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PERFORMANCE OF FARMS BASED ON THE RELATIONSHIP OF FARM SIZE AND EFFICIENCY

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Abstract *This study attempts to provide a comparison of performance of farms based on their relationship of farm size and efficiency indicators. A series of SLRM have been conducted by taking farm size as predictor variable over a sample size of 120 paddy farms of Assam, India. Majority of absolute measures, irrespective of financial and physical in nature, show positive relation with the farm size. However, the physical ratio measures such as yield per hectare, production efficiency, man day per hectare, machine day per hectare are reversely related to the same. Yet, financial ratio measures like profit per hectare, overhead charge ratio, operating ratio, etc., indicate better performance towards the higher farm size categories. This study concludes by suggesting that on maintaining a proper liquidity position, a medium farm can be the most efficient category of farm size in Assam.*

Keywords: *Farm Size, Farm Size Categories, Farm Performance, Measures of Performance*

INTRODUCTION

The farm sector has unparalleled importance in the economy and lives of people in India. Providing livelihood to more than 50% of the population, besides being the major source of raw material for the industries, agriculture contributes nearly 14% to the nation's economy (FICCI, 2015). A considerable portion of the budget is allotted for the farm sector every year. However, policy makers are found formulating the agricultural policies based on the aggregate measures of resource used, production, productivity and income from this sector. Further, majority of Indian farmers take decisions on farm operations without assessing fully the state of liquidity, solvency, debt repayment capacity, profitability, efficiency and development possibilities of their farm operations. Without proper appraisal of performance, farmers fail to treat the cause of the problem and end up dealing only with its symptoms (Crane, 1998), which may hamper the sustainability of farm operation in the long run.

Among the decisions, determining the appropriate farm size for operation is regarded as one of the prime strategic decisions of farmers (Johl & Kapur, 2000). Such decisions should be based on good knowledge of the current state of business; which is not possible without the indicators to performance of its key processes (Fechete & Nedekcu, 2014). The farmer's decision on the farm size has vital impact on the overall farm structure of the nation. It is therefore; rigorously addressed by many researchers across the world over the time, especially on the relationship between the farm size and the economic performances of the farms. The findings of such research help the farmers as well as policy makers in allocating scarce land resources appropriately.

On this backdrop, the present article attempts to study the performance of farms at various level of their size of operation, in the context of India, more specifically in the state of Assam. The study compares the five size categories of farms as defined by the agricultural censuses of India in terms of their performance using both financial and non-financial data.

REVIEW OF LITERATURES

The literatures for the purpose of the article are discussed in following two sections:

Measures of Performances

Land productivity and economic efficiency have been discussed and tested with farm size numerously. Various authors use efficiency measures such as – technical efficiency, allocative efficiency, total factor productivity as the performance indicators of the farms. These efficiency measures reveal the yield gap, with the help of which, the gain that could be obtained by improving performances in production with existing resources and technology can be estimated for a farm (Islam, Backman, & Sumelius, 2011). Colie, Rao,

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O'Donnell, and Battese (2005) discuss productivity, technical efficiency, allocative efficiency, scale economies, total factor productivity (TFP), production frontier as the measures of performances, which are derived from essential methods like- least-squares econometric production models (LS), total factor productivity indices (TFP), data envelopment analysis (DEA) and stochastic frontiers (SF). Literatures like Toma, Dobre, Dona, and Cofas (2015), Burja (2011), Dhungana, Nuthall, and Nartea (2004), etc., use Data Envelopment Analysis (DEA) for calculating efficiencies as a measure of farm performances. Some of the studies that use stochastic model of efficiency estimation are - Taylor and Shonkwoler (1986), Gupta, Roy, Deb, and Mazumder (2013), etc.

A range of literatures consider the classical financial ratios and measures for evaluating the performance of the farms. Kulawik (2012) provides a historical representation of the financial efficiency measurement methods and nature of an enterprise value. For comparing the small farms with the large ones, USDN (2007) adopts (i) profitability measures (rate of return on assets, rate of return on equity, and operating profit margin), (ii) income measures (net farm income), (iii) financial efficiency measures (operating expense ratio), (iv) solvency measures (debt asset ratio) and (v) solvency and income measures (financial position- favorable, marginal income, marginal solvency and vulnerable) as the performance indicators. CAPI (2009) seeks suggestion from the respondents on farm profitability and performance indicators as – (a) income: gross margin per farm, net income per farm (b) profitability ratios: operating profit margin, return on asset, return on equity (c) productive efficiency ratio: capital turnover, labor intensity (e) financial efficiency ratios: gross margin efficiency, operating expense ratio, contribution margin, interest coverage (f) liquidity ratios: current ratio, working capital ratio, debt structure and (g) solvency ratios: leverage and equity position; to be included in the annual reports. Wadsworth and Brav-Ureta (1992) uses debt-equity ratio, return on assets, return on equity, and equity as the performance indicators to find out their determinants. Escalante and Barry (2002) estimate growth in equity capital of the farms as a performance indicator for a successful farm business. Johl and Kapur (2000) classified such indicators into two groups as – (a) physical efficiency indicator and (b) financial efficiency indicators. Sureshkumar, Patel, Asodiya, and Parmar (2014) consider 11 factors to calculate resource use efficiency, namely- hired human labor, seed rate, manures and cakes, fertilizer, insecticides and pesticides spray, irrigation, no of weeding, bullock labor, fuel and farm size.

