.46	36.27
2-3	16.30	26.78
3-4	3.62	8.64
4-5	2.71	8.48
5-6	0.90	3.24
Total	100.00	100.00

Source: same as for Table I

It is clear from Table II that both in terms of number and area, most of the farmers in our sample are marginal and small farmers[5].

[4] An owner operator cum tenant is one who cultivates on leased land besides his own land. A pure tenant is one who does not own any land and cultivates only leased in land. On the other hand, an owner operator cum lessor is one who cultivates a part of his owned land and leases out the remaining part.

[5] Farmers with operational holding less than one hectare are marginal farmers and those who cultivate 1-2 hectares are considered as small farmers.

Table III presents the cropping pattern of the three types of farmers. The major crops that the owner operators grow are winter paddy (58.35 percent) followed by summer paddy (21.67 percent) and winter vegetables (9.15 percent). The sharecroppers, however, predominantly[6] grow winter paddy (88.37 percent). On the other hand, the fixed rent tenants mainly grow the following crops: summer paddy (39.36 percent), winter paddy (22.12 percent), winter vegetables (21.54 percent) and rape and mustard (16.20 percent).

Table III
Tenure status wise cropping pattern

Tenure Status	Winter Paddy	Summer Paddy	Winter Vegetable	Rape &Mustard	Potato	Jute
Owner Operator	**58.35**	**21.67**	9.15	7.72	2.21	0.90
Sharecropping	**88.37**	9.40	-	1.31	0.48	0.44
Fixed rent	22.12	**39.36**	21.54	16.20	0.39	0.39
Overall	**58.18**	**22.09**	9.37	7.78	1.74	0.84

Note: the figures are in percentage and they represent the areas of the crops in the total cropped area
Source: same as for Table I

Thus, it is clear from the above discussion that in terms of tenure status, there are four categories of farmers in our sample. Sharecropping and fixed rent tenants are the major forms of tenancy contracts prevailing in the field study locations. On the other hand, it has been observed that most of the farmers in our sample are marginal and small farmers. In terms of cropping pattern, while the sharecroppers and owner operators grow mainly winter paddy, the fixed rent tenants grow summer paddy, winter vegetables, winter paddy and to some extent rape and mustard.

4. DOES FARM SIZE INFLUENCE PRODUCTIVITY AND VALUE ADDED?

Figures 2 and 3 show the relation of farm size with VHAC and VADHAC respectively. It is evident from the figures that no clear pattern could be observed in so far as the association of farm size with VHAC and VADHAC is concerned.

[6] Goswami and Bezbaruah (2013, p.63) have explained as to why the sharecroppers predominantly grow winter paddy in the following way: "Sharecropping is usually the preferred form of contract when the crop grown is the conventional winter paddy. Winter paddy is grown during the rainy season and harvested during winter. As a result, it is subjected to greater risk and uncertainty caused by weather conditions than crops grown in the other seasons. Since, under sharecropping, the risk associated with the crop is also shared along with the output, the tenants prefer sharecropping when they grow winter paddy". See Goswami and Bezbaruah (2013) for a detailed discussion on choice of crops and tenancy contracts.

