Total factor productivity change and innovation in farms producing paddy in Bafra District of Samsun, Turkey

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Abstract

Paddy business owner does not use a significant portion of production factors to be effective for various reasons, but most of the time and get enough income, they are not at the desired level in terms of benefiting from innovations. The main objective of this research is to test whether the income sourced from efficiency increase was sufficient for being innovative, or not. The research data sources were farms producing paddy, previous studies related paddy, related institutions, view of academician and technical person in the research area and field observation. The farm level data covered the period of 2011-2013 and collected from randomly selected 60 farms by using well-structured questionnaire. To measure productive efficiency, DEA was used while we used Malmquist productivity index for exploring the change in total factor productivity. Innovation index was calculated in order to reveal innovation capacity of farms. Research results revealed that economic performance and innovation capacity of second group farms was better comparing to rest. Research results also showed that the percentage of the farms getting enough income from efficiency increase for being innovative for first, second and third group farms were 31 %, 40 % and 62 %, respectively. Income sourced by efficiency increase was lower than the required investment, while that of second and third was larger. The study suggest initiating the farmers for certified seed use via extension services and increasing the technology level through buying machine for drying, peeling and land leveling for increasing the productive efficiency.

Keywords: Paddy. Total Factor Productivity. Innovation.

1. Introduction

Nowadays, the more appropriate strategy to be sustainable for any firm are benefiting innovation and increasing competitive power by means of innovation. Since agriculture sector has the strategic position for human and animal nutrition, enhancing the competitive power of firm by using innovation was important in agriculture, as well as all the other sectors. According to the last agricultural census, approximately 3 million farms have conducted their activities and serve the employment opportunities nearly 35% of the active population in Turkey. Most Turkish farm has not used their production factors efficiently due to their structural problems and they have not satisfied from innovation adequately even if they have produced sufficient revenue. This fact has emerged in the farms that produce raw material to agriculture based industry such as paddy.

In last decade, there have been increasing attentions to measure production efficiency and to explore inefficiency determinants in paddy farming like other crops all over the world. In one hand, some researches have focused on the efficiency in paddy production. Tadesse and Krishnamoorthy (1997), Goyal et al. (2006), Umanath and Rajasekar (2013) in India, and Xiao and Li (2011) in China measured the production efficiency of paddy farming by using data envelopment analysis. Similarly, Ghee et al. (2012) examined the efficiency by using stochastic frontier in Nigeria. On the other hand, some researchers have focused on the relationship between risk and efficiencyin parallel with the development in world.

Villano and Fleming (2006) in Philipinne and Chang and Wen (2011) in Taiwan explored the relationship between risk and efficiency scores in paddy farming. However, the case was a little bit different in Turkey. There have been pioneer researches focused on the relationship between risk and efficiency scores (Ceyhan, 2003; Cinemre and Ceyhan, 2006), variation of the efficiency measures associated with time (Candemir and Deliktaş, 2006, Özok, 2006) and relationship between sustainability and efficiency (Gündüz et al., 2011) for different crops in Turkey. But, there has been no study focusing on the production efficiency in paddy farming in Turkey up to now.

At the present day, the issues of agricultural innovation, intellectual property rights, trade of biological innovation and the role of education in the transfer of innovation and risk taking have been taken place in the research agenda and many researchers have been concentrated to these issues worldwide (Horbulky; 1993; Lawett, 1996; Graff, 2002; Alfranca and Rama, 2003; Woldehannaet al., 2003; Padgette, 2013; Vanclayet al., 2013; Zamzow, 2013). Exploring the level of benefiting from the innovations and measuring innovation capacity has increased their importance. Some researchers, therefore, have focused on these kinds of research.The research conducted by Ariza et al. (2013) was one of the examples to analyze the benefiting level of the farms from innovation by using innovation matrix and probit analysis. However, the innovation issue was the relatively new research topic in Turkey. In Turkey, many researches have been conducted on adoption of innovation up to now (Kumuk and Özerin, 1997; Bayav, 2007; Yılmaz, 2008; Sezgin, 2010; Kaya, 2011; Öztürk, 2010; Yener, 2013). Unfortunately, there has been no study focusing on exploring the level of benefiting from the innovations and measuring innovation capacity (Özertan, 2013; Elmacı and Yalçın, 2013).