Farm Size and Performance

The relationship of Farm size and performance especially in terms of efficiency has been much discussed in the literatures. Studies of during 1960s, most of the researches show increase in the productivity with decrease of farm size, which give an inverse relationship (IR) between farm size and performance parameters (Sen, 1962; Saini, 1971). However, IR is not a static phenomenon always. It may exist, but it is not universal (Rudra, 1968). Feder (1983) shows that a systematic (either positive or negative) relationship between per acre yield and farm size will prevail when the performance of hired labor is affected by the family supervision and the accessibility of credit depends on owned land. Otherwise, such relationship disappears in a model with no supervision effects on labor productivity. In context of sub-Saharan African countries, Savastano and Scandizzo (2017) shows a direct-inverse-direct relationship between farm size and efficiency. They found an inverted U-shape relation between farm size and land productivity among less productive labor, while more productive labor showed a U-shaped relationship. In both the cases there is a threshold value. To the left of the threshold the relation is direct (positive) for very small farms. For middle size farms, the relation is inverse (negative) and for large farms it again turns into a direct (positive) relation. Similar studies (Eastwood, Lipton, & Newell, 2010; Happe, Balmann, Kellermann, & Sahrbacher, 2008) conducted in advanced countries basically argue in favour of large scale farming to achieve economies of scale. The operations of farms of advance countries are machine-based. Therefore, influence of labor productivity is neutralized by the low-cost machineries and higher opportunity cost of labor. A Recent study by Bhatt and Bhat (2014) in India has also found that technical efficiency first falls and then rises with the farm size. Hence, the relationship is non-linear.

METHODS

The study assumes inferential quantitative approach for the purpose of data analysis throughout. The individual farms being the subject matter of the study, are looked as an entity, managed and supervised by the main cultivators of the farm households. It is therefore, a microeconomic investigation, self-reported by the main cultivators during the period 2015-2016. The study concentrates on the hypothesis that farm performances do not vary across the different farm size groups. To test the hypothesis, the study measures as set of performance indicators first, and then attempts to collect empirical evidence on the relationship of such indicators with that of the respective sizes of the studied farms.

Sampling Design and Data Collection

Paddy farms of Assam are selected considering the huge involvement of agricultural land, workforce and consumption demands of rice in the state. As per Agricultural Census 2010-11, the state has 2,702,616 (99.35%) numbers are individual holding across the six agro-climatic zones, such

as North Bank Plain Zone, Upper Brahmaputra Valley Zone, Central Brahmaputra Valley Zone, Lower Brahmaputra Valley Zone, Barak Valley Zone and Hill Zone. The study chooses to collect data from all the six agro-climatic zones by using multistage stratified sampling. Then, one district, from each zone is selected, based on its close proximity with the figure of average paddy production of the zone for the year 2014. All total there are 121 Agricultural Development Officers (ADOs) in these districts. A total of 12 numbers (10%) of ADOs are selected (2 ADOs form each district) in the next stage, followed by picking up of 1 village each from the ADOs. Finally, 10 farm households from each village are drawn systematically. For this purpose, the first household at the entrance of village is taken as random starting point and 2 households are fixed as the periodic interval. The total count of sample farms is 120 thereby. The sample size accommodates all the five acreage sizes of operational holdings as given in the agricultural censuses of India. Thus, the sample size constitutes 30 marginal (below 1 hectare), 41 small (between 1 to 2 hectare), 32 semi-medium (between 2 to 4 hectare), 13 medium (between 4 to 10 hectare) and 4 large farms (10 hectare and above) as given in the table 1 below-

Table 1: Distribution of Samples

Farm Size	Size	Number of farms
Marginal Farm	Below 1 hectare	30
Small farm	Between 1to 2 hectare	41
Semi medium farms	Between 2 to 4 hectare	32
Medium farms	Between 4 to 10 hectare	13
Large farms	10 hectare and above	4
Total		120

Select Measures for Farm Performance

Johl and Kapur (2000) have suggested a list of measures of farm performance under the two broad categories of - (A) Physical Efficiency Measures and (B) Financial Efficiency Measures. Each of these categories is further categorized as - (a) absolute or aggregate measures and (b) ratio measures. This list incorporates performance indicators both in physical units and in financial values, which give more comprehensive comparison of the performance among the farm size categories. Therefore, the present study adopts and calculates these for each of marginal, small, semi-medium, medium and large sample farm categories.

Efficiency is one of central terms in assessing and measuring the performance of organizations as well as inter-organizational arrangements (Mouzas 2006). The term efficiency is expressed as the ration of maximum potential output achievable from a given level of input or the ratio of minimum possible input to produce a given level of output. Thus, efficiency of a production system is a term of comparison between observed and optimal values of its output and input. Both the output and input of a production system are basically some financial data, which are expressed in efficiency scores to derive at useful information on the performance of an economic unit. The select farm efficiency measures are as follows-

Physical Efficiency Measures

a. Absolute or aggregate measures: total area of the farm (farm size), total production.
b. Ratio measures:
   – Land use efficiency: yield per hectare, production efficiency, cropping intensity.
   – Labour efficiency: return per family labor day.
   – Machine efficiency: machine hour (or horse power) per hectare (available and used).

Financial Efficiency Measures

a. Absolute or aggregate measures: Total capital managed, gross profit, net profit.
b. Ratio measures:
   – Income efficiency: Profit per hectare
   – Capital efficiency: Cost per hectare, overhead charges ratio, fertilizer cost per crop hectare, operating ratio, capital per unit of gross income, rate of capital turnover.

