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ScienceDirect
Agricultural Systems 94 (2007) 649–656
AGRICULTURAL SYSTEMS
www.elsevier.com/locate/agsy

Measuring the technical efficiency and exploring the inefficiency determinants of vegetable farms in Samsun province, Turkey

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Received 25 May 2006; received in revised form 21 December 2006; accepted 29 January 2007

Abstract

The purposes of this research were to measure the technical efficiency of sample vegetable farms and subsequently to explore determinants of technical inefficiency in the Samsun province of Turkey. Stochastic Frontier Analysis was used to measure technical efficiency. Farm managers from 75 randomly selected farms were interviewed for farm level data in the 2002–2003 production periods. Research results revealed that the average output of vegetable farms in Samsun could increase by 18% under prevailing technology. The technical efficiency of the sample vegetable farms ranged from 0.56 to 0.95 (0.82 average). The variables of schooling, experience, credit use, participation by women and information score negatively affected technical inefficiency. However, age, family size, off-farm income and farm size showed a positive relationship with inefficiency. Therefore, this study proposes strategies such as providing better extension services and farmer training programs, integrating women into the training and extension programs, raising the educational level of farmers, and providing farmers with greater access to credit, to enhance technical efficiency.

Keywords: Vegetable farming; Female labor; Stochastic production frontier; Technical efficiency; Determinants of inefficiency

1. Introduction

Turkey is one of the largest countries in Europe and agriculture is still a relatively important sector in its economy. The agriculture sector contributed 12.9% of gross domestic product, and accounted for 32.9% of total employment in 2004 (TURKSTAT, 2006). According to the last agricultural survey in 2001, there were approximately 3 million farms in Turkey. In addition, some industrial sectors rely on agriculture through the processing of agricultural products such as sugar beet, tobacco, hazelnuts and vegetables.

Vegetables are one of the main food sources for humans. World vegetable production has increased by 120% during the last two decades. In 2005, world vegetable production was 883 million tons. Turkey was the third largest vegetable producer with 2.9% of the total. In 2005, it produced 25.4 million tons (FAO, 2006), which equalled 25.2% of the total value of crop production (TURKSTAT, 2006). Recently, vegetables have increased their importance in the Turkish economy due to growing demand and the accompanying supply response. About 5% of all Turkish farms are involved in vegetable farming. Currently, the area of vegetable production constitutes 3% of the total of 26.6 million hectares of agricultural land in Turkey and production has increased 53% during the last two decades.

Vegetables are very labor intensive in Turkey and provide substantial employment, not in only production but also in transportation, processing and marketing. Together with irrigation, there has also been intensive chemical input in vegetable farming. Although vegetable farming in Turkey requires managerial skills and up-to-date information, vegetable farmers have great difficulties in understanding and adopting new technologies due to their low level of education, poor extension services, insufficient physical infrastructure and lack of credit. This causes Turkish veg-

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0308-521X/$ - see front matter © 2007 Elsevier Ltd. All rights reserved.
doi:10.1016/j.agsy.2007.01.007

etable farmers to fail to fully exploit the potential of technology by making inefficient decisions (İlhan, 1984; Bingöl, 1992). Many policy makers have therefore focused on improving productivity and efficiency as an important source of potential growth in the vegetable production sector in Turkey. However, farm level information on efficiency and productivity is unsatisfactory, especially on vegetable farms (Ceyhan, 1994; Cinemre and Ceyhan, 1998).

