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Relationship Between Innovation and Sustainability in Farms Producing Paddy in Bafra District of Samsun, Turkey

Selime Canan* Vedat Ceyhan
University of Ondokuz Mayıs, Faculty of Agriculture, Departmant of Agricultural Economics, Samsun, Atakum 55139, Turkey

Abstract
The purposes of the study focused on the relationship between innovation and sustainability were to (i) measure the sustainability level and the level of benefiting from innovation in farms producing paddy in Bafra district of Samsun and (ii) explore the relationship between innovation and sustainability. 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 2013 and collected from randomly selected 60 farms by using well-structured questionnaire. To measure economic, environmental and social sustainability, sustainability index was used while we used innovation index for exploring the level of benefiting innovation. Research results revealed that economic performance and innovation capacity of second group farms was better comparing to rest. Research results also showed that the sustainability was higher in farms that their benefiting level from innovation is high. Positive effects of innovation on sustainability were lower than of second and third ones. The study suggests initiating the farmers' education program based on farmers' need. For small scale farms that their benefiting level from innovation was low, financial and infra structure support may strength the relationship between innovation and sustainability.
Keywords: Paddy farms, innovation, sustainability, Samsun

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 [14], Goyal et al.[9], Umanath and Rajasekar [15] in India, and Xiao and Li [18] in China measured the production efficiency of paddy farming by using data envelopment analysis. Similarly, Ghee et al. [8] 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 [16] in Philippine and Chang and Wen [5] 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 [4-6], variation of the efficiency measures associated with time [3] and relationship between sustainability and efficiency [11] 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 [1-10-12- 13-17-19). 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. [2] 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 [21-22-23]. Unfortunately, there has been limited study focusing on exploring the level of benefiting from the innovations and measuring innovation capacity [7-20]. Although some pioneer study related the relationship between efficiency and sustainability such as Gündüz et al., [11], there has been no study focusing on sustainability measurement and exploring the link between sustainability and innovation capacity in paddy production.Therefore, the purposes of the study were (i) to measure the innovation capacity of paddy farms in Bafra district of Samsun province, (ii) to explore the economic, social and environmental sustainability of paddy farms and (iii) to reveal the link between

innovation and sustainability.

2. Material and Methods

2.1. The Research Area

Bafra is located in the coordinates of 41.3355º N latitudes and 35.5342º 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 9% of the total Turkish paddy production. The paddy yield 734 kg per hectare and the price of paddy is approximately $4 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.

2.3. 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 were the 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.

2.4. Measuring the sustainability of paddy farms

Sustainability of the sample paddy farms was measured by using sustainability index, which was based on sustainability indicators. Three dimensions of the sustainability such as economic, social and environmental were examined in the study by using 15 different indicators. The economic sustainability was measured by using the variables of return to capital (%), total factor productivity, risk (%), agricultural income per person (TL) and credit use (TL). The social sustainability indicators were having social security (%), distance to medical care (km), and the share of own land (%), existence of off farm income (%) and membership to farmers' union. The variables of technical efficiency, synthetic fertilizer use (%), synthetic pesticide use (%), diversification and having good agricultural practices certificate (%) were used to explore environmental efficiency. Based on the data collected via questionnaire, sustainability indices, which varied between 0 and 1, were calculated for three dimensions of sustainability. Sum of the indices of three dimensions of sustainability was attributed to the total sustainability index for each paddy farms.

2.5. Exploring the link between innovation and sustainability

Regression analysis was used to reveal relationship between innovation and sustainability. Sustainability index values was the dependent variables of the regression model. The independent variables of the model were innovation index values, labor, return on equity, schooling and experience of the operators, agricultural income per hectare and working capital per hectare. The variables of household size, cooperative membership and the level of benefiting from technical advice were also included the model. However, these variables were removed

from the model due to they were superfluous variables based on the solution of Frisch' Conflict. Since we assumed that it was impossible to reach social and environmental sustainability without ensuring the economical sustainability, constant term was not included the model when estimating the regression model. After checking the all possible function such as logarithmic, semi logarithmic and linear, we selected the linear functional form to explore relationship between innovation and sustainability based on the statistical significance level of coefficients and the size of disturbance term. The multiple regression model used in the study was depicted below:

$$Y = b_1Q + b_2R + b_3S + b_4T + b_5W + b_6X + b_7Z + e$$

Where Y was sustainability index, Q was innovation index, R was labor (AWU/ha), S was return on equity, T was experience of operators, W was schooling of the operators, X was agricultural income (TL/ha), Z was working capital (TL/ha) and e was the disturbance term. The problems of multi-collinearity and heteroscedasticity in the model were tested by using Frisch' Conflict solution and White test, respectively. Since we used the cross sectional data in the model, we did not test the auto correlation problem.

3. Results and Discussion

3.1. Socio-Economic Characteristics of Sample Farms

Socio-economic characteristics of sample paddy farms were depicted in Table 1. 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 13 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 7710 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 (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

3.2. 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).