Empirical Modeling

The hypothesis of the study has led to investigate any significant influence of farm sizes over the efficiency of farms empirically. When the data are plotted in a scattered diagram to determine the best fitted model; linear relationships are found approximately in most of the cases. This gives a series of two variables simple linear regression models (SLRM) with efficiency measure of farms as the dependent variable (Z_i) and farm size as the predictor variable (X_i), which can be expressed as-

$$Z_i = \alpha + \beta X_i + \varepsilon_i \qquad (3.3.a)$$

Where, Z_i = the individual efficiency measure of farms

X_i = farm size

β = the regression coefficient for the explanatory variable X_i

α = constant value

ε_i = stochastic disturbance term

If the numerical estimates of α and β are ά and β́ respectively, then the estimated regression is-

$$\acute{Z}_i = \acute{\alpha} + \acute{\beta} \quad X_i \qquad (3.3.b)$$

The least square criteria are applied for the models so that the ά and β́ are chosen in such a way that $\Sigma\varepsilon_i^2$ are near zero. The null hypothesis (H_0: the value of true average farm size for the entire farms in Assam i.e. β and constant i.e. α are both zero) is formulated to test the statistical significance of ά and β́ by computing t –value as-

$$\acute{t} = \frac{\acute{\beta}}{SE(\acute{\beta})} \text{ (under } H_0\text{: } \beta = 0) \qquad (3.3.c)$$

The confidence level is constructed at 95%, which can be given by-

$$\acute{\beta} \pm SE\ (\acute{\beta})t_{\lambda/2} \qquad (3.3.d)$$

Where, $t_{\lambda/2}$ is the critical value of t with λ/2(=0.05) level of significance and (n-2) degrees of freedom. Apart from the t-value, the SPSS software also provides the p-values to access the significant of the estimates.

Measuring Goodness of Fit: Adjusted R- **s**quare ($0 \leq r^2 \leq 1$ is used to measure the goodness of fit. It shows how much the variation in farm size is responsible for the variation of each efficiency measures, which is given by-

$$r^2 = 1 - \frac{\Sigma \varepsilon i2}{\Sigma z i2} \qquad (3.3.e)$$

DATA AND DESCRIPTIVE STATISTICS

Physical Efficiency Measures

The average area operated by the farms under the study is 2.24 hectare. The farm size varies from 0.13 to 11.03 ha with a standard deviation of 2.08 ha. On an average, each farm produces 9.57 quintal of paddy. The lowest production is 0.45 ql., whereas the highest production rises up to 56 quintal The yield per hectare for the sample farms is 4.64 quintal, which is a good figure and indicates improved paddy cultivation in Assam. Combining the yield per hectare with the average production of the farms, production efficiency is found as 1.09 > 1. It implies that the farms can produce efficiently by using minimum resources with usual effort and skill. Return per family labor day use is only 0. 003 million ranging from 0.000 million to 0.019 million. Return per family labor day is calculated in terms of currently prevailed waged rate of the study areas. The man day used is 84 days, whereas machine day used is 46 days on an average, indicating labor intensive agriculture in the state. Table 2 shows the descriptive statistics of the physical efficiency measures.

Table 2: Physical Efficiency Measure

Measures	Details	Obs	Mean	SD	Min	Max
Absolute or aggregate measures						
Total area operated	In hectare	120	2.24	2.08	0.13	11.03
Total production	In quintal	120	9.57	8.18	0.45	56
Ratio measures						
Yield per hectare	$\frac{\text{Total production}}{\text{Area operated in hectare}}$	120	4.64	1.62	1.35	12.26
Production efficiency	$\frac{\text{Yield per hectare}}{\text{Average production of the area}}$	120	1.09	0.38	0.32	2.87
Cropping intensity	$\frac{\text{Area cropped}}{\text{Total cultivated area}} \times 100$	120	114	28	83	200
Return per family labor day	$\frac{\text{Family labour income}}{\text{Number of family labour days}}$	120	0.003	0.002	0.000	0.019
Man day per hectare	$\frac{\text{Total man day employed}}{\text{Area operated in hectare}}$	120	84	28	6	217
Machine day per hectare	$\frac{\text{Total machine day}}{\text{Area operated in hectare}}$	120	46	35	4	254

Authors' calculation

Financial Efficiency Measures

Financial efficiency is a proxy to the economic sustainability of farms. In this respect, Table 3 shows the descriptive statistics for select financial efficiency measures for the sample farms. The absolute measures of total capital, gross income and net income of the sample farms are calculated as 0.137 million, 0.111 million and 0.122 million respectively. The cost of production (CoP) is not deducted while calculating the gross income and net income. The standard deviations calculated for the same are 0.104 million and 0.122 million; which are quite high figures. This implies that the farms under study are highly diverse in terms of income generation. The cost per hectare is 0.055 million with a standard deviation of 0.064 million. The minimum cost incurred per hectare is 0.001 million and maximum is 0.400 million. When cost per hectare figure is matched with the net income per hectare, the average of profit per hectare comes as 0.007 million with a standard deviation of 0.064 million within the range of 0.343 million (loss per ha.) to 0.157 million (profit per ha.).

The average overhead charge ratio of 0.52 indicates that farms under the study generate income almost two times higher than the amount of fixed cost borne by the farms. However, the operating ratio of 1.20 is not very encouraging as the average net income earned by the farmers is not adequate to cover the total operating cost. Fertilizer cost per hectare is 0.005 million on an average. However certain farms spend no money, while some farms spend as big as 0.028 million in fertilizer per hectare. A major portion of this cost is subsidized by the government. The capital employed is 1.72 times of gross income of the farms, indicating resource availability of the farms. The average rate of capital turnover is found to be 36.42% with a very high standard deviation of 107.19%. The lowest percentage is 0.02 and highest is 874.69. This indicates that there are certain farms which are profitable at lower investment in fixed assets, which raises a very important managerial query for the farmers of the state regarding whether to buy or hire/lease fixed equipment (tractor, pump, etc.) for their farming activities.