Figure 2: Association between farm size and VHAC

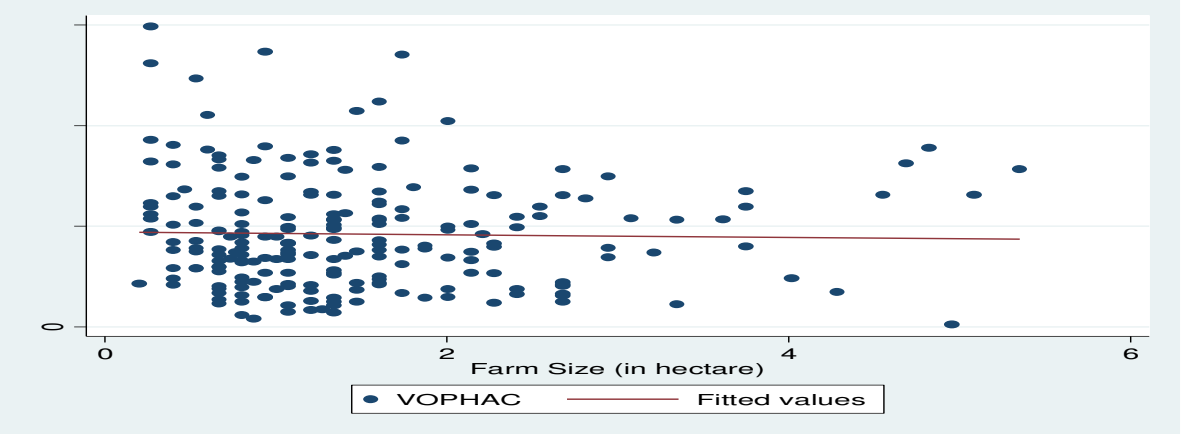
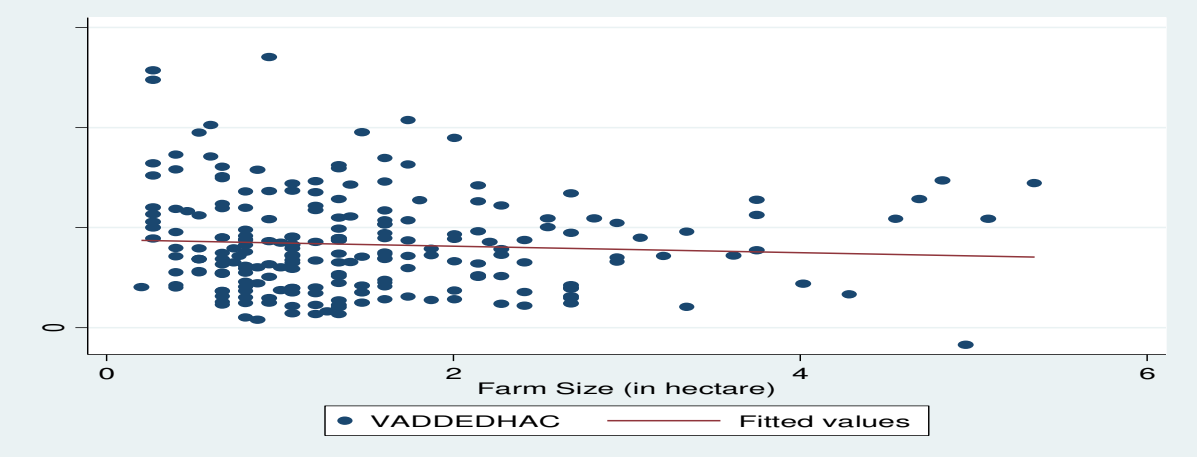


Figure 3: Association between farm size and VADHAC



Figures 2 and 3 give a preliminary impression about the relationship between farm size and productivity and value added. But to ascertain the impact of farm size on productivity and value added more rigorously, we now turn to a regression analysis. The regression analysis has been carried out in two steps. At the first step, VHAC and VADHAC have been regressed only on farm size and locational dummies without controlling for the impacts of other variables which may potentially influence productivity and value added. In the second step, the control variables have also been introduced. This exercise allows us to check for the robustness of the regression results.

The independent and the control variables considered in the regression analysis are broadly divided into five categories, viz., farm characteristics, tenure status, input intensity, enabling factors and locational dummy. Farm characteristics include age of the farmer (AGE), education level of the farmer (EDU) and farm size measured in terms of operational holding in hectare (FS). Tenure status includes two variables, such as, area under sharecropping as a percentage of operational holding (ASC) and area under fixed rent as a percentage of operational holding (AFR). Input intensity includes the following five variables: labour cost per hectare of operational holding (LAB), tilling cost per hectare of operational holding (TILL), area under irrigation as a percentage of operational holding (IRRI), area under HYVs as percentage of operational holding (HYV) and NPK per hectare of operational holding (NPK). Enabling factors include access to extension service (EXT) and access to credit (CREDIT). Access to extension is used as a dummy variable, where $D_1 = 1$ if the i-th farmer has received any direct benefits from the government's extension service network; $D_1 = 0$,

otherwise. Similarly, access to credit is also a dummy variable, where, $D_2 = 1$, if the i-th farmer has access to institutional credit and otherwise $D_2 = 0$. Finally since the data used in the regression analysis come from a sample of households covering four different agro-climatic zones, three locational dummies have been introduced to control for the impact of agro-climatic variations and differences in soil quality on productivity and value added. Thus taking Dibrugarh as the reference category, three dummies that have been used are - D_1, D_2 and D_3, Where $D_1 = 1$ for Morigaon, 0 otherwise; $D_2 = 1$ for Nalbari, 0 otherwise; and $D_3 = 1$ for Cachar, 0 otherwise.