Just as in the case of the sectors of industry and services in economy, innovation has affected positively not only competitive power of firms, but also production efficiency of them in agriculture. The relationship between production efficiency and innovation was mutual rather than one way. The variations in efficiency scores by time also might affect the innovation capacity. That is why, the issues of examining the level of benefiting innovation together with the variations in productive efficiency simultaneously and exploring whether the revenue gained from efficiency change is enough for implementing necessary innovations, or not have come into research agenda at the present days.

In last decades, the research examining the relationship between total factor productivity changes and the level of benefiting innovation in farms and food industry has been very limited in world, as well as Turkey (Sauer, 2012; Sauerand Zilberman, 2012). Especially, there has been no study exploring the relationship between total factor productivity changes and the level of benefiting innovation Turkish paddy farms.

Therefore, the purposes of the study were to measure the changes in total factor productivity together with the sources, to explore the sufficiency level of revenue gained from efficiency change for implementing necessary innovations and to determine the efficient and innovative paddy farms in Bafra district of Samsun province, Turkey.

2. Material and Methods

2.1. The research area

Bafra is located in the coordinates of 41.3355^o N latitudes and 35.5342^o E longitudes in Turkey. The land area is 175 square kilometers. The population stands at 143 thousand people. Bafra is one of the main actors in Turkish paddy production due to having good ecological conditions. There have been 2080 paddy farms and 8 rice plants in the research area. Based on the statistics, Bafra constituted the 8.7% of the total Turkish paddy production.

The paddy yield 734 kg per hectare and the price of paddy is approximately $0.51(€0.46) per kilogram in the research area.

2.2. Research data

Research data were collected from randomly selected 60 paddy farms out of 2080 active paddy farmers by using via well-structured questionnaire. Stratified random sampling procedure was followed when determining the optimum sample size. Sample farmers were grouped as small, medium and large farms. If the farms had 10-79 hectares of farmland, 80-129 79 hectares of farmland and more than 130 79 hectares of farmland, it was classified as small, medium and large farms, respectively. 42.5 and 13 sample farms were assigned as small, medium and large farms, respectively. The precision and confidence levels were 10% and 95%, respectively during the sampling process. Farm level panel data covering last three years was collected in the study. Questionnaires were administered to the sample farmers to collect management data by considering the 2011-2013 production years.

The variables measured in the study were age of operators, experience of operators, schooling of operators, family size, labor, total asset, working capital, input-output coefficients, labor use, machinery use, fertilizer use, chemical use, paddy yield, paddy price, profit, revenue, solvency, liquidity and credit use. Socio-economic characteristics of sample paddy farms were depicted in Table 1.

Table 1: Some socio-economic characteristics of sample paddy farms

	Farm size		
	Small	*Medium*	*Large*
Farmland (ha)	*7.66*	*17.75*	*28.26*
Labor (person)	*1.79*	*2.85*	*2.65*
Land allocated to paddy (ha)	*4.70*	*11.40*	*24.00*
Paddy yield (kg/ha)	*7500.00*	*8500.00*	*8080.00*
Paddy price ($/kg)	*0.48*	*0.52*	*0.56*
Total asset (thousand $/ha)	*59.60*	*55.10*	*39.40*
Working capital (thousand $/ha)	*11.00*	*6.80*	*7.70*
Land per capita (ha/EİB)	*4.42*	*6.62*	*10.67*
Agricultural revenue per hectare (thousand $)	*1.50*	*2.10*	*4.20*
Agricultural revenue per capita (thousand $)	*6.34*	*12.68*	*45.03*
Net profit per hectare(thousand $)	*-0.20*	*0.70*	*3.10*
Return on equity (%)	*2.19*	*6.02*	*13.71*
Return on total asset (%)	*2.01*	*3.82*	*9.84*

In the research area, most operators were man and their age varied from 26 to 64. They have 19 years of experience in paddy production and their education level was moderate. Approximately, 97% of the sample paddy farms joined the social security pool and 21% of them had the retirement pension. Approximately two people conducted their activities on 23 hectares, on average, in paddy farms. They allocated nearly 80% of the farmland to paddy production. Land per capita varied from 4 hectares to 10 hectares and it was almost 5 hectares, on average. Their paddy yield was 780 kilograms per hectare and sold them with the price of $0.37 per kilogram. The maximum yield was observed in large paddy farms, while the large paddy farms obtained the maximum price.