Table 3: Financial Efficiency Measure

Measures	Details	Obs.	Mean	SD	Min	Max
Absolute or aggregate measures						
Total capital managed	In million	120	0.137	0.140	0.008	0.821
Gross income	In million	120	0.115	0.104	0.005	0.722
Net farm income	In million	120	0.122	0.119	0.005	0.842
Ratio measures						
Profit per hectare	$\frac{\text{Net farm income}}{\text{Area operated (in hectare)}}$	120	0.007	0.064	-0.343	0.157
Cost per hectare	$\frac{\text{Total cost}}{\text{Area operated (in hectare)}}$	120	0.055	0.064	0.001	0.400
Overhead charges ratio	$\frac{\text{Total cost per year}}{\text{Gross income}}$	120	0.52	1.39	0.00	14.90
Operating ratio	$\frac{\text{Total operating cost}}{\text{Net income}}$	120	1.20	1.93	0.05	17.37
Fertilizer cost per crop hectare	$\frac{\text{Total cost of fertilizer}}{\text{Area operated (in hectare)}}$	120	0.005	0.007	0.00	0.038
Capital per unit of gross income	$\frac{\text{Capital employed}}{\text{Gross income}}$	120	1.72	1.83	0.06	9.48
Rate of capital turn over	$\frac{\text{Gross income}}{\text{Total farm assets}} \times 100$	120	36.42	107.19	0.02	874.69

Authors' calculation

FARM SIZE AND MEASURES OF PERFORMANCE

Physical Efficiency Measures and Farm Size

Table 4 is a summary of the results of regression models conducted by taking physical efficiency measures as dependent (Z_i) and farm size as predictor variable (X_i). The calculation of Pearson correlation coefficient shows that total production (0.796) is positively correlated with change of farm size. On the other hand, the composite efficiency measures like- yield per hectare (-0.228), production efficiency (-0.228), return per family labor day (-0.154), man day per hectare (-0.405) and machine day per hectare (-0.490) are having inverse relations with farm size change. The relation with cropping intensity (0.023) is positive but insignificant. Unlike many research findings, this study shows a decreasing trend of both man day and machine day with the increase of farm size.

Table 4: Regression Models (taking farm size as X_i)

Dependent variables (Z_i)	Pearson correlation coefficient	R-Square	Adjusted R -square	Coefficient (t-ratio)	Constant (t-ratio)
Total Production	0.796*	0.634	0.631	8.170* (14.297)	5.587* (10.499)
Yield per hectare	-0.228*	0.052	0.044	-0.462* (-2.540)	4.869* (28.705)
Production efficiency	-0.228*	0.052	0.044	-0.108* (-2.540)	1.138* (28.705)
Cropping intensity	0.023	0.001	-0.008	0.805 (0.251)	113.538* (38.028)
Return per family labor day	-0.154*	0.024	0.016	-0.0005* (-1.698)	0.003* (10.222)
Man day per hectare	-0.405*	0.164	0.157	-14.267* (-4.806)	90.477* (32.724)
Machine day per hectare	-0.490*	0.240	0.233	-21.257* (-6.099)	56.700* (17.467)

Authors' calculation

* Significant at 0.05 level of significance

The adjusted R-square value of 0.631 indicates that the change in farm size explains approximately 63% of variance in total production of the farms under the study. This figure is approximately 16% and 23% for man day and machine day per hectare respectively. However, very less portion of variance in the yield per hectare (4%), production efficiency (4%), return per family labor day (2%) is explained by the variance of farm size.

Except cropping intensity, other physical efficiency measures are showing either positive or negative relation with the farm size. Increase in farm size by 1 ha increases 8.170 quintal (α = 5.588 quintal) of total production, which is significant at 0.05 level. However, increase in farm size by 1 ha reduces the yield per hectare by 0.463 quintal (α = 4.870 quintal), production efficiency by 0.108 points (α = 1.138), return per family labor day by 0.0005 million (α = 0.003 million), man day per hectare by 14 days (α = 90 days) and machine day per hectare by 21 days (α = 57 days).

Financial Efficiency Measure

Table 5 is a summary of the results of regression models conducted by taking financial efficiency measures as dependent (Z_i) and farm size as predictor variable (X_i). The Pearson correlation coefficient for total capital managed (0.323), gross income (0.740), net farm income (0.779) are positive and significant at 0.05 level of significance. This figure for cost per hectare (-0.303), overhead charge ratio (-0.204), operating ratio (-0.258), fertilizer cost per crop hectare (-0.181) and capital per unit of gross income (-0.281) are negative and significant at 0.05 level of confidence. However, their associations are not so strong. Profit per hectare (0.113) is found insignificantly correlated.

The gross income and net income can be explained by the variance in farm size almost 55% and 60%, respectively, as indicated by adjusted R-square value. The portion of other financial efficiency measures like- total capital managed

(10%), cost per hectare (8%), overhead charge ratio (3%), capital per unit of gross income (7%), fertilizer cost per crop hectare (2%), operating ratio (5%) and rate of capital turnover (3%) are explained by the farm size very meagerly. Total capital managed, gross income and net profit increases by 0.057 million (α = 0.110 million), 0.110 million (α = 0.068 million), 0.102 million (α = 0.065 million) respectively, when farm size increases by 1 ha. However, when profit is measured in terms of profit per hectare, then no significant β value could be derived. On the other hand, cost per hectare, overhead charges ratio, operating ratio, fertilizer cost per hectare, capital per unit of gross income and rate of capital turnover are found decreasing by 0.024 million (α = 0.067 million), 0.355 (α = 0.696), 0.624 (α = 1.502), 0.002 million (α = 0.006 million), 0.645 (α = 2.032) and 27.457 (α = 23.039) respectively with the increase of 1 ha of farm size.

