PRODUCTIVITY ANALYSIS OF EXTERNAL INPUT USE IN RICE PRODUCTION: A CASE STUDY OF SAMSUN PROVINCE, TURKEY

[1]Mehmet Bozoğlu, [2]Elif Yurdakoş Yörük

[1] Associate Professor, Ondokuz Mayis University, Faculty of Agriculture,

Department of Agricultural Economics, 55200 Samsun, Turkey

[2] Mediterranean Electricity Distribution Company, Antalya, Turkey

ABSTRACT

During the last century, there has been a decreasing trend on cultivated areas in the world. Therefore, increasing productivity and efficiency have become the main way to promote agricultural development in all countries. Rice is one of the main agricultural crops for food security in the developing countries. In this paper, we examine the productivity of external input use of rice production for the farm level. Cobb-Douglas production function is employed on cross-sectional data of 59 rice farms in 2007. In the model, rice productivity per hectare is the dependent variable. Pesticide use, chemical fertilizer use, seed use, labor use, diesel oil use and crop rotation are explanatory variables. The results reveal that farmers overdo seed, labor and diesel oil in rice production. However, the uses of pesticides and fertilizers were not use enough.

Keywords: Rice, External Inputs, Productivity, Cobb-Douglas Function, Turkey.

INTRODUCTION

Rice can be grown in all continents. In 2007, rice production of the world was 652 million tons. China, India, Indonesia and Bangladesh are main producer countries and their shares in the total production were 28%, 19%, 8% and 7%, respectively. Common characteristic of these countries can be stated that they have high population and rice is a basic agricultural crop for their consumption. Whereas Turkey had only 0,1% in the world rice production (Yurdakoş, 2009). During the average period of 2000-2008, while 515.000 tons of rice was produced in Turkey, over 400.000 tons of rice was imported from other countries. Turkish government had given support to the farmers for producing rice. Since the second period of 1990 years, rice yield has shown an increasing trend. This trend was caused by using new technology e.i. especially a variety named as Osmancık-97 adapted by the farmers (Gaytancioğlu, 1997). Turkey has a competitive rice yield with other European producer countries such as Spain and Greece (MARA, 2002). However, the production technology depends on labor in Turkey and this dependence affects Turkey negatively in the world rice markets. Samsun province had about 10% of total rice area of Turkey and its share in production was 12% in 2006. Rice yield per hectare in Samsun was 7,99 tons which was higher than the average yield of Turkey (Yurdakoş, 2009).

Despite the rapid development of rice production after the second period of 1990 years in Turkey, farmers have inadequate information about the marginal impact of external factors affecting rice yield. This result in rice farmers failing to fully exploits technology by making inefficient decisions. Farm level information about productivity of external input use is unsatisfactory.

Previously, some empirical work were conducted to reveal the economics and policy of rice sector (Gaytancioğlu, 1997; Zan, 2004; Gaytancioğlu ,2007). Toksal (1991) investigated yield, yield factors of some rice varieties in the same research area. There are some researches about affecting of external input use such as zinc (Özcan, 2004), salinity (Tatar, 2006) and sowing-time (Kıran, 1992) on rice yield in Turkey. Bozoğlu (2001) investigated factors affecting productivity for hazelnut production at the farm level and trout production (Bozoğlu, 2007), there is no studies have addressed the issue of external input productivity in rice production at the farm level. In this respect, our objective was to estimate a yield function for rice production and to create strategy for the rice farms based on the determinants of yield model.

MATERIAL AND METHODS

This study was conducted in the Samsun province, which is located in northern Turkey. The bulk of the data used in this study was collected from 59 randomly selected rice farms in the Samsun province. Farm data were gathered through a questionnaire. Randomly selected farms were interviewed to obtain input use and yield data. A quantitative model was developed to determine the factors affecting rice yield. Rice yield per hectare was used as the dependent variable. Seven inputs, i.e. pesticide use, chemical fertilizer use, seed use, labor use, diesel oil use and crop rotation were included in estimating the function as independent variables. The results of a likelihood ratio-type test that as used to test the Cobb-Douglas model against the translog showed that Cobb-Douglas was an appropriate model for data available. Thus, we used the following model:

$$\ln Y_{p/r} = \ln\beta_1 + \beta_2 \ln PU + \beta_3 \ln CFU + \beta_4 \ln SU + \beta_5 \ln LU + \beta_6 \ln DOU + \beta_7 \ln CR + u_i$$

where;

$Y_{p/r}$: Rice yield (ton/ha)