The mean value of total asset and working capital per hectare used in sample paddy farms were approximately $55000 and $10000, respectively. Agricultural revenue per capita and per hectare increased associated with the farm size. Return on equity and total asset varied from 2% to 14%, and increased associated with farms size. Medium and large scale paddy farms had the positive net profit per hectare, while the reverse was the case for small paddy farms.

2.3. Efficiency model and measuring total factor productivity change

When estimating the production efficiency measures, the relative efficiency approach suggested by Farrell (1957) was adopted in the study. The study focused on the technical efficiency (TE) and its components that were scale efficiency (SE) and pure technical efficiency (PTE). Data envelopment analysis (DEA) procedure was followed to calculate efficiency scores. Since the homogeneity was the critical assumption of the DEA, efficiency scores were estimated for each farm size separately.

In the study, we developed the output oriented efficiency model. Based on the suggestions Charnes et al. (1978) and Banker et al. (1984), we assumed that each paddy farms produced paddy (Y_i) using the inputs of seed, nitrogen, phosphorus, potassium, herbicide, fungicide and insecticide (x_i^*). Output oriented technical efficiency scores under variable return to scale (VRS) were estimated by running the linear programming depicted below:

$$\text{Maximum}_{\phi,\lambda}\ \phi$$

$$\text{Subjet to}\quad -\phi y_i + Y\lambda \geq 0$$

$$x_i^* - X\lambda \geq 0$$

$$N1'\lambda = 1$$

$$\lambda \geq 0,$$

Where ϕ_i was the proportional variation in output, λ was the vector of ones, X was the input matrix, $Y$was the output matrix, and 1/ϕ was technical efficiency score of each paddy farm.

After estimating the technical efficiency scores, total factor productivity changes of sample farms were calculated by using Malmquist Index (MI) based on the farm level panel data. Then, we decomposed the total productivity indexes into the two basic components based on the suggestion by Coelliet al.(1998). The first component was the efficiency change and reflected the change in technical efficiency scores during the examined time period. Efficiency change was also decomposed into two basic components such as pure technical efficiency change and scale efficiency change.

Pure technical efficiency change attributed to the changes in ability of the operators on transforming inputs to the output during the production process. Scale efficiency change expressed the change in the scale of farm during the examined time period. The second component of total factor productivity was technological change attributed to technological advance occurred in paddy farms via technological transfer and innovation.

Total factor productivity indexes were calculated by using the mathematical programming models suggested by Fare et al. (1997).We considered a set of 60 farms in which each consuming *m* different inputs to produce *s* outputs. X_{ij}^t , Y_{rj}^t denote the *i*th input and *r*th output, respectively of the *j*th paddy farm at any given point in time *t*. We used two single-period and two mixed-period measures for obtaining DEA-MI estimations and models were performed separately for each paddy farms. The two single-period measures were calculated by solving the output-oriented DEA model depicted below:

$$D_0^t(X_0^t Y_0^t) = min\ \theta$$

$$s.t. \quad \sum_{j=1}^{n} X_{ij}^t \lambda_j \geq X_{io}^t, \qquad i = 1, \ldots\ldots, m$$

$$\sum_{j=1}^{n} Y_{rj}^t \lambda_j \leq \theta Y_{ro}^t, \qquad r = 1, \ldots\ldots, s$$

$$\lambda_j \geq 0, \qquad j = 1, \dots \dots \dots, n$$

Where the subscript of *o* referred to the paddy farm, θ was the proportional decrease in the outputs of *o*th paddy farm of and varied from 0 to 1. Its minimum amount was known as the DEA efficiency score for farm *o*, which also equaled to the distance function of farms *o* in year *t*, i.e.,$D_0^t(X_0^t Y_0^t)$

As a result, if the value of θ equaled to one, then the paddy farm was efficient and its input-output combination lied on the efficiency frontier. In the case that $\theta < 1$ the paddy farm was inefficient, and it lied inside the frontier. In a similar way, using *t+1* instead of *t* for the above model, we obtained the efficiency score of farm *o* in the time period *t+1*, denoted as $D_0^{t+1}(X_0^{t+1} Y_0^{t+1})$.