Table 5: Regression Models (taking farm size as X_i)

Dependent variables ***(Z_i)***	**Pearson correlation coefficient**	**R-Square**	**Adjusted R -square**	**Coefficient (t-ratio)**	**Constant (t-ratio)**
Total capital managed	0.323*	0.104	0.097	0.057* (3.706)	0.110* (7.694)
Gross income	0.740*	0.740	0.547	0.110* (11.948)	0.068* (7.953)
Net farm income	0.779*	0.607	0.604	0.102* (13.503)	0.065* (9.218)
Profit per hectare	0.113	0.013	0.004	0.009 (1.231)	0.003 (0.670)
Cost per hectare	-0.303*	0.092	0.084	-0.024* (-3.451)	0.067* (10.160)
Overhead charges ratio	-0.204*	0.041	0.033	-0.355* (-2.258)	0.696* (4.753)
Operating ratio	-0.258*	0.067	0.59	-0.624* (-2.903)	1.502* (7.509)
Fertilizer cost per crop hectare	-0.181*	0.033	0.024	-0.002* (-1.996)	0.006* (8.317)
Capital per unit of gross income	-0.281*	0.079	0.071	-0.645* (-3.181)	2.032* (10.762)
Rate of capital turn over	0.204*	0.042	0.034	27.457* (2.265)	23.039* (2.041)

Authors' calculation

* Significant at 0.05 level of significance

To sum up, except total production, other physical efficiency measures like - yield per hectare, production efficiency, return per family labor day, man day per hectare and machine day per hectare are inversely and significantly related with the growth of farm size. Financial efficiency measures such as- total capital managed, gross income, net income and rate of capital turnover are positively and significantly related to the increase of their size. On the other hand, cost per hectare, overhead charges ratio, operating ratio, fertilizer cost per hectare, and capital per unit of gross income are reversely and significantly related to the growth of farm size.

ANALYSIS AND DISCUSSION

A cross sectional descriptive analysis has been set as the criteria for arriving at the best performing farm size categories in the study area. The data for the study were collected in five different farm sizes and the arithmetic mean of efficiency measures are calculated for each such group. Further, a series of one way ANOVA test has been undergone to know the significant difference of efficiency measures among the five farm size categories.

Table 6 shows the farm size-wise physical efficiency measures, calculated as mean values. The F-statistic values derived from

one-way ANOVA, indicate that the mean of total production, yield per hectare, production efficiency, man day per hectare, machine day per hectare and the ratio between man day and machine day per hectare are significantly different for each category of farms at 0.05 level of significance. The average areas of operation are 0.68 ha for marginal, 1.37 ha for small, 2.63 ha for semi-medium, 5.08 ha for medium and 10.41 ha for large farms. Expectedly, the total production of paddy for each categories are- 3.403 ql., 6.79 ql., 11.15 ql., 23.16 ql., 27.51 ql. The yield per hectare figure for the categories are – 5.083 ql. per ha (marginal), 4.88 ql. per ha (small), 4.262 ql. per ha (semi-medium), 4.446 ql. per ha (medium), and 2.638 ql. per ha (large). These figures indicate the marginal farms to be the most efficient one. There is a gradual declination of yield per hectare till semi medium category. However, farms of medium category show an increased value, which again decreases for large farms. Likewise, the production efficiency figure for marginal farms is 1.19 which is gradually decreasing for small (1.14) and semi-medium (1) farms. Then, there is a slight upward of this figure for medium farms (1.04). The lowest production efficiency is shown by the large farms (0.62). The average cropping intensity for the farms increases with the farm size. This figure is 113 for marginal farms, 114 for small farms and 117 semi-medium farms. However, there is a decrease in cropping intensity for medium farms (110) and a further decrease for large farms (107). The marginal farms (0.0033 million) provide the highest return to family labor days, which decreases for small farms (0.0027 million) and for semi-medium (0.0019 million).

Table 6: Farm Size Wise Physical Efficiency Measures [Figures are as: Mean (Minimum, maximum)]

Measures	F-Statistics	Marginal	Small	Semi medium	Medium	Large
Absolute or aggregate measures						
Total area operated (in hectare)	425.586*	0.68 (0.13,0.94)	1.37 (1, 1.87)	2.63 (2.01,3.88)	5.08 (4.01,7.22)	10.41 (10.10,11.03)
Total production (in quintal)	55.044*	34 (4.5,82)	67.9 (24,130.4)	111.5 (40,242.5)	231.6 (54,560)	275 (234,336)
Ratio measures						
Yield per hectare (in quintal per ha.)	2.984**	50.8 (29.9,122.6)	48.8 (22.4,81.8)	42.6 (19.9,74.8)	44.5 (13.5,83.7)	26.4 (22.6,30.5)
Production efficiency	2.984**	1.19 (0.70,2.87)	1.14 (0.52,1.90)	1 (0.47,1.75)	1.04 (0.32,1.96)	0.62 (0.53,0.71)
Cropping intensity	0.242	113 (100,200)	114 (100,200)	117 (83,200)	110 (100,148)	107 (100,129)
Return per family labor day (INR'000 per labor day)	1.079	3.13 (4.73,13.78)	2.67 (4.89,19.22)	1.89 (3.35,4.13)	2.05 (2.79,5.71)	2.82 (1.63,5.13)
Man day per hectare	6.602*	96 (49,149)	88 (20,217)	82 (38,139)	66 (13,118)	35 (6,50)
Machine day per hectare	6.708*	67 (17,148)	49 (7,254)	37 (9,95)	22 (4,45)	18 (5,36)
Ration of Man to Machine day per hectare	4.083*	1.79 (0.76,4.04)	2.4 (0.85,9)	2.65 (1,4.41)	3.5 (0.99,7.8)	3.2 (0.45,845)