Thus, after incorporating the variables mentioned above, the following four linear multiple regression equations have been arrived at for estimation.

$$VHAC_i = \beta_0 + \beta_1 FS_i + \beta_2 D_{1i} + \beta_3 D_{2i} + \beta_4 D_{3i} + U_i \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

$$VHAC_i = \beta_0 + \beta_1 AGE_i + \beta_2 EDU_i + \beta_3 FS_i + \beta_4 ASC_i + \beta_5 AFR_i + \beta_6 LAB_i + \beta_7 TILL_i + \beta_8 IRRI_i + \beta_9 HYV_i + \beta_{10} NPK_i + \beta_{11} EXT_i + \beta_{12} CRE_i + \beta_{13} D_{1i} + \beta_{14} D_{2i} + \beta_{15} D_{3i} + U_i \quad \ldots\ldots\ldots (2)$$

$$VADHAC_i = \beta_0 + \beta_1 FS_i + \beta_2 D_{1i} + \beta_3 D_{2i} + \beta_4 D_{3i} + U_i \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

$$VADHAC_i = \beta_0 + \beta_1 AGE_i + \beta_2 EDU_i + \beta_3 FS_i + \beta_4 ASC_i + \beta_5 AFR_i + \beta_6 LAB_i + \beta_7 TILL_i + \beta 8 IRRI_i + \beta_9 HYV_i + \beta_{10} NPK_i + \beta_{11} EXT_i + \beta_{12} CRE_i + \beta_{13} D_{1i} + \beta_{14} D_{2i} + \beta_{15} D_{3i} + U_i \quad \ldots\ldots (4)$$

U_i is the random disturbance term which is assumed to be normally distributed with zero mean.

The summary statistics of the independent and control variables have been presented in Table AI in appendix A. Results of the regression analysis have been summarized in Table IV[7]. The major inferences that may be drawn from results are as follows.

- Productivity (VHAC) and value addition (VADHAC) depend on input intensities. In case of productivity, while the coefficients of LAB, TILL and HYV are found to be positive and significant at 1 percent level of significance, the coefficient of IRRI is positive and significant at 10 percent level of significance. The results imply that higher the expenditures on labour and tilling and more the area under irrigation and HYVs, higher is the productivity. The households having irrigation facility on farm land, on the average are more productive relative to other households without access to irrigation. These households may cultivate lands frequently, diversify, use HYVs and more of other inputs and thereby raise production and productivity.

- Among the inputs only LAB, TILL and HYVs are found to have positive and significant impact on value added. The coefficients of LAB, TILL and HYV are positive and significant at 1 percent level of significance. In case of value addition, though higher expenditure on tilling and more area under high yielding varieties seeds would mean more costs on purchased inputs to be deducted from value of output, the productivity gains from the use of these inputs may outweigh the inputs costs and thereby contribute positively to value added.

[7] The results of regression analysis presented in Table IV corresponds to the relationship between farm size and productivity in overall cultivation (as defined in footnote 2). The same issue has been investigated in case of two major crops, i.e. winter paddy and summer paddy, separately as well. The results of crop specific regression analysis have been presented in Table AII in Appendix A. it may be mentioned here that the results are consistent in all the cases under consideration. In other words, no significant relationship between farm size and productivity could be established whether it is in case of overall cultivation or any specific crop.

- While the locational dummies D_1 and D_3 have been found to be significant at 1 percent level of significance with positive values of the coefficient in the first regression equation for productivity, D_2 is significant at 5 percent level of significance with a negative coefficient in the second equation for productivity. On the other hand, in case of value added, while D_2 and D_3 are significant at 1 percent level of significance with positive coefficient in the first equation, D_2 is significant at 10 percent level of significance with a negative coefficient in the second equation. D_1 and D_3 are the dummies for Morigaon and Cachar and D_2 is the dummy for Nalbari respectively. Thus, it can be inferred that the farmers in Morigaon and Cachar are more productive and value added by them is more relative to the farmers in Nalbari. The reason for this can, at least partially, be found in the cropping pattern prevailing in these locations. Summer paddy, winter vegetables and rape and mustard are the major crops cultivated in Morigaon. In Cachar also, summer paddy is grown to a sizable extent. These crops involve little weather risk. The fact that these crops involve little weather risk induces the farmers to apply costly inputs like HYV seeds and irrigation and grow the crops largely on commercial basis. Application of these inputs minimizes the production risk caused by factors other than weather, increases production and productivity and fetches higher returns.