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 2).

3.3. Economic, Social and Environmental Sustainability of Sample Farms

Sustainability index values of the sample farms showed that sustainability index values varied from 48 to 63 associated with farm size and the mean sustainability index was 50% in the research area, indicating that there has been some factors hindered the sustainability of sample farms. The lowest sustainability was observed in small size paddy farms, while the highest was in medium size paddy farms. Interestingly, sustainability of the medium size paddy farms was higher than that of large ones due to low level of financial risk. For all size of paddy farms, the most important problem was the economic sustainability. Risk faced the sample paddy farms and low level of agricultural income were the main problems for economic sustainability of small and large paddy farms (Table 3).

3.4. The link between sustainability and innovation

It was clear based on the results of regression analysis that there was a positive causal relationship between sustainability and innovation. Also, the variables of return on equity, schooling and experience of operators, working capital and agricultural income affected the sustainability positively. However, labor variable had the negative effects on sustainability. In the research area, sustainability index value of the paddy farms would increase by 0,436 when innovation index value increased one unit. This findings confirmed the results of previous study conducted by Gündüz et al. [11]. Gündüz et al. [11] stated that increasing efficiency through innovation increased the sustainability of the farms. Expectedly, the most magnificence factor positively influenced the sustainability of sample paddy farms was return on equity. The profile of operators was another important factor influenced the sustainability of the sample paddy farms (Table 4).

Table 2. Innovation capacity of sample paddy farms

İndex values	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

Table 3. Sustainability index for sample paddy farms

Index values	Farm size		
	Small	Medium	Large
Economic sustainability	1.60	2.64	1.58
Return on equity (%)	0.19	0.25	0.35
Total factor productivity	0.47	0.68	0.50
Risk (%)	0.00	0.80	0.10
Agricultural income per capita (TL)	0.06	0.05	0.13
Credit use (TL)	0.88	0.86	0.50
Social sustainability	2.45	2.98	3.11
Benefiting social security (%)	0.95	1.00	0.92
Distance to medical care (km)	0.85	0.87	0.88
Own farmland/total farm land*100 (%)	0.15	0.34	0.56
Having off farm income (%)	0.10	0.20	0.23
Cooperative membership (count)	0.40	0.56	0.52
Environmental sustainability	3.15	3.79	3.22
Technical efficiency	0.81	0.92	0.92
Synthetic pesticide use (%)	0.81	0.60	0.62
Synthetic fertilizer use (%)	0.95	1.00	0.85
Diversification (unit)	0.34	0.47	0.30
Having good agricultural practices certificate (%)	0.24	0.80	0.54
Total sustainability index (%)	47.94	62.67	52.76

Table 4. Parameter estimates and their standard errors of the regression model

Variables	Coefficient	Standard error	t-value	p
Innovation index (Q)	0.436	0.150	2.901	0.005
Labor per hectare (R)	-31.170	46.759	-0.667	0.508
Return on equity (S)	8.140	2.908	2.799	0.007
Experience of operators (T)	0.211	0.101	2.089	0.042
Schooling of operators (W)	0.877	0.407	2.156	0.036
Agricultural income per hectare (X)	0.002	0.001	2.177	0.034
Working capital pet hectare (Z)	0.001	0.001	0.273	0.786

4. Conclusion

Under the light of the research findings, it was clear that not only the benefiting level from innovation of paddy farms but also sustainability level of them was unsatisfactory level in research area. 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 and sustainability. 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 sustainability via total factor productivity increase 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 and sustainability of the paddy farms in the research area.

References

Alfranca, O., and Rama, R. 2003. Introduction: Innovation in Agriculture, International Journal of Agricultural Resources, *Governance and Ecology*, , Vol 2, Issue 3-4, P. 221 – 227, ISSN 1462-4605.

Ariza C., Rugeles L., Saavedra D., Guaitero B. 2013. Measuring Innovation in Agricultural Firms: A

Methodological Appoach, *The Electronic Journal of Knowledge Management*, Vol:11. İssue 3 (P185-198), Article: 396, ISSN: 1479-4411.

Candemir, M., and Deliktaş, E. 2006. TİGEM İşletmelerinde Teknik Etkinlik, Ölçek Etkinliği, Teknik İlerleme, Etkinlikteki Değişme ve Verimlilik Analizi: 1999-2003, *Tarım ve Köy İşleri Bakanlığı, Tarımsal Ekonomi Araştırma Enstitüsü*, Yayın No:141, ISBN:975-407-194-2, Ankara.

Ceyhan, V. 2003. Tarım İşletmelerinde Risk Analizi; Çorum İli Kızılırmak Havzası Örneği, *Ondokuz Mayıs Üniversitesi Ziraat Fakültesi Araştırma Seri* No:6, Samsun.

Chang, H.H., and Wen, F.I. 2011. Off-Farm Work, Tecnical Effiency, and Rice Production Risk in Taiwan, *Agricultural Economics*, 42 (2011) 269-278.