Authors' calculation

*Significant at 0.01 level of significance

**Significant at 0.05 level of significance

***significant at 0.1 level of significance

However, it rises for medium farm to 0.0021 million and for large farms to 0.0028 million; which is a noticeable outcome of the study. Both man day per hectare and machine day per hectare are declining with the increase of farm size. On an average a marginal farms uses man day (96 days) which is 1.79 times of machine days (67 days) by such farms. Likewise, the man day per hectare used by small farms, semi-medium farms, medium farms and large farms are – 88 days, 82 days, 66 days and 35 days, using machine day per hectare as -49 days, 37 days, 22 days and 18 days respectively. A general expectation is that if man day per hectare decreases with the farm size, the machine day should be substituted. Therefore,

there should be an increasing trend of machine days used by the farms. In other word, the larger farms should be more machine intensive. This is not found in the present study. The ratio of man day to machine day is found increasing with the farm size (1.79 for marginal, 2.4 for small, 2.65 for semi-medium, 3.5 for medium farms, 3.2 for large farms). This indicates labor incentive agriculture of the state irrespective of size of operating area.

Table 7 presents the financial efficiency measures for the five categories of farm size. The F-statistics derived from one way ANOVA, indicate that the mean of total capital employed, gross income, net income, cost per hectare, operating ratio and capital per unit of gross income are significantly different for each category of farms at 0.05 level of significance. There is an increasing trend in managing total capital by the farms. The farms manage 0.067 million (marginal), 0.1,50 million (small), 0.129 million (semi-medium), 0.241 million (medium) and 0.2,53 million (large) of capital respectively. Similarly, other two absolute measures i.e. gross income and net farm income are also found increasing with the growth of farm size. The gross income figures are - 0.040 million (marginal), 0.079 million (small), 0.128 million (semi-medium), 0.290 million (medium) and 0.354 million (large). The corresponding net income figures are – 0.041 million (marginal), 0.087 million (small), 0.133 million (semi-medium), 0.316 million (medium) and 0.363 million (large) respectively. The medium farms (0.0 26 million) is found as the most efficient in terms of earning profit per hectare, followed by marginal (0.0156 million), semi-medium (0.015 million) and Large farms (0.008 million). On the contrary, small farms show loss of 0.011 million per hectare.

Table 7: Farm Size Wise Financial Efficiency Measures [Figures are as- Mean (Minimum, maximum)]

Measures	F-statistics	Marginal	Small	Semi medium	Medium	Large
Absolute or aggregate measures						
Total capital managed	5.086*	0.067 (0.008,0.281)	0.151 (0.020,0.626)	0.129 (0.019,0.339)	0.241 (0.014,0.821)	0.253 (0.062,0.414)
Gross income	54.919*	0.04 (0.005,0.077)	0.079 (0.029,0.141)	0.128 (0.049,0.248)	0.290 (0.053,0.722)	0.354 (0.267,0.433)
Net farm income	40.343*	0.04 (0.005,0.080)	0.087 (0.029,0.34)	0.133 (0.050,0.376)	0.319 (0.053,0.842)	0.363 (0.267,0.450)
Ratio measures						
Profit per hectare	1.382	1.382	0.02 (-0.03,0.16)	-0.01 (-0.34,0.15)	0.02 (-0.26,0.07)	0.03 (-0.03,0.92)
Cost per hectare	3.189**	3.189**	0.07 (0.02,0.23)	0.08 (0.012,0.400)	0.04 (0.01,0.08)	0.03 (0.00,0.06)
Overhead charges ratio	1.125	1.125	0.95 (0.00,14.9)	0.49 (0.00,1.96)	0.35 (0.01,1.54)	0.16 (0.03,0.46)
Operating ratio	2.229***	2.229***	1.68 (0.21,17.37)	1.45 (0.20,7.87)	0.79 (0.12,2.21)	0.46 (0.05,0.92)
Fertilizer cost per crop hectare	1.576	1.576	0.006 (0.001,0.018)	0.007 (0.000,0.038)	0.003 (0.001,0.014)	0.003 (0.00,0.011)
Capital per unit of gross income	2.698**	2.698**	1.95 (0.41,7.77)	2.28 (0.24,9.48)	1.21 (0.13,3.69)	0.89 (0.06,2.63)
Rate of capital turn over	1.694	1.694	27.42 (0.02,254)	32.73 (0.13,546.65)	19.30 (0.63,161.61)	81.11 (0.50,874.69)

Authors' calculation

*Significant at 0.01 level of significance

**Significant at 0.05 level of significance

***significant at 0.1 level of significance

The cost per hectare for marginal (0.067 million) and small farms (0.074 million) is much higher as compared to semi-medium (0.035 million), medium (0.027 million) and large farms (0.018 million). The overhead charged ratio is lowest for medium farms (0.16), indicating efficiency in recovering fixed cost with the gross profit earned by the farms. This figure is 0.95 for marginal, 0.49 for small, 0.35 for semi-medium and 0.21 for large farms. The operating ratio worked out in the present study also shows that medium farms (0.46) are most efficient in recovering the total operating cost from their net income.

The operating cost is 1.68, 1.45, 0.79 and 0.69 for marginal, small, semi-medium and large farms respectively. Fertilizer is one of the indicators of using science and technology in the production process. The figure is gradually declined with the increase of farm size. The fertilizer cost per hectare for the farm categories are –0.006 million (marginal), 0.007 million (small), 0.003 million (semi medium), 0.003 million (medium) and 0.002 million (large) respectively.