- Age and education of the farmer, forms of tenancy contracts, use of chemical fertilizer, excess to extension service and institutional credit have been found to have no impact on productivity and value added.

- **It is interesting to note here that the coefficient of farm size does not appear to be significant in any of the four regression equations. This implies that farm size does not have any impact on productivity and value added. It may be mentioned here that our results are broadly in conformity with Mahesh (2000). In a study in the context of the Indian state of Kerala, Mahesh (2000) found that though a size-class wise analysis suggests that large farms are more productive, more detailed analysis using regression methods failed to establish any relationship between farm size and productivity.**

  The results of regression analysis allows us to conclude that the use of inputs is more important a factor than farm size in so far as farm productivity is concerned. This result is further explored in section 5. Section 5 shows as to how the emergence of rental markets allowed the farmers across farm sizes to overcome their resource induced constraints which otherwise might have prevented them from using the inputs (such as tilling, labour, irrigation and so on) sufficiently. Emergence of the rental markets has thus eliminated the disadvantages caused by farm size and made it largely irrelevant as far as farm productivity is concerned. This phenomenon is not considered in any of existing studies.

Table IV
Results of regression analysis for VHAC and VADHAC

Test of Heteroskedasticity	BP/CW test Chi^2 [1] = 0.45 Prob. = 0.5013	BP/CW test Chi^2 [1] = 40.48 Prob. = 0.0000	BP/CW test Chi^2 [1] = 4.55 Prob. = 0.0329	BP/CW test Chi^2 [1] = 36.83 Prob. = 0.0000
Dependent variables →	VHAC	VHAC	VADHAC	VADHAC
Independent variables /constant ↓	Estimates of the Coefficients/Values			
AGE	-	121.91 (111.09)	-	115.09 (103.26)
EDU	-	1065.53 (1476.19)	-	1138.20 (1400.91)
FS	1063.63 {1798.97}	-1607.82 (1687.41)	51.91 (1963.17)	-1885.39 (1602.70)
ASC	-	-3.35 (37.63)	-	-1.07 (35.22)
AFR	-	-19.21 (65.81)	-	-19.72 (61.98)
IRRI	-	121.64* (65.44)	-	83.38 (55.30)
LAB	-	1.56*** (0.49)	-	1.15*** (0.43)
TILL	-	3.20*** (0.81)	-	2.93*** (0.77)
HYV	-	156.61*** (55.93)	-	140.17*** (52.57)
NPK	-	35.30 (24.74)	-	13.59 (22.40)
EXT	-	12600.85 (15324.78)	-	9872.62 (12137.78)
CREDIT	-	4063.53 (4150.69)	-	4126.54 (3793.89)
D_1	23548.24*** {4917.68}	-8731.47 (6385.06)	2252.51 (4020.17)	-1318.10 (5710.35)
D_2	967.56 {5174.76}	-12367.17** (5277.85)	24129.34*** (4643.99)	-9002.44* (4810.67)
D_3	15675.05*** {5049.52}	-2105.96 (4335.54)	15032.84*** (4147.89)	197.26 (3869.15)
CONSTANT	33781.25*** {4838.37}	-3600.95 (7142.20)	30445.65*** (4442.89)	-1552.80 (6625.21)
R^2	0.13	0.55	0.17	0.50
F	8.04*** [4, 211]	15.10*** [15, 198]	9.59*** [4, 211]	13.93*** [15, 198]

Figures within { }, ( ) and [ ] are standard error, heteroskedasticity consistent robust standard error and degrees of freedom respectively. ***,** and * indicate significant at 1 percent, 5 percent and 10 percent level of significance.

5. MAKING FARM SIZE INSIGNIFICANT THROUGH ENDOGENOUS INNOVATIONS IN INSTITUTIONS

The analysis in section 4 suggests that farm size is not a factor that influences the variations in productivity and value added across households. This implies that the farm size induced constraints were non-binding. Table V however suggests that the marginal and small farmers and especially the tenant farmers did face the resource constraints. While not a single tenant farmer owned tractor and power tiller, only a few relatively better off (in terms of size of operational holding) owner operators possessed these capital goods. This raises the question as to how the marginal, small and tenant farmers could overcome the farm size induced constraints.