Cinemre, H.A., and Ceyhan, V. 2006. Application of Utility-Efficient Programming to Determine Economic Efficiency of Turkish Farmers in The Central Anatolian Region, *New Zealand Journal of Crop And Horticultural Science,* Vol. 34:381-391.

Elmacı, O., and Yalçın M. 2012. Measurıng Innovatıon Power of Busınesses: A Regıonal Research in Food and Agrıcultural Industry, Tübitak Ulakbim Dergipark, İktisat Fakültesi Mecmuası, Cilt 62, Sayı 2.

Ghee-Thean, L., Ismail, M.M., Harron, M. 2012. Measuring Technical Efficiency of Malaysian Paddy Farming: An Application of Stochastic Production Frontier Approach, *Journal of Applied Sciences*, Vol 12, Issue 15, P. 1602 – 1607, ISSN 1812-5662.

Goyal, S.K., Suhag K.S., Pandey U.K. 2006. An Estimation of Technical Efficiency of Paddy Farmers in Haryana State of India, *Indian Journal of Agricultural Economics*, Vol 61, Issue 1,P. 108-122, ISSN: 0019-5014.

Graff, G.D. 2002. Generating and Trading Biological Innovations in Agriculture, Phd Thesis, University of California, P.130, Berkeley.

Gündüz, O., Ceyhan V., Erol E., Özkaraman F. 2011. An Evaluation of Farm Level Sustainabilityof Apricot Farms in Malatya Province of Turkey, *J. Food, Agric. Environ*., 9 (1): 700-7005.

Horbulky, T.M. 1993. Intellectual Property Rights and Technological Innovation in Agriculture. Technological Forecasting and Social Change, *Technological Forecasting & Social Change : An İnternational Journal*, Vol 43, Issue 3-4, P. 259 – 270, ISSN: 0040-1625.

Padgette, S.R. 2013. Innovation in Agriculture: Biotechnology, Genetics, Genomics and Beyond, *American Chemical Society*, Vol. 245, P.1, ISSN: 0065-7727, Washington.

Tadesse, B., and Krishnamoorthy, S. 1997. Technical Efficiency in Paddy Farms of Tamil Nadu: An Analysis Based on Farm Size and Ecological Zone, *Elsevier Science Bv*., Vol 16, P. 185-192, ISSN: 0169-5150.

Umanath, M., and Rajasekar, D.D. 2013. Estimation of Technical, Scale and Economic Efficiency of Paddy Farms: A Data Envelopment Analysis Approach, *Canadian Center of Science And Education*, Vol 5, Issue 8, P.243. ISSN: 1916-9752.

Villano, R., and Flemin, E. 2004. Analysis of Tecnical Efficiency in A Rainfed Lowland Rice Environment in Central Luzon Philippines Using A Stochastic Frontier Production With A Heteroskedastic Error Structure. *Working Paper Series in Agricultural and Resource Economics*, No: 2004-15, ISSN: 1442 1909.

Woldehanna, T., Weir, S., Knight, J. 2003. The Role of Education in Facilitating Risk-Taking and Innovation in Agriculture, *Journal of Development Studies*, Vol 39, Issue 6, P. 1–22, ISSN. 0022-0388.

Xiao, J., and Li, D. 2011. An Analysis on Technical Efficiency of Paddy Production in China, *Asian Social Science*, Vol. 7, Issue 6, p. 170-176, ISSN: 1911-2017, 1911-2025.

Zamzow, B.F. 2013. Guilt And Reciprocity in Labour Markets and The Diffusion of Agricultural Inovations, Doctor of Philosophy. Graduate College The University of Arizona, Tucson.

Özertan, G. 2013. Türkiye Tarım Sektöründe Yapısal Dönüşüm ve Teknoloji Kullanımının Rolü, Boğaziçi Üniversitesi Ekonomi Bölümü Çalışma Notları, http://www.econ.boun.edu.tr/content/wp/EC2013_01.pdf.

Bayav, A. 2007. Isparta İlinde Elma İşletmelerinde Yeniliklerin ve Araştırma Sonuçlarının Benimsenme Düzeyleri ve Etki Değerlendirmeleri, Yüksek Lisans Tezi, Adnan Menderes Üniversitesi, Fen Bilimleri Enstitüsü, Aydın.

Yılmaz, F. 2008. Osmaniye İli Düziçi İlçesinde Hayvancılık Yapan Tarım İşletmelerinde Yeniliklerin Benimsenmesi ve Yayılmasında Kooperatiflerin Rolü, Yüksek Lisans Tezi, Çukurova Üniversitesi, Fen Bilimleri Enstitüsü, Adana.

Kaya, T.E. 2011. Kırsal Kadının Tarımsal Yenilikleri Benimsemesini Etkileyen Faktörler Üzerine Bir Araştırma (TRA1 Bölgesi Örneği), Doktora Tezi, Atatürk Üniversitesi, Fen Bilimleri Enstitüsü, Erzurum.