The capital per unit of gross profit is the lowest for medium farms (0.89), which indicate the efficiency of such farm as compared to other categories (marginal -1.95, small 2.28, semi-medium- 1.21 and large-0.92) in terms of using capital. This gives a higher rate of capital turnover for medium farms at 81.11%. However, large farms supersede the medium farms with 133.56% of capital turnover. Marginal, small and semi-medium farms have this rate as - 27.42%, 32.73% and 19.30%, respectively.

From the above discussion, the marginal, medium and large farms are found performing efficiently in terms of studied measures. Their performance are summarized as under-

Marginal farms: Marginal farms are found performing best in majority of physical efficiency measures such as – yield per hectare (5.083 ql.), production efficiency (1.19), return to family labor day (0.003 million), man day per hectare (96 days), machine day per hectare (67 days). They could perform better in terms of fertilizer cost per hectare (0.006 million) as well. The use of highest man and machine day and fertilizer per hectare could be the cause of highest yield per hectare and production efficiency of the farms.

However, the average size of such farms is 0.68 (minimum 0.13, maximum 0.94) ha., which could derive only 0.016 million of profit per hectare. Therefore, the total profit for such farm is 0.011 million with minimum profit of 0.002 million and maximum profit of 0.015 million approximately, left for household consumer expenditures. Such a meager income is not sufficient to cover the average rural household consumer expenditure of estimated 0.079 million (NSSO Report) of the state. Further, these farms are highest in overhead charges ratio (0.95) and operating ratio (1.68) and second highest in cost per hectare (0.067 million). These figures indicate cost inefficiency of marginal farms. They miserably fail to recover the fixed cost as well as total operating cost from their income earned. The capital employed by such farms is 1.95 times of their gross income with relatively low rate of capital turnover (27.42%).

Medium farms: Profit per hectare for medium farm is 0.026 million ranging between losses of 0.034 million to profit of 0.092 million. The average size of such farms is 5.08 hectare (minimum 4.01 hectare, maximum 7.22 hectare), which yield approximately 0.134 million total profit to the farms on an average. This figure indicates the situation of net savings for the households after deducting the average household consumer expenditure of the state. Likewise, the overhead ratio (0.16) and operating ratio (0.46) indicates that the income from such farms could sufficiently cover the fixed cost and the total operating cost. The capital per unit of gross income (0.89) is lower than the other categories, indicating efficient use of available capital. The rate of capital turnover for these farms is 81.11%, which is again a positive indicator for these farms. Further, these farms show comparatively better performance in terms of total production (23.16 ql., second highest), yield per hectare (4.446 ql, third highest), production efficiency (1.04, third highest), cropping intensity (110, third highest).

However, in terms of use of labor days (66 man days and 22 machine days) and fertilizer (0.003 million per hectare); medium farms are not doing well. Yet, these could maintain good level of profit and production. Moreover, these are using 3.5 times more man day than the machine days, showing the nature of high labor intensive farming.

Large farms: Large farms are found performing best in all the absolute efficiency measures. This finding can be generally accepted as a farm with more operating area will require more total capital and will produce more gross and net income as well as total production. The cost per hectare (0.018 million) is minimal for this type of farms. Further, the rate of capital turnover (133.56%) is the highest among the five farm size categories. Their return per family labor day is 0.003 million next to its corresponding figure of marginal farms (0.003 million). This indicates proper utilization available family labor day by the farms.

However, large farms cannot be said efficient as this category performs poorly at other important measures like- yield per hectare (2.618 ql., lowest), production efficiency (0.62, lowest), cropping intensity (107, lowest), man day per hectare (35 days, lowest), machine day per hectare (18 days, lowest), profit per hectare (0.008 million, second lowest), fertilizer cost per hectare (0.002 million, lowest). Insufficient use of labor (both man and machine) and fertilizer may be reason of their lower performance in these efficiency measures.

Further, looking at the lower use of labor, fertilizer towards the higher sizes, a weak liquidity position can be predicted for the farms with the growth of their size for the state. Due to bigger size of operational area, these farms require heavy cost (both capital and revenue) to be incurred. If the liquidity is not ensured, then there is an indication of insufficient cost allocation in different expenditure heads like-labor, fertilizer, etc., by the farms. This is evident in case of medium and large farms of the state. Thus, from the above discussion, a conclusion can be drawn in favor of medium farms as the most efficient amongst the five farm sizes; provided their liquidity position is strengthened up.

CONCLUSION

This study has presented a farm management understanding on the performance of farms based on the relationship between farm size and efficiency. The relationship as established by a series of SLRM are-

- Total production, which is an absolute physical efficiency measure is positively and significantly related with farm size.
- Ratio physical efficiency measures such as- yield per hectare, production efficiency, return per family labor day, man day per hectare and machine day per hectare are inversely and significantly related with farm size. These outcomes favor the small scale operation of paddy of the state.
- Absolute financial efficiency measures such as - total capital managed, gross income and net income significantly increase with the increase of farm size.
- The relationship of farm size with the ratio financial efficiency measures like- cost per hectare, overhead charges ratio, operating ratio, fertilizer cost per hectare, and capital per unit of gross income are reverse and significant in nature. This implies that farms with larger size are more capable of producing paddy at low cost and adequately recover the fixed cost, total operating cost and capital employed with their present level of income.
- Rate of capital turnover are positively and significantly related to the increase of their size, which again favours large scale of operation for paddy cultivation of Assam.

The best performance of farms based on the efficiency indicators can be seen for the farm categories of marginal, medium and large. However, interpreting the results of marginal farms, it is found that though this category could do well in many of the ratio physical efficiency measures, yet they miserably fail in meeting the rural household consumption expenditure. The meager size of operation becomes the constraint in this regard. Continuous deficiency in household expenditure may lead to acute poverty for this category of farms. Again, though large farms are found with the highest total production, total capital, gross income and net income, but this category could not do well in terms of yield per hectare, profit per hectare, production efficiency, man and machine day used, etc.