It is this query which led the author to discover the presence of rental markets for factors of production in the areas under study[8]. The figures in Table V imply that since there is a mis-match in resource endowments in terms of ownership of capital goods across households, there is scope of better allocation of these resources among rural households through transactions in the rental markets[9]. Consequently the institution of rental markets have been innovated to take advantage of these profitable opportunities as suggested by the induced institutional innovation hypothesis[10]. This is why we call these developments as indigenously crafted endogenous innovation in the institution. It is interesting to note that such rental market transaction is a profitable venture for both the buyers and suppliers of the services of the capital goods. While the buyers can have access to the services of the capital goods without having to own them and thereby can overcome the resources constraints induced by farm size; the sellers on the other hand, earn the rental income.

As the analysis below indicates, not only has the institution of rental market enabled the farmers to face the farm size induced resource constraints but it has also brought about a change in the process of cultivation in these locations. The change in the process of cultivation has enabled big farmers to overcome the disadvantages of not being able to use family labour on agricultural land.

Table V
Percentage Distribution of sample Farmers owning capital goods by tenure status

Tenure status	Tractor	Power tiller	Bullock pair
Pure tenants	0.00	0.00	33.33
Owner Operators*	1.62	10.27	55.68
Total	1.36	8.15	52.04

Note: * includes owner operator cum tenant and owner operator cum lessor
Source: same as for Table I

[8] None of the existing studies that deals with issues related to the agrarian economy of Assam talks of the presence of these markets. In fact, the exiting literature does not discuss anything about the functioning of rental markets, except the land lease market. Thus one can infer the emergence of these markets as a recent event.

[9] Figures in Table V relate only to the owners of tractor/power tiller among the respondents. There are however some more households in each village who are primarily engaged in non-farm activity but own tractor and power tiller and rent them out to the farm households in the village.

[10] Innovation in the institution in terms of the emergence of the rental markets is a spontaneous response of the rural households to the mis-match in their factor endowments. The mis-match in resource endowment created an opportunity for both the owners and buyers of the services of the agricultural machineries to be better off by exchanging them among themselves in markets. The rural households just exploited this opportunity and that's how these markets emerged.

5.1. Extent of the Rental Markets for the Services of Inputs

Among all the rental markets, the most crucial ones in terms of extent of development are the markets for the services of tractor/power tiller and bullock pair. Table VI represents the extent of the rental markets for tractor/power tiller and bullock pair.

Table VIa

Percentage of owner operators participating in the Rental Markets for Tilling Equipment and Bullock pair (%)

Operational Holding (hectare)	Tractor + Power tiller			Bullock Pair	
	Possessed	Didn't use	Hired	Possessed	Didn't use
0-1	0.00	27.16	72.84	59.26	32.10
1-2	6.12	12.24	81.63	69.39	22.45
2-3	23.33	3.33	76.67	46.67	43.33
3-4	27.27	0.00	81.82	45.45	54.55
4-5	66.67	0.00	66.67	66.67	33.33
5-6	50.00	0.00	50.50	50.00	50.00

Table VIb

Percentage of sharecroppers participating in the Rental Markets for Tilling Equipment and Bullock pair (%)

Operational Holding (hectare)	Tractor + Power tiller			Bullock Pair	
	Possessed	Didn't use	Hired	Possessed	Didn't use
0-1	0.00	36.96	63.04	60.87	28.26
1-2	0.00	23.53	76.47	64.71	29.41
2-3	0.00	25.00	75.00	100.00	0.00
3-4	0.00	0.00	100.00	100.00	0.00

Table VIc

Percentage of fixed rent tenants participating in the Rental Markets for Tilling Equipment and Bullock pair (%)

Operational Holding (hectare)	Tractor + Power tiller			Bullock Pair	
	Possessed	Didn't use	Hired	Possessed	Didn't use
0-1	0.00	12.12	87.88	36.36	57.57
1-2	0.00	23.08	76.92	38.46	61.54
2-3	0.00	0.00	100.00	100.00	0.00
3-4	0.00	0.00	100.00	0.00	100.00

Source: same as for Table I

It is clear from Table VI that while only a small proportion of farmers in the lower size classes did not use tractor/power tiller, substantially higher proportion of farmers hired the services of tractor/ power tiller in all size classes. This is true irrespective of the tenure status of the

farmers. In fact, 100 percent of the sharecroppers and the fixed rent tenants in the relatively higher size classes hired the services of tractor/power tiller.