It is recognized that, one of the key development issues concerning efficiency of resource use is that without womens' involvement, policies directed towards productivity and efficiency are unlikely to succeed. Most studies have used the term "labor" to show working hours, irrespective of the gender. As a matter of fact, women constitute a substantial portion of the labor input in agriculture. Rees and Smith (1998) made explicit mention that women produce about half of the world's food and their working hours tend to be longer than those of men. Other studies have recently provided more information about gender differentiation in labor participation all over the world (Kabadaki, 1994; Spio, 1997; Shah, 2000; McCoy et al., 2002). Lately, there has been an effort made to obtain gender data in Turkey because of the important role of women in agricultural development. Womens' participation in agricultural activities has been analyzed in some studies, which indicated the subordinate position of women relative to men (Özkan et al., 2000; Ceyhan et al., 2001). Since the presence of male bias in households and the low education level of women has led to inefficient use of resources, attention to womens' role in vegetable farming systems is an important issue for increasing labor efficiency in Turkey. Not only for vegetable farming systems, but also for other agricultural activities, there has been a lack of information about womens' participation in production activities, decision making and efficiency.

A great deal of empirical study has measured farm level technical efficiency by using the production function, parametric or non-parametric frontier function, and mathematical programming with cross-sectional, panel or aggregate data (Chennerady, 1967; Sahota, 1968; Lau and Yotopoulos, 1971; Sidhu, 1974; Kalirajan, 1984; Kumbhakar, 1987; Ali and Chaudhry, 1990; Papadas and Dahl, 1991; Battese et al., 1996; Laura Gow and Langemeier, 1999; Morrison, 2000; Lerman, 2001; Mathijs and Swinnen, 2001; Tzouvelekas et al., 2001; Latruffe et al., 2002; Alvares and Arias, 2004). However, few studies have addressed the issue of technical efficiency in vegetable production (Wilson et al., 1998; Zaibet and Dharmapala, 1999; Gandhi and Namboodiri, 2002; Trip et al., 2002; Iràizoz et al., 2003; Aramyan et al., 2004; Zhang and Xue, 2005). Similarly, efficiency analysis has been applied relatively few times in Turkey (Zaim and Çakmak, 1998; Günden et al., 1998; Aktürk, 2000; Demirci, 2001; Cinemre et al., 2006). However, there have been no studies on farm level technical efficiency and its determinants in vegetable farming.

In designing appropriate policy measures to enable Turkish vegetable farms to increase productivity through improved efficiency, it may be useful to measure farm level technical efficiency and its determinants. Therefore, the objectives of this study were (i) to calculate farm level technical efficiency on vegetable farms in Samsun, Turkey, (ii) to identify important factors causing efficiency differentials among those farms, with special focus on womens' participation, and (iii) to infer policy implications based on technical efficiency scores and their determinants.

2. Methodology

2.1. The research area

This study was conducted in Samsun province which is located on the northern Black Sea coast of Turkey. Samsun province is 958000 hectares in area, 47% of it is used for agricultural production, and there are 104000 farms. Samsun has a mild climate. It's average temperature is 14.2 °C and the average rainfall is 664.9 mm annually (Mazgal, 2006). Vegetable farming is carried out mainly in the field. The research area constituted 3% of the total vegetable area and it produced 4.8% of the total vegetable production in Turkey. The Bafra and Çarşamba plains of Samsun produced 80% of the total vegetable output in 2004 (TURKSTAT, 2006). Vegetable farmers in the research area grow a wide range of vegetable crops, including tomatoes, cucumbers, peppers, eggplant, beans, watermelons, melons, cabbages, leeks, lettuce and spinach. Common varieties, yield, gross margin and price of vegetables widely produced in the research area are presented in Table 1. Cabbages had the largest gross margin of $9214 per hectare. Melon and water melon, pepper and tomatoes followed it. The gross margins of the other vegetables were moderate. Considering output prices, beans had the highest price, while those of cucumbers and lettuce were lowest (Table 1).