For the mixed-period measures, the first one was defined as $D_0^t(X_0^{t+1} Y_0^{t+1})$ for farm *o*, which was computed by using the following linear programming model.

$$D_0^t(X_0^{t+1} Y_0^{t+1}) = min\ \theta$$

$$s.t. \quad \sum_{j=1}^{n} X_{ij}^t \lambda_j \geq X_{io}^{t+1}, \qquad i = 1, \dots \dots, m$$

$$\sum_{j=1}^{n} Y_{rj}^t \lambda_j \leq \theta Y_{ro}^{t+1}, \qquad r = 1, \dots \dots \dots, s$$

$$\lambda_j \geq 0, \qquad j = 1, \dots \dots \dots, n$$

This model compared$(X_0^{t+1} Y_0^{t+1})$ to the frontier at time *t*. Similarly, we obtained the other mixed-period measure of $D_0^{t+1}(X_0^t Y_0^t)$, which compared$(X_0^t Y_0^t)$ to the frontier at time *t+1*.

The output-oriented DEA-MI, which measures the productivity change of a particular farm *o* at time *t+1* and *t*, was expressed as follows:

$$MI_0 = \left[\frac{D_0^t(X_0^{t+1} Y_0^{t+1})}{D_0^t(X_0^t Y_0^t)} \frac{D_0^{t+1}(X_0^{t+1} Y_0^{t+1})}{D_0^{t+1}(X_0^t Y_0^t)} \right]^{1/2}$$

MIo>1 indicated the increase in the total factor productivity of the farm *o* from the period *t* to *t+1*, while that of *MIo*=1 and *MIo*<1 meant the status of indifference and decrease in productivity, respectively.

After calculating the total factor productivity indices for each paddy farm, we modified the total factor productivity indices in order to decompose it into the components such as efficiency change and the technological change by using below equation.

$$MI_0 = \frac{D_0^{t+1}(X_0^{t+1}Y_0^{t+1})}{D_0^t(X_0^tY_0^t)}\left[\frac{D_0^t(X_0^{t+1}Y_0^{t+1})}{D_0^{t+1}(X_0^{t+1}Y_0^{t+1})}\frac{D_0^t(X_0^tY_0^t)}{D_0^{t+1}(X_0^tY_0^t)}\right]^{1/2}$$

The first term, $EFFCH = D_0^{t+1}(X_0^{t+1}Y_0^{t+1})/D_0^t(X_0^tY_0^t)$ indicated the magnitude of the efficiency change from the period *t* to *t+1*, which also reflected the capability of sample paddy farm in catching up with those efficient ones. The second one, $TECHCH = \left[\frac{D_0^t(X_0^{t+1}Y_0^{t+1})}{D_0^{t+1}(X_0^{t+1}Y_0^{t+1})}\frac{D_0^t(X_0^tY_0^t)}{D_0^{t+1}(X_0^tY_0^t)}\right]^{1/2}$ measured the shift in the technology frontier between two time periods.

We used the software package of DEAP 2.1 developed by Coelli (1996) when calculating the total factor productivity indices.

2.4. Exploring innovation capacity of paddy farms

Innovation index was developed by using 16 different innovation indicators to explore the innovation capacity of the sample paddy farms. When calculating the innovation index, innovation summarized into 4 different subgroups such as products innovation, processes innovation, marketing innovation and organizational innovation. Indicators for products innovation were the share of farms used certified seed (%), the share of farms followed crop rotation (%), the share of farms used seedling use (%) and the share of farms changing paddy variety (%).

The variables of the share of farms invested money for new machinery (%), the share of farms used new production technology (%), the share of farms having GAP certificate (%) and the share of farms followed soil analysis (%) were included for processes innovation. For the subgroup of marketing innovation, the indicators of the share of farms changing marketing place (%), the share of farms storing option (%), the share of farms marketing peeled paddy (%) and the share of farms marketing dried paddy (%) were used.

Indicators for organizational innovation werethe share of farms joined insurance pool (%), the share of farms recorded management data (%), the share of farms participated education program (%) and the share of professional paddy farms (%). After calculating these indicators based on the farm level panel data collected from sample paddy farms via questionnaire, total innovation index varied from 0 to 1 was calculated by summing the subgroup indexes. Then total innovation index value was multiplied by 6.25 to express the index as a percentage.

2.5. Determining the sufficiency of revenue gained from efficiency increase for innovation

Necessary innovation to become economically sustainable for sample paddy farms by farm size were determined considering prevailing technology of the sample farms based on the data collected from farmers through questionnaire and from expert and academician via group discussion. Partial budget analysis was used to examine the economic feasibility of the selected innovation for sample farmers. A partial budget helps managers to evaluate the financial effect of incremental changes.