In so far as the market for the services of bullock pair is concerned, given the higher extent of the market for the services of tractor and power tiller, it is obvious that percentage of farmers hiring the services of bullock pair is not very high. Besides, a sizeable proportion of farmers across tenure status and size classes (except the fixed rent tenants in the size class of 3-4 hectares) owned bullock pair. Nonetheless, a small proportion of farmers, especially the owner operators and the sharecroppers in the lower size classes did hire the services of bullock pair for tilling land.

Alongside the development of the market for the service of tractor/power tiller and bullock pair, another market that has emerged prominently is that for the service of instrument for irrigation, or more precisely for the service of pump-set. This rental market is however important especially for the fixed rent tenants who cultivate mainly water intensive crops like summer - paddy and winter vegetables. Since the sharecroppers predominantly grow winter paddy (see Table III), they do not require irrigation[11]. Winter paddy is the major crop for the owner operators as well though they grow water intensive crops like summer paddy and winter vegetables on some parts of their lands. However, most of the owner operators who cultivate these crops own pump-set. Only three of the owner operators who did not own pump-set are found to have hired the services of pump-set; rest of them used their own pump-sets. While it makes sense for the owner operators to possess the pump-set since they have their own land, the same is not the case for the fixed rent tenants. It may neither be possible to purchase the pump-set due to financial constraint nor will it be viable to purchase it given the small scale of operation of the fixed rent tenants. Thus they depend on the market for the services of pump-set. Except for one, all the fixed rent tenants have been found to have hired the services of pump-set.

In terms of rent charged in the market for the services of tractor, power tiller and bullock pair, it has been found that though across locations there are variations (see Table VII), within the same location (i.e. in the villages of a district), the prevailing rent is the same. On the other hand, the usual arrangement across locations in the market for the services of pump-set is such that a farmer pays 2-2.5 maund (1 maund = 40 kg) of paddy to the owner of the pump-set while hiring it. Thus, if absence of variations in price is considered as an indication of the existence of a competitive market, the rental markets are competitive, at least locally[12].

Table VII
Location wise Rental Rate for one round of tilling (in Rupees/per bigha*)

Field Study Locations	Tractor	Power tiller
Dibrugarh	113	188
Morigaon	213	163
Nalbari	98	113
Cachar	163	163

Notes:* 1 bigha = 0.13387 hectare
Source: same as for Table I

[11] Winter paddy is sown during the summer and harvested during winter. Since it is sown during the summer, i.e. the rainy season, it does not require irrigation.

[12] So far, government has no role in regulating these markets. In fact, there is no need of government regulation since these markets seem to be competitive at least locally. In a community set-up where everybody knows everybody else, it is difficult for the owners of the agricultural machineries to discriminate among the buyers of the services of the machineries.

5.2. Change in the Process of Cultivation

A decade ago or so, the process of cultivation was such that the farmer would stand behind the plough by himself and perform each part of the cultivation process. He would, at best, hire labour to work alongside him during the time of transplantation and harvesting. But now-a-days, it has been observed that the way cultivation especially that of paddy is managed has undergone a sea change. Most of the farmers prefer to contract out almost all the parts of the cultivation process. Starting from weeding to carrying the harvested paddy to the farmer's house, each part of the process is contracted out. Contracting out is preferred by the farmers as it minimizes the necessity to monitor to a large extent which otherwise would have been a costly affair. After outsourcing the job, the farmer can make the payment to the party to whom the work has been outsourced once the job is done. Such an arrangement allows the farmer to avoid the principal-agent problem[13]. Thus the farmer's job has become less labour intensive; in fact the farmer's role has got reduced to that of a manager only.

The out-sourcing of different parts of the cultivation process has been possible due to the development of the markets for the various services required. For example, when a farmer hires the services of bullock pair and tractor/power tiller, he does not use them by himself to till the land. Rather, in some cases the owners of these items and in most of the cases somebody appointed either by the owners of the tractor/power tiller or somebody hired by the owner of land perform the job. This essentially means that the farmer has outsourced the job and this change in the process of cultivation has been induced by the development of rental markets for the services of the factors of production. Table VIII shows the extent of the phenomenon of outsourcing parts of cultivation process performed exclusively by human labour. From Table VIII, it is observed that expenditure on human labour for outsourced work as a percentage of total human labour increases with the size of operational holding. This implies in the smaller size classes more of family labour is employed whereas extent of outsourcing is higher in the higher size classes.