Table 1
Some characteristics of vegetables produced on Samsun vegetable farms (TURKSTAT, 2006; MARA, 2006)

Species	Yield (kg/ha)	Output price ($/kg)	Gross margin ($/ha)
Tomatoes	33930	0.17	*2416.46*
Peppers	25000	0.26	*2972.76*
Eggplant	20690	0.18	*1043.08*
Cucumbers	20630	0.16	*730.15*
Beans	8820	0.37	*469.38*
Watermelons	36560	0.17	*4068.00*
Melons	30140	0.25	*5145.85*
Cabbages	31470	0.35	*9213.85*
Leeks	30120	0.12	*1303.85*
Spinach	10000	0.17	*452.00*
Lettuces	*19640*	*0.16*	*990.92*

2.2. Stochastic frontier model

The Stochastic Frontier Approach (Coelli et al., 1998) was used for measurement of technical efficiency. In this study, inefficiency was defined as the distance between a farm's actual vegetable production value and the estimated frontier vegetable production value that corresponds to the state of its production technology. Output value in $ was used as the dependent variable, assuming there is a perfectly competitive market structure. Similarly, some previous empirical studies have used the monetary value as the dependent variable (Battese and Coelli, 1988; Aigner et al., 1977).

In this study, one-stage procedure was used to estimate the inefficiencies and the reasons for them. The explanatory variables used to explain efficiency were included in the model when estimating the measures of technical efficiency. The results of the likelihood ratio-type test, used to test Cobb-Douglas against the translog, showed that Cobb-Douglas was an appropriate model for our data. Based on Battese and Coelli (1995) and Coelli et al. (1998), the following model was used:

$$\ln(T_i) = \ln(X_i)\beta + V_i - U_i, \quad i = 1, \ldots, 75$$

where T_i is the vegetable production value of the ith farm, X_i is a vector of inputs for ith farm, β is a vector of unknown parameters, V_i is the random variables that were assumed to be independently and identically distributed with $N(0, \sigma_V^2)$ and independent of U_i, and U_i represents the non-negative random variables, which are assumed both to account for technical inefficiency and be independently distributed as truncations at zero of $N(\mu_i, \sigma_U^2)$.

In this definition of U_i, $\mu_i = z_i\delta$, where (z_i) is a vector of explanatory variables that may influence the technical efficiency of a farm, and (δ) is a vector of parameters to be estimated.

Pure random disturbance, V, is separated from disturbances that can be attributed to the factors influencing the efficiency, U, via δ. The level of technical inefficiency was estimated as $e^{-U(i)}$.

Maximum-likelihood estimates of the parameters for the stochastic frontier production function were obtained by use of the computer program FRONTIER, Version 4.1, developed by Coelli (1994).

3. Data

The bulk of data used in the study was collected from farmers growing only vegetables on the Bafra and Çarşamba plains. Farm data was collected through a questionnaire. Seventy five randomly selected farms were visited to obtain resource use and production data for the 2002–2003 production period.

Output prices were gathered from individual farms. All vegetables produced on the sample farms were aggregated into one output value in ($), which was the dependent variable. Gross production was calculated as sales + farm use + farm house consumption + closing valuation − opening valuation.

Three inputs (land, labor and capital) were included in the estimation of the frontier production function. Capital was the aggregate value of cash expenditures on fertilizers, pesticides, plowing and harvesting. Farm land was included in the model in hectares, while labor was measured in annual work units (AWU).

The variables most commonly used in previous studies to explain the efficiency of a sample farm were size, age of operators, experience of farmers, education level of farmers, use of extension services, data recording, credit use and combination of inputs (Phillips and Marble, 1986; Kalirajan and Shand, 1989; Bravo-Ureta and Rieger, 1991; Bravo-Ureta and Evenson, 1994; Parikh et al., 1995; Ahmad and Bravo-Ureta, 1996; Lewelyn and Williams, 1996; Seyoum et al., 1998; Amara et al., 1999; Sharma et al., 1999; Zaibet and Dharmapala, 1999; Wilson et al., 2001; Trip et al., 2002 and Iràizoz et al., 2003).