Partial budgeting is a procedure based on the principle that small business changes affected the income and cost structure of the business (Cinemre, 2007).Profitability of the recommended innovation was evaluated by using return on investment (ROI). When ROI calculation performed, the amount of investment for innovation was divided by net revenue gained changes.

The innovation having larger ROI value than the opportunity cost of capital (10%) was selected. We assumed that the all necessary investment for selected innovation was executed by using credit. The payback period of the credit was 5 years. Economic life of the innovation was assumed 10 years, when calculating the financial risk of investment.

The results of the partial budget analysis showed that the ROI and payback period for small paddy farms were 43% and 2.5 years, respectively, while that of medium farms were 26% and 4 years. Therefore, purchasing laser smoothing machinery was selected as an innovation for small and medium size farms. Similarly, calculated ROI value of large farms was larger than opportunity cost of capital and payback period was very short. Since 85% of the large paddy farms had laser smoothing machinery, stripper for paddy was recommended as an innovation.

When determining the sufficiency of revenue gained from efficiency increase for selected innovation, at first, revenue gained from efficiency increase was calculated via multiplying yield increase sourced by efficiency increase with the mean price of paddy. Following, discounted amount of annual investment for innovation was calculated and compared with revenue gained from efficiency increase. The farms having positive difference between discounted annual investment and revenue gained from efficiency increase were defined as innovative farms. All calculations were performed for individual farm and farms size group.

Sample paddy farms were classified into three groups such as technically efficient, innovative and mixed associated with both technical efficiency scores and innovation capacity. Then these three groups of farm were compared in terms of socio-economic characteristics by using one way variance analysis.

3. Research Results and Discussion

3.1. Innovation capacity of sample farms

Research results showed that the innovation capacity of sample farms was unsatisfactory level. The innovation index was 37% and varied associated with farm size. The most satisfactory innovation capacity was observed in medium size farms due to their adoption capability to new production technology.

Since large farms had already all necessary machinery and equipment and changed their production techniques before, innovation index of large farms was smaller than that of large farms. In the research area, the lowest level of benefiting innovation was observed in small size farms (Table 2).

Table 2: Innovation capacity of sample paddy farms

İndeksler	*Farm size*		
	Small	*Medium*	*Large*
Products innovation	*1.12*	*1.40*	*1.75*
The share of farms used certified seed (%)	*0.76*	*0.60*	*0.92*
The share of farms followed crop rotation (%)	*0.26*	*0.40*	*0.39*
The share of farms used seedling use (%)	-	-	*0.15*
The share of farms changing paddy variety (%)	*0.10*	*0.40*	-
Processes innovation	*1.08*	*2.60*	*1.77*
The share of farms invested money for new machinery (%)	*0.17*	*0.20*	*0.31*
The share of farms used new production technology (%)	*0.19*	*0.40*	*0.23*

The share of farms having GAP certificate (%)	*0.24*	*0.80*	*0.54*
The share of farms followed soil analysis (%)	*0.48*	*0.80*	*1.00*
Marketing innovation	*0.91*	*1.80*	*1.77*
The share of farms changing marketing place (%)	*0.12*	*0.20*	*0.08*
The share of farms storing option (%)	*0.12*	*0.60*	*0.62*
The share of farms marketing peeled paddy (%)	-	-	*0.08*
The share of farms marketing dried paddy (%)	*0.67*	*1.00*	*0.99*
Organizational innovation	*1.75*	*2.40*	*2.16*
The share of farms joined insurance pool (%)	*0.50*	*0.60*	*0.54*
The share of farms recorded management data (%)	*0.24*	*0.60*	*0.54*
The share of farms participated education program(%)	*0.10*	*0.40*	*0.31*
The share of professional paddy farms(%)	*0.91*	*0.80*	*0.77*
İnnovation index (%)	*30.38*	*51.25*	*44.75*

Regarding the components of the innovation index, there have been differences among the sample farms. In small scale size farms, marketing innovation was the weakest, while that of the medium size was satisfactory level. Medium size farms had the advantages in aspect of process, marketing and organizational innovations comparing to others. When focusing on the product innovation, large farms were more innovators comparing the rest (Table 3).