β_i : Unknown parameters

PU : Pesticide use (€/ha)

CFU : Chemical fertilizer use as active matter (kg/ha)

SU : Seed use (kg/ha)

LU : Labor use (man power/ha)

GOU : Diesel oil use (€/ha)

CR : Crop rotation (Dummy)

u_i : a stochastic error term

RESULTS AND DISCUSSIONS

Sampled rice farms had 1,42 hectares land totally and 68,6% of total land was cultivated for rice production. Average rice yield and production were about 7 tons and 530 tons, respectively. Average seed, labor, machine, fertilizer, diesel oil, foreign labor and electricity use per hectare were 248 kilograms, 104 manpower, 18 horsepower, 17 kilograms, 172 liters, 49 manpower and € 205, respectively. Broadcast sowing primitive system was common among farmers (99%). Ideal seed quantity per hectare is about 160-180 kilograms. While farmers must not use the same land more than 3 years, 45,8% of the farmers had used their land for rice cultivation more than 5 years. About 39% of the farms applied crop rotation for rice cultivation with some crops wheat, maize, soybean, common vetch, watermelon, head cabbage, sugar beet and oat. There were 6,27 population and 63% of the population was economically active. Average formal education period was about 7 years for the literate population. Average experience on rice production of the farmers was about 30 years. About half of the farmers used TL 6.256 credit averagely.

Table 1. Some characteristics of the farms for rice production

Variable	Minimum	Maximum	Average	Standard deviation
Harvested area (ha)	0,30	60,00	7,42	11,35
Yield (ton/ha)	1,80	8,53	7,16	1,53
Production (tons)	180,00	853,00	53,16	153,19
Seed use (kg/ha)	170,00	330,00	247,60	24,87
Labor use (manpower/ha)	50,00	440,00	104,10	107,00
Machine use (horsepower/ha)	10,00	70,00	18,20	14,79
Fertilizer use (ton/ha)	1,00	55,60	17,14	10,16
Diesel oil use (lt/ha)	17,5	526,9	171,78	95,73
Foreign labor use (manpower/ha)	0,00	350,70	49,20	64,61
Electricity use (€/ha)	0,00	543,86	204,85	15,01
Experience on rice production (year)	2,00	67,00	30,07	13,98
Education period of farmer (year)	0,00	12,00	6,88	2,66
Use rate of certificated seed (%)			57,63	
Use rate of credit (%)			52,54	
Use rate of external labor (%)			5,08	
Use rate of external seed (%)			91,5	
Membership rate to any farmer organization (%)			81,40	

Rate of getting benefit from extension services (%)	64,5
Gross product value (€/ha)	3224,39
Production cost (€/ton)	2382,11
Net income (€/ha)	842,28
Profitability rate (%)	35,00

While 67,8% of the farms hired external part-time labor for seeding, grading, apply pesticide and fertilization, 32,2% of the farms use own labor for rice production. About 92% of the farmers purchased seed from outside of the farms and 58% of the farms used certificated seed. About 81% of the farmers were a member of any farmer organization. However, 62,1% of the farmers couldn't benefit any services (mainly supply input) of their organizations. 65% of the farmers got benefit form extension services given by public institutions (50,9% of the farmers) or private sector (49,1%). Gross product value of rice production per hectare was about € 3224, production cost per hectare was € 2382 and net income was € 842. Profitability rate for rice production was 35% (Table 1). The cost share of external inputs to total rice cost was %58,71 (Table 2).

Table 2. Costs of external inputs in total rice production cost

Items	Cost (€/ha)	Share of external use (%)	Cost of external input (€/ha)	External input cost/the total cost (%)
Diesel oil	295,87	100,00	295,87	12,42
Pesticide&herbicide	228,08	100,00	228,08	9,57
Chemical fertilizer	206,45	100,00	206,45	8,67
Electricity	204,85	100,00	204,85	8,60
Seed	191,40	91,50	175,13	7,35

Tractor	343,08	35,00	120,08	5,04
Labor	203,95	47,26	96,39	4,04
Land rent	228,66	31,36	71,71	3,01
Others	479,77	0,00	-	-
Total	2382,11	-	1398,56	58,71

The most important problem areas for the rice farmers were high input cost, low price and insufficient irrigation water, respectively. The other problems were disease and prevailing of disease and hazardous, insufficiency of drying substructure, insufficient government support, low input quality, small and splintery farm land, difficulties of finding enough part-time labor (Table 3).