In this study, the explanatory variables were obtained from the sample farms by questionnaire. This study introduced a new explanatory variable named the women's participation (score), which was not used in the studies mentioned previously. In Turkey, women play a crucial role in the vegetable farming systems. Özkan et al. (2000) and Ceyhan et al. (2001) stated that women were involved in vegetable production (especially planting, hoeing, har-

Table 2
Basic characteristics of Samsun vegetable farms: Descriptive statistics

	Mean	Standard deviation	Minimum	Maximum
Family size (persons)	6.28	1.99	2.00	12.00
Labor (AWU)	3.71	1.15	1.22	7.25
Age of farm owner	41.66	7.68	24.00	64.00
Owner's experience in vegetable production	18.92	8.20	5.00	40.00
Schooling (years)	3.62	1.39	0	5.00
Information score	5.36	13.67	0	40.00
Women's participation score	22.15	4.95	14.00	37.00
Farmland (ha)	4.47	6.09	0.50	38.00
Total assets ($)	42181.99	26950.01	5887.00	100821.01
Output value ($)	5548.80	13537.67	1071.52	41684.93
Gross farm income ($)	2281.81	1548.33	600.00	14142.00

vesting) and in marketing activities in Samsun, Turkey. Post-harvest processing of vegetables was also a part of womens' tasks. However, women farmers were relatively less involved in activities such as fertilization, irrigation and spraying. In addition, womens' participation in the decision making process was also relatively low, compared with their participation in production activities. Since womens' participation in production activities and the decision making process may affect technical efficiency (Özkan et al., 2000; Ceyhan et al., 2001), it was measured as a score by using female family members' nominally-scaled (0: minimum participation, 5: maximum participation) responses to specific questions. A total of 8 different activities were included in time allocation analysis, namely, soil preparation, planting, fertilization, irrigation, hoeing, spraying, harvesting, marketing and decision making. Based on the responses of female family members, this study graded the total womens' participation score which varied from 0 to 40. The maximum score meant that all activities were performed by women, while the minimum score expressed no participation by women in vegetable farming.

The age variable included in the inefficiency model served to test the hypothesis that younger farmers were more receptive to innovations. Because lack of experience, low level of education and large family size were potential sources of technical inefficiency, the variables schooling, the experience of farmers (years) and family size (persons), were included as variables. Farm size was included as a dummy, which was equal to 1 if the size was greater than 3 ha, and 0 otherwise in order to reveal the relationship between farm size and technical efficiency. To explore the relationship between technical efficiency and the existence of off-farm income, the off-farm income variable was a dummy. It equalled 1 for off-farm income and 0 otherwise. Credit use was the other dummy variable. It equalled 1 if farmers used credit and 0 otherwise. The information score was calculated by using farmers' responses to questions which were related to contact with information sources such as extension services and farm advisors, and was included in the model to show the effects of farmers' contact with extension services and other information sources on technical efficiency.

Some basic characteristics of sample farms are presented in Table 2. It is evident that farms were small in terms of output and total area farmed. Farm operators averaged 42 years old. Their experience in vegetable production was vast, while their education level and total information score (reflecting access to institutions such as extension services and cooperatives) were moderate. Women's participation in vegetable production was scored at 22, indicating that women took part in 55% of all vegetable farming activities. Sample vegetable farms averaged approximately 4 ha. On average, they received \$5548 from outputs and \$2282 of gross farm income from \$42182 of total assets. They also used little credit and preferred instead to use equity. Only 28% of the total sample of farmers used credit, averaging \$5260 per year.

4. Results and discussion

Maximum-likelihood estimates of the parameters of the model are presented in Table 3. The estimated values for the variance parameters were significant and indicated that technical efficiency had an impact on the total value of vegetable production. This suggested that a conventional production function was not an adequate representation of the data. The variance parameter of the model (γ) was significantly different from zero at the 5% level. The ratio of standard errors was close to 1 (0.71), indicating that a high level of inefficiency exists. In addition, the likelihood-ratio (LR) test[1] was used to test the null hypothesis: that inefficiency effects exist and were indeed stochastic. Based on the results of the LR test, the null hypothesis was strongly rejected.