Table 3: Technical efficiency scores of sample paddy farms by size

	Farm size		
	Small	*Medium*	*Large*
Technical efficiency	*0.790*	*0.961*	*0.926*
Pure technical eficiency	*0.795*	*0.961*	*0.952*
Scale efficiency	*0.994*	*1.000*	*0.973*

3.2. Production efficiency of sample farms

Based on the results of the efficiency analysis, the technical efficiency score of sample farms was 0.83, on average, indicated that sample paddy farms would be able to increase their paddy production by 17% with same input combination.

Technical efficiency scores varied associated with farm size and it was 0.79 for small farms, 0.96 for medium farms and 0.93 for large farms. The basic technical inefficiency source was scale inefficiency in small size paddy farms, while that of rest was pure technical efficiency (Table 4).

Table 4: Total factor productivity of sample paddy farms and its change by time

	Farm size		
	Small	*Medium*	*Large*
Efficiency changes	*1.004*	*0.961*	*0.991*
Pure technical efficiency changes	*1.007*	*0.961*	*0.979*

Scale efficiency changes	*0.997*	*1.000*	*1.012*
Technological changes	*0.859*	*1.122*	*1.067*
Total factor productivity changes	*0.862*	*1.079*	*1.057*

This finding confirmed the results of the studies conducted by Hansson (2008), Madau (2011) and Bhatt and Bhat (2014). However, Fandel (2003), Gündüz et al., (2011) and Fernandez and Nuthal (2012) reported the a little bit difference results. They stated that the main inefficiency sources was pure technical inefficiency for all size groups.

3.3. Total factor productivity changes in sample farms

Total factor productivity of examined farms decreased by 7.6% annually during the examined period. The development of the total factor productivity varied associated with farm size. Total factor productivity decreased in small size paddy farm while the reverse was the case for medium and large paddy farms. Total factor productivity increase in medium size paddy farms was more than that of large farms.

Based on the decomposition of the total factor productivity indices, the basic source of total factor productivity decrease was unsatisfactory level of technological changes in small paddy farms even if their efficiency change was positive due to good performance of the operators.

The case was different in medium and large scale paddy farms. The main driver of total factor productivity increase was innovation and technology. The level of benefiting from technology and innovation was more in medium size paddy farms comparing to large one in the research area. However, technical inefficiency sourced by managerial performance of operators was observed in both medium and large scale paddy farms (Table 5).

Table 5: The sufficiency level of revenue gained from efficiency change for implementing necessary innovations

	Farm size		
	Small	*Medium*	*Large*
Total factor productivity	*0.86*	*1.08*	*1.06*
Efficiency increase	*-0.14*	*0.08*	*0.06*
Revenue gained from efficiency increase($/year)(A)	*-2342.17*	*3969.31*	*6140.80*
Investment need for innovation ($/year) (B)	*1111.11*	*1111.11*	*1516.67*
Sufficiency level ($)(A-B)	*-1231.06*	*1110.80*	*4624.13*
Sufficiency level ($)(A/B)	*-2.10*	*3.57*	*4.05*

3.4. Sufficiency of revenue gained from efficiency increase for innovation

In the research area, small scale paddy farms did not gain revenue from efficiency increase during the examined period, while the reverse was the case for medium and large scale paddy farms. Revenue gained from efficiency increase for medium and large paddy farms were $3970 and $6141, and the difference among the sample farms in terms of revenue gained from efficiency increase was statistically significant (p<0.05).

Sample farms were also heterogenic in each size group in the research area. 31% of the small scale paddy farms gained revenue from efficiency increase, while the ratio of farms gaining revenue from efficiency increase for medium and large paddy farms were 40% and 62%, respectively (Table 6).

Table 6: The distribution of sample farms by efficiency level and the benefiting level from innovation

		Farm size		
		Small	*Medium*	*Large*
Farms gained revenue from efficiency increase	*Frequency*	*13.00*	*2.00*	*8.00*
	%	*30.95*	*40.00*	*61.54*
Farms having sufficient revenue for innovation	*Frequency*	*5.00*	*2.00*	*8.00*
	%	*11.91*	*40.00*	*61.54*
Technically efficient and innovative farms	*Frequency*	*2.00*	*2.00*	*8.00*
	%	*4.76*	*40.00*	*61.54*

When comparing revenue gained from efficiency increase to cost of the suggested innovation, 18% of the sample paddy farms had the sufficiency for benefiting suggested innovation. The share of paddy farms having sufficiency for benefiting suggested innovation was 12% in small farms. However, all medium and large scale farms had sufficiency for benefiting suggested innovation in the research area (Table 3.5).