Table 3. Problem analysis (Yurdakoş, 2009)

Problem	1	2	3	Total score	The order of importance
High input cost	44,1	15,3	3,4	166,3	1
Low price	16,9	5,1	3,4	64,3	2
Insufficient water for irrigation	10,2	8,5	1,7	49,3	3
Prevailing of disease and hazardous	8,5	8,5	1,7	44,2	4
Insufficiency of drying substructure	6,8	1,7	5,1	28,9	5
Insufficiency of government support	1,7	5,1	3,4	18,7	6
Low input quality	1,7	3,4	0,0	11,9	7
Small and splintery farm land	1,7	0,0	0,0	5,1	8
Difficulty of finding part-time labor	0,0	1,7	0,0	3,4	9

For the parameters of the productivity model, the signs of the coefficients of the function were as expected (Table 4). The rice productivity model was statistically significant at the 1% level. The adjusted R^2 of the model indicated that 38,5% of the variation in rice productivity was explained by the explanatory variables. The calculated F statistics (5,881) was significant at the 1% level and this indicates that the model can explain variance in rice yield.

Table 4. Variables and estimated parameters in the yield function by ordinary least-squares regression.

Variable	Parameter estimates			
	b_i	S_b	t	Sig.
Constant	5,633	0,506	11,122	0,000
Pesticide use (€/ha)	0,202	0,068	2,990	0,005
Chemical fertilizer use (€/ha)	0,208	0,094	2,212	0,034
Seed use (€/ha)	-0,255	0,148	-1,727	0,093
Labor use (man power/ha)	-0,079	0,090	-0,874	0,388
Diesel oil use (€/ha)	-0,069	0,097	-0,710	0,483
Crop rotation (Dummy)	0,352	2,521	0,017	0,017

There are positive relationship between pesticide use, chemical fertilizer use, crop rotation and rice productivity. However, there is a positive relationship between seed use, labor use and Diesel oil use. The estimated elasticity for pesticide use, chemical fertilizer use, seed use, labor use and Diesel oil use were 0,20, 0,21, -0,25, -0,08, -0,07 and 0,35, respectively. Based on these results, seed use, chemical fertilizer use and pesticide use had major effects on rice productivity. Sum of the coefficients indicate that there is decreasing returns to scale. Restricted least-squares regression was used to formally test the null hypothesis of a constant return to scale.

The model predicted that when other explanatory variables are held constant, a 10% increase in chemical fertilizer use would increase rice yield by 2,08%. Based on this coefficient, it is clear that the sample rice farms were inefficient in terms of chemical fertilizer use. The main reasons for this inefficiency were unconscious fertilizer use, relatively high price of fertilizers, and unsuitable weather conditions. There were some application errors of fertilizers on timing, doses and application forms. About half of the farmers didn't make soil analysis and farmers didn't generally take consideration genetic capacity of varieties on applying fertilizers. In addition, farmers didn't use enough zinc and potassium application in rice production.

The elasticity of the variable of pesticide use indicated that with a 10% increase in pesticide use would increase rice yield by 2,02%. Farmers should apply herbicide a month later/after seed sowing. Rainfall occurred during this period delays herbicide application and this requires second and third application. This situation caused stress and yield loses on rice plants. This yield loses can reach about 40%.

The model estimation revealed that increasing seed use negatively affected the rice yield. With a 10% decrease in seed use would increase rice yield by 2,55%. This coefficient indicates that the current seed use was higher than the optimum seed use (160-180 kilogram per hectare). About 99% of farmers applied broadcast sowing system and more seed are necessary for reliable germination in this system. Farmers didn't generally trust their seed for reliable germination and they throw extra seed on the soil. Firms have problem to obtain certificate because of leaf blighted and fungus diseases.

Coefficients of labor use and diesel oil use show that these inputs were overdo in rice production. These overuses might be caused by multi piece of lands, low mechanization level, broadcast sowing system, heavy land structure and unfavorable climate conditions. However, coefficients of labor use and diesel oil use are not statistically significant. Therefore, we can't make any critique about their effects on the rice yield.

Crop rotation is necessary for high yield and struggle of diseases and hazardous in agriculture. In rice production, if rice is produced on a land more than three years, there would be some corruption in physical, chemical and microbiologic structure of soil. In our model, sign of crop rotation coefficient shows that rotation affected rice yield positively.