The results of the estimation showed the expected signs of the coefficients of the stochastic production frontier. The coefficients of land, labor and capital confirmed the expected positive relationship among land, labor, capital and total value of vegetable production. The estimated elasticity for land, labor and capital were 0.64, 0.62 and 0.25, respectively ($p < 0.01$), which indicated that returns to scale were increasing. Restricted least squares regression was used to formally test the null hypothesis of constant return to scale. The calculated F statistic was 5.64, which exceeded the critical F value of 3.92 at the 5% level of significance. Therefore, the null hypothesis of constant return to scale was rejected. Land and labor showed the greatest elasticity. It was concluded that these two inputs had a major effect on the total value of vegetable production (Table 3).

The results of efficiency analysis revealed that technical efficiency scores of sample farms, estimated as $e^{-U(i)}$, varied from 0.56 to 0.95 (average 0.82). This implied that there was substantial technical inefficiency in vegetable farming. The main implication of this result was that vegetable farms could reduce their inputs by around 18% without reducing their vegetable production, simply by improving technical efficiency. Improved efficiency would reduce production costs and increase the gross margin on vegetables. Frequency analysis of efficiency indices showed that 4% of the sample farms had technical efficiency below 60%, whereas 67% of farms had a technical efficiency level of more than 81%. The rest had a technical efficiency level between 61% and 80% (Fig. 1).

Based on the results of the inefficiency model, all exogenous variables, with the exception of family size, off-farm income and farm size, had a significant coefficient. Most of the signs related to inefficiency determinants were as expected. The parameter estimates showed that factors such as schooling, experience, credit use, womens' partici-

[1] The likelihood-ratio test statistics, $\lambda = -2\{\ln[\text{likelihood } (H_0)] - \ln[\text{likelihood } (H_1)]\}$, have approximately chi-square distribution with parameter equal to the number of parameters assumed to be zero in the null hypothesis, (H_0), provided.

Table 3
Maximum likelihood estimates of the Cobb-Douglas stochastic frontier model

Variables	Parameters	Standard error	*t*-Value
Production function			
Constant	3.02	0.30	10.06***
Ln (Land)	0.64	0.08	7.95***
Ln (Labor)	0.62	0.19	3.19***
Ln (Capital)	0.25	0.06	3.94***
Sum of elasticity of inputs	1.51		
F statistics CRTS[a]	5.64**		
Variance parameters			
σ^2	0.10	0.03	3.33***
γ	0.71	0.20	3.55***
Log likelihood	66.54	0.258	257.91***
$\chi^2(1)$	5.16**		
Inefficiency effects			
Age of farmers	0.61	0.41	1.49*
Experience of farmers	−0.71	0.37	−1.92**
Schooling	−0.21	0.12	−1.75**
Family size	0.83	0.97	0.86
Off-farm income	0.27	0.66	0.41
Credit use	−0.18	0.07	−2.57***
Farm size	0.13	0.44	0.29
Womens' participation score	−0.27	0.16	−1.69**
Information score	−0.32	0.18	−1.78**

*, **, *** significance at the 10%, 5% and 1% level, respectively.
[a] CRTS = constant return to size.

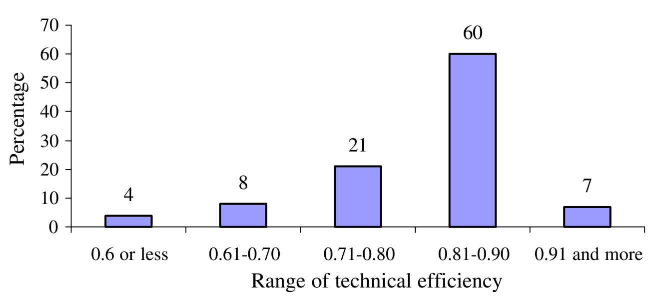

Fig. 1. Percentage distribution of technical efficiency scores for Samsun vegetable farms.

pation and information score negatively influenced technical inefficiency, while age, family size, off-farm income and farm size showed a positive relationship with inefficiency (Table 3).