[13] If the farmer had hired labour, he/she would have to monitor the work of the labourer in order to ensure that the labourer works in the farmer's interest. However, when the job is outsourced, the farmer does not have to do the continuous monitoring. The arrangement is such that once the job is done, the farmer pays to the person/party after monitoring whether the job is done to his satisfaction. If he is not satisfied, he may request the concerned party to do what is required before the payment is made. For example, in many of the villages it was observed that there were groups of women who did the weeding job. A farmer would outsource the weeding part of the cultivation process to one of these groups. The group informs the farmer once the job is done. The farmer then monitors whether the job has been performed properly. If he finds that some more work is to be done, he can request the concerned party to do so. The farmer makes the payment only when the group performs the remaining work.

Under a hired labour contract, the farmer has to pay the labourer on a per day basis. On the other hand, when the job is outsourced the farmer pays only for the job irrespective of the days taken to finish the job. Given the arrangement or terms of outsourcing, it is thus in the interest of the party who takes the outsourced job to work without shirking from the beginning to finish to work within the minimum possible time.

Table VIIIa
Extent of the outsourcing of works performed only by human labour: the case of the owner operators

Operational holding (in hectare)	% of farmers who outsourced parts of cultivation process
0-1	86.25
1-2	100
2-3	96.66
3-4	100
4-5	100
5-6	100

Table VIIIb
Extent of the outsourcing of works performed only by human labour: the case of the sharecroppers

0-1	82.61
1-2	82.35
2-3	100
3-4	100

Table VIIIc
Extent of the outsourcing of works performed only by human labour: the case of the fixed rent tenants

0-1	84.84
1-2	100
2-3	100
3-4	100

Note: i) total labour costs include costs of labour for outsourced work and imputed value of family labour
ii) Outsourced works include transplanting, weeding, harvesting and agricultural labour for the preparation of field.

Source: same as for Table I

Thus, as can be understood from the above discussion the institution of rental markets for factors of productions has proved to be a major instrument to nullify the impact of farm size induced resource constraints both on the small farmers as well as big farmers. The emergence of rental markets has allowed small farmers to hire the services of the agricultural machinery and thereby to reduce the impact of resource constraint on their farming activities. The institution of rental markets has also created the possibility of contracting out parts of cultivation process which has nullified the disadvantage that big farmers face for not having sufficient family labour. Consequently, farm size as a factor influencing variations in productivity and value added across farm households has tend to become insignificant in the sample areas under study. This discussion is further supported by the results of the regression analysis presented in Table IX wherein VOPHAC (productivity) has been regressed on two dummy variables besides farm size and

the locational dummies[14]. One of the two dummy variables included in the regression analysis is hiring where $D_1 = 1$ if the i-th farmer has possessed/hired the services of agricultural machinery; $D_1 = 0$, otherwise. The other dummy variable is outsourcing where $D_2 = 1$ if the i-th farmer has outsourced parts of cultivation of process; $D_2 = 0$, otherwise. Drawing on from the discussion above, it is expected that both the dummy variables shall have positive and significant coefficients. Then only it will be possible to establish that the farmers could overcome their constraints through hiring of the services of agricultural machineries and outsourcing of parts of cultivation process.

Table IX: Results of regression analysis showing the relation between VOPHAC, possession/hiring of the services of agricultural machineries and outsourcing of parts of cultivation process

Test of Heteroskedasticity →	BP/CW test Chi^2 [1] = 0.91 Prob. = 0.3414
Variables	Estimates of coefficients/values
Possession/hiring of agricultural machinery	10479.76** (4825.25)
Outsourcing	12344.54* (6579.84)
Farm size	229.02 (1800.99)
D_1	21713.57*** (4910.07)
D_2	-171.41 (5125.32)
D_3	16684.60*** (5224.37)
Constant	15499.93* (7992.09)
F	6.92*** [6, 209]
R^2	0.17

Figures within ( ) and [ ] are standard error and degrees of freedom respectively. ***,** and * indicate significant at 1 percent, 5 percent and 10 percent level of significance.