CONCLUSIONS AND POLICY IMPLICATIONS

We examined the external factors that affect rice yield at the farm level by estimating a yield function. Pesticide use, chemical fertilizer use and crop rotation positively affected rice production, whereas seed use, labor and diesel oil use negatively affected rice yield. Additionally, the rice farms had decreasing returns to scale. It is clear that the rice farms were inefficient in terms of pesticide and fertilizer use. Pesticide and fertilizer uses must be increased and their applications about timing and doses must be correctly. Policy makers should focus on enhancing farmers' access to information via the provision of better extension services and raising the education level of farmers to increase rice yield. Farmer training and extension programs should be provided in Samsun province to improve yield efficiency of the rice farms. Extension services given by government and private sector should be concentrated on preparing land consolidation and seedbed, sowing, fertilization and chemical application. Farmer training and extension activities are relatively low-cost methods of increasing the production efficiency (Ellis, 1993). Hence, programs should focus on human resource development and be directed to peer-leader farmers open to transforming their farms to be more market oriented. There is a big gap between demand and supply of certificated rice seed. In Turkey, while the need of certificated rice seed is 20.000 tons, about 12,5% of the demand could be hardly provided. Private sector must be encouraged on developing good quality certificated rice seed by the government.

ACKNOWLEDGEMENTS

We thank to the rice farmers in Samsun Province and Ismail Sezer (PhD) for their considerable contributions to this study.

REFERENCES

Bozoğlu, M., 2001. Econometric analysis of hazelnut productivity in Ordu and Giresun provinces, Turkey. Proceedings of the Fifth International Congress on Hazelnut, Acta Horticulture (ISHS), Number 556, 125-129 p.

Bozoğlu, M., Ceyhan, V., Cinemre, H.A., Demiryürek, K., Kiliç, O., 2007. Important factors affecting trout production in the Back Sea Region, Turkey. Czech Journal of Animal Science, 52 (9): 308-313.

Doll, J.P., Orazem, F., 1978. Production Economics: Theory with Applications. Grid Inc., Columbus, Ohio, USA.

Ellis, F., 1993. Peasant Economics: Farm Households and Agrarian Development. 2nd ed., Cambridge University Press, Cambridge, UK.

Gaytancioğlu, O., 2007. Rice Market Problems of Turkey and Determining of Rice Production Potential of Turkey. Istanbul Trade Chamber, Pub. Number: 2007/25, İstanbul (in Turkish).

Gujarati, D.N., 1995. Basic Econometrics. Int. ed., Litratur Publishers Ltd., McGraw Hill, Ankara.

Kıran, A.K., 1992. Güneydoğu Anadolu Bölgesinde Çeltik (*Oryza Sativa L.*) Ekim Zamanının Verim ve Verimm Öğeleri Üzerine Etkisi. Doktora Tezi, Ankara Üniversitesi Fen Bilimleri Enstitüsü, Ankara, 101 s.

MARA (Ministry of Agriculture and Rural Affairs), 2002. Samsun Tarım Master Planı. Samsun Tarım İl Müdürlüğü Yayını, Samsun.

Özcan, H., 2004. Çinko Uygulamasının Bazı Çeltik (*Oryza Sativa L.*) Çeşitlerinde Verim ile Tanede Çinko, Fosfor ve Fitin Asidi Konsantrasyonuna Etkisi. Doktora Tezi, Ankara Üniversitesi Fen Bilimleri Enstitüsü, Ankara, 116 s.

Tatar, M.Ö., 2006. Tuzluluğun Bazı Çeltik Çeşit ve Hatlarının Çimlenme ile Fide Gelişimi Üzerine Etkisi. Yüksek Lisans Tezi, Ege Üniversitesi Fen Bilimleri Enstitüsü, İzmir, 93 s.

Thirtle, C., 1996. The Cobb-Douglas production function. Distribution exclusive pour les participants. Course of Econometric Modelling of Agricultural Markets Organized by CIHEAM-IAMZ, Adana, Turkey.

Toksal, A., 1991. Çarşamba Ovası'nda Bazı Çeltik Çeşitlerinin (*Oryza Sativa L.*) Verim, Verim Öğeleri ve Tane Kalitesi Üzerine Bir Araştırma. Yüksek Lisans Tezi, Ondokuz Mayıs Üniversitesi Fen Bilimleri Enstitüsü, Samsun, 72 s.

Yurdakoş, E., 2009. Impact Analysis of Turkey's Accession to the European Union on the Rice Common Market Organization and Rice Enterprises in Samsun Province, Master Science Thesis (Unpublished), Ankara University, 150 p., Ankara