3.5. Comparative analysis of sample farms by efficiency and innovation groups

Research findings showed that 5% of the small paddy farms, 40% of the medium size paddy farms and 62% of the large paddy farms were both technical efficient and innovative. Despite the small scale farms were technically efficient; they were not innovative due to scale problems. The number of farms that were both technically efficient and innovative was the highest in large size paddy farms (Table 3.6).

The difference among the technically efficient farms, innovative farms and both technically efficient and innovative farms were not statistically significant in terms of the age, education level and experience of operators, working capital per ha and total asset per ha (p>0.05)(Table 3.6).

Regarding the land to allocated paddy, the farmland allocated to paddy in technically efficient and innovative farms was more comparing to others (p<0.05). However, there were no statistically difference between technically efficient farms and innovative farms in terms of land allocated to paddy (p>0.05) (Table 3.6).

In the research area, innovative paddy farms gained much more revenue comparing to others (p<0.05), indicated that innovation increased the farm revenue. However, the difference between technically efficient farms and both technically efficient-innovative farms was not statistically significant in terms of farm revenue (p>0.05).

When focusing on the profitability indicators such as return on asset and return on equity, it was clear that technically efficient farms, in which benefiting from innovation was unsatisfactory level presented the worst performance comparing to others (Table 7).

Table 7: Comparative statistics of sample farms by efficiency and innovation groups

	Technically efficient farms	*İnnovative farms*	*Both technically efficient and innovative farms*
Number of the farm	*18.00*	*3.00*	*12.00*
Age of operators (year)	*51.20[a]*	*50.70[a]*	*45.30[a]*
Experience of operators (year)	*35.30[a]*	*35.00[a]*	*25.00[a]*
Schooling of operators (year)	*5.94[a]*	*7.00[a]*	*7.16[a]*
Land allocated to paddy (ha)	*11.29[ab]*	*6.20[a]*	*17.32[b]*
Total asset ($/ha)	*41069.52[a]*	*39306.81[a]*	*35552.00[a]*
Working capital ($/ha)	*3309.41[a]*	*2027.79[a]*	*2366.14[a]*
Agricultural revenue per hectare ($)	*395.80[a]*	*1830.04[b]*	*1266.15[ab]*
Agricultural revenue per capita ($)	*13402.05[ab]*	*83930.01[c]*	*48010.32[bc]*
Technical efficiency score	*0.87[a]*	*0.92[a]*	*0.93[a]*
Return on asset (%)	*2.45[ab]*	*13.82[c]*	*11.09[bc]*
Return on equity (%)	*2.50[ab]*	*10.47[b]*	*11.74[b]*

4. Conclusion

Under the light of the research findings, it was clear that innovation capacity and the level of benefiting from innovation of the paddy farms was unsatisfactory level in the research area and process, organizational and marketing innovation capacity of the medium size paddy farms was relatively better than others. Unfortunately, small size paddy farms did not utilized from positive contribution of the innovation due to scale problem. Insufficient revenue gained from efficiency increase for necessary innovation was the basic problem of paddy farms.

Utilizing the economies of scale in paddy farms may be the starting point to increase total factor productivity and benefit positive contribution of the innovation. Cooperation is the most effective strategy for small scale paddy farms is the research area. Efficient cooperation may increase the likelihood of benefiting innovations. Simultaneously, stimulate the farmers to use certified seed, changing paddy variety and activities to increase value added of paddy such as marketing peeled and dried paddy via well designed extension and farmers' education programs may be beneficial to increase total factor productivity in the research area.

Organizing the effective credit system having low interest rate and suitable repayment plan to enhance the farmers' access to credit for the necessary machinery and equipment and new production systems may contribute to the efficiency of stimulation activities related to effort for increasing value added of paddy. Municipal administration should increase the storage facilities for paddy and simplify the farmers' accesses to them in order to increase time value of utility from paddy.

To stabilize the revenue of paddy farms in Bafra, policy makers should organize some incentive to enhance the benefiting from agricultural insurance scheme against to catastrophic risks such as hail, fluid, fire, earthquake etc. and disseminate it among the farmers.

Motivation of the farms having sufficient revenue for suggested innovation via suitable education and extension programs may increase the innovation capacity of the paddy farms in the research area.

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