From Table IX, it is clear that the coefficients of the dummies for possession/hiring of agricultural machinery and outsourcing are significant at 5 percent and 10 percent level of significance. As expected, both the dummy variables have positive coefficients. Thus the results imply that farm households possessing/hiring the services of agricultural machineries are more productive relative to those who do not possess or hire the services of these machineries. Similarly, the farm households who outsource parts of cultivation process are more productive as compared to those who do not do so. The reasons for these findings have already been discussed above in details. Thus the results of the regression analysis presented

[14] Those control variables which appear to be insignificant in the regression results presented in Table IV have not been included in this regression. Besides, variables relating to input intensity also are not included here. The reason for not including input intensity variables here is the fact that outsourcing or hiring of machinery may affect the input intensity resulting in multicollinearity problem. For example, area under irrigation may go up if a farmer could hire the services of pump-set.

in Table IX firmly establish the fact that emergence of the rental market has helped the farmers to overcome their constraints through the process discussed above and has in the process made farm size irrelevant as far as farm productivity is concerned.

6. CONCLUSION

The present study delves into the hitherto unexplored issue of the potential of rental market institutions in helping the farmers overcoming the farm size induced constraints that they face. It first analyses if farm size has any impact on productivity and value added and finds none. The explanations for farm size having no impact on productivity and value added have been provided in terms of changes in the institutional organization of agricultural production in the area under study. Two major changes in the institutional arrangement have been observed, such as i) emergences of rental markets for the services of tractor, power tiller and bullock pair and ii) changes in the process of cultivation in terms of outsourcing various parts of cultivation rather than doing it by the farmers themselves, facilitated by the emergence of rental markets. Emergence of the rental markets, on the one hand, has made the resource constraints that the small farms face non-binding. On the other hand, out-sourcing of different parts of the cultivation process has helped the farmers in avoiding the principal - agent problem. Consequently, the relevance of farm size has become insignificant to a large extent.

The emergence of the rental markets or the changes in the cultivation process are not some exogenous institutional developments. These developments in the institutions are innovations induced by mis-match in resource endowments across households. Such institutional innovations have resulted in better allocation of the resources across rural households. Hence there is reason to believe that these endogenous innovations in the institution will sustain.

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Appendix A

Table AI: Summary Statistics of the independent and control variables used in the regression analysis

Variables	Observations	Mean	Std. Dev	Min	Max
AGE	216	43.51	11.50	19	73
EDU	216	1.92	1.11	0	4
FS	216	1.47	1.01	0.20	5.35
ASC	216	16.77	30.45	0	100
AFR	216	10.66	24.74	0	100
IRRI	216	42.30	43.08	0	100
LAB	216	9025.84	4671.64	1556.00	38656.91
TILL	216	6747.60	4507.92	1243.81	23507.88
HYV	216	58.78	35.81	0	100
NPK	216	74.95	82.36	0	463.14
EXT	216	.0278	0 .16	0	1
CREDIT	216	0.19	0.39	0	1
D_1	216	0.27	0.45	0	1
D_2	216	0.22	0.41	0	1
D_3	216	0.26	0.44	0	1

Table AII: Results of regression analysis for winter paddy and summer paddy

Test of heteroskedasticity →	Winter paddy BP / CW test Chi2(1) = 4.96 Prob. = 0.0259	Summer paddy BP / CW test Chi2(1) = 5.22 Prob. = 0.0259
Variables	Estimates of coefficients/values	
Farm size	-963.18 [2260.49]	6510.04 [5201.83]
D_1	18672.17*** [5960.21]	-10784.68* [6407.49]
D_2	614.18 [5009.34]	
D_3	14300** [5912.76]	
Constant	31362.55*** [5737.83]	66800.85*** [6633.23]
R^2	0.09	0.07
F	4.46*** (4, 175)	3.06* (2, 68)

Figures in ( ) and [ ] are degrees of freedom and heteroskedasticity consistent standard error. ***, ** and * indicate significant at 1 percent, 5 percent and 10 percent level of significance. The definitions of the location dummies used in the regression for winter paddy, i.e. D_1, D_2 and D_3, are the same as before. The locational dummy D_1 in the regression for summer paddy takes value 1 if the ith observation belongs to Morigaon, otherwise D_1 =0.