On the other hand, the medium farms could perform well in many of the ratio financial measures of efficiency, especially in terms of total profit earned and cost efficiency. Moreover, their performance in physical ratio measures is also satisfactory. Therefore, this category is identified to be the most efficient farm size. However, it is predicted that the higher sized farms of the state are suffering from weak liquidity position. Hence, strengthening the liquidity position is suggested for the farms.

A more in-depth analysis with panel farm management data is suggested as future scope of this study. Researcher may also attempt to bring out an exhaustive list of efficiency measures. This study is expected to contribute to the field of farm management, especially to one of the most prominent strategic decisions on farm size by the farmers. The interpretation of ratio measures can be helpful in developing ratio analysis techniques for farm accounting. Additionally, this study can contribute empirical evidences towards the age old debate on farm size and efficiency.

REFERENCES

Bhatt, M. S., & Bhat, S. A. (2014). Technical efficiency and farm size productivity: Micro level evidence from Jammu & Kashmir. *International Journal of Food and Agricultural Economics*, *2*(4), 27–49.

Burja, V. (2011). Regional disparities of agricultural performance in Romania. *Annales Universitatis Apulensis Series Oeconomica*, *13*(1), 115–121.

CAPI. (2009). *Measuring farm profitability and financial performance*, Farm Profitability Report, Canadian Agri-Food Policy Institute, Ottawa.

Colie, T. J., Rao, D. S., O'Donnell, C., & Battese, G. E. (2005). *An introduction to efficiency and productivity analysis* (2nd ed.). New York, NY: Springer.

Crane, L. M. (1998). *Measuring financial performance: A critical key to managing risk*. Overland Park: National Crop Insurance Services.

Dhungana, B., Nuthall, P., & Nartea, G. (2004), Measuring the economic inefficiency of nepalese rice farms using data envelopment analysis. *Australian Journal of Agricultural and Resource Economics*, *48*, 347–369.

Eastwood, R., Lipton, M., & Newell, A. (2010). Farm Size. In P. L. Pingali & R. E. Evenson (Eds.), *Handbook of agricultural economics*. North Holand.

Escalante, C. L., & Barry, P. J. (2002), Business growth strategies of Illinois grain farms. *Agricultural Finance Review*, *62*(1), 69–79. doi:10.1108/00214890280001130

Feder, G. (1983). *The Relation between Farm Size and Farm Productivity: The Role of Family Labor, Supervision and Credit Constraints* (Discussion Paper), Agriculture and Rural Development Department, World Bank, ARU 18.

Fechete, F., & Nedekcu, A. (2014). *Analysis of the Economic Performance of a Organization using Multiple Regression*, Paper presented in International Conference of Scientific papers AFASES, 22–24 May, 2014.

FICCI. (2015). *Labour in Indian Agriculture: A Growing Challenge*, FICCI, India.

Gupta, M., Roy, A. T., Deb, U., & Mazumder, R. (2013). Determinants of technical efficiency of paddy cultivators: A study of hailakandi district of Assam. *Journal of Humanities and Social Sciences*, *9*(1), 19–28.

Happe, K., Balmann, A., Kellermann, K., & Sahrbacher, C. (2008). Does structure matter? The impact of switching the agricultural policy regime on farm structures. *Journal of Economic Behavior and Organization*, *67*(2), 431–444.

Islam, K. M., Backman, S., & Sumelius, J. (2011). Technical, economic and allocative efficiency of microfinance borrowers and non-borrowers: Evidence from peasant farming in Bangladesh. *European Journal of Social Sciences*, *18*(3), 361–377.

Johl, S. S., & Kapur, T. R. (2000). *Fundamentals of farm business management.* NOIDA, New Delhi: Kalyani Publishers.

Kulawik, J. (2012). *Financial efficiency in agriculture: The essence, measurement and perspectives*. Institute of Agricultural and Food Economics, National Research Institute, Waesaw.

Rudra, A. (1968). Farm size and yield per acre. *Economic and Political Weekly*, *3*(26–28), 1041–1044.

Saini, G. R. (1971). Holding size, productivity, and some related aspects of Indian agriculture. *Economic and Political Weekly*, *6*(26), A79–A85.

Savastano, S., & Scadizzo, P. L. (2017). *Farm size and productivity: A "direct-inverse-direct" relationship*, Policy Research Working Paper Series 8127, The World Bank.

Sen, A. K. (1962). An aspect of Indian agriculture. *The Economic and Political Weekly*, *24*(4), 243–226.

Sureshkumar, A., Patel, K., Asodiya, P., & Parmar, V. (2014). Input use, cost structure, return and resource use efficiency analysis of Wheat Crop in South Gujrat, India. *International Journal of Agricultural Extension*, *2*(1), 5–12.

Taylor, G. T., & Shonkwiler, J. S. (1986). Alternative stochastic specialization of the frontier production function in the analysis of agricultural credit programmes and technical efficiency. *Journal of Development Economics*, *21*, 149–160.

Toma, E., Dobre, C., Dona, I., & Cofas, E. (2015). DEA applicability in assessment of agriculture efficiency on areas with similar geographical pattern. *Agriculture and Agricultural Science Procedia*, *6*, 704–711.

USDN (2007). *Structure and Finances of U.S. Farms: Family Farm Report*, 2007 Edition/EIB-24, Economic Research Service/USDA.

Wadsworth, J. J., & Brav-Ureta, B. E. (1992). Financial performance of New England dairy farms. *Agribusiness*, *8*(1), 47–56.