The age coefficient indicated that the younger farmers were more efficient than the older ones (Table 3). This finding confirmed the results of previous studies conducted by Battese and Coelli (1995) and Mathijs and Vranken (2000). The negative estimate for the experience of farmers implied that the number of years in vegetable farming led to better managerial skills being acquired over the years (Table 3). This meant that the vegetable farming is highly dependent on the experience of farmers.

In this study's model, schooling negatively affected technical inefficiency, supporting the hypothesis of Schultz (1964); that education increases the ability to perceive, interpret and respond to new events and enhances farmers' managerial skills, including efficient use of agricultural inputs (Table 3). This finding also confirmed the results of Kalirajan and Shand (1985); Phillips and Marble (1986); Pinherio (1992); Kebede (2001); Binam et al. (2004) and Zavela et al. (2005).

Another outcome of the inefficiency model was that the negative and significant effect of credit use on technical inefficiency implied that access to credit enhanced the technical efficiency of the sample farms (Table 3). In the research area, the shortage of working capital due to high input costs and low returns on outputs was common and this negatively affected the farmers' level of technical inefficiency. The purchase of agricultural inputs occurs during the vegetable growth periods, whereas returns are received only after the crops are harvested several months later. This is the perennial problem, so most vegetable farmers have negative cash flow during the planting and growing period. Credit use therefore increased technical efficiency, a result similar to the findings of Binam et al. (2004) and Zavela et al. (2005).

With respect to womens' participation, the negative and significant coefficient did not support the hypothesis that farms with high womens' participation were less efficient (Table 3). This finding was consistent with the results of Mathijs and Vranken (2000) and Zavela et al. (2005).

Information score as a variable of frequency of contact with extension and other information sources was negative and this implied that farmers with a high information score were more efficient (Table 3). Similar results were reported by Kalirajan (1981) in India, Kalirajan and Flinn (1983) in the Philippines, Kalirajan (1984) in the Philippines and Binam et al. (2004) in Cameroon.

While the variable of farm size had an insignificant effect on technical inefficiency, the small farms were more technically efficient than the large ones. The technical efficiency of the large farms ranged from 0.59 to 0.92 (average 0.80), while that of small farms was 0.81 (Table 4). This finding confirmed the results of Torkamani and Hardaker (1996) and Laura Gow and Langemeier (1999). These authors found that efficiency level was irrespective of farm size. However, some authors have shown conflicting results.

Table 4
Farm size and technical efficiency on Samsun vegetable farms

	Number of farms	Technical efficiency	Standard deviation	Minimum	Maximum
Small farms (<3.0 ha)	42	0.81	0.074	0.56	0.95
Large farms (⩾3.0 ha)	33	0.80	0.128	0.59	0.92
Total	75	0.82	0.088	0.56	0.95

Table 5
The differences between technically efficient and inefficient vegetable farms

Characteristics	Technically efficient farms ($N = 8$)	Technically inefficient farms ($N = 67$)
Gross farm income ($/ha)	880.17 (345.04)	459.80 (475.85)
Gross farm income ($/person)	678.40 (265.84)	324.43 (335.68)
Output value ($/ha)	3056.06 (1131.85)	993.92 (1152.12)
Land (ha)	5.01 (3.91)	4.41 (6.37)
Education of the farmer (years)	4.61 (1.25)	3.50 (2.07)
Experience (years)	25.38 (11.83)	18.15 (7.34)
Age (years)	35.64 (7.15)	42.38 (9.78)
Labor (AWU)	4.49 (1.65)	4.81 (1.34)
Working capital ($)	11507.41 (3682.24)	8936.31 (3216.96)
Womens' participation score	25.48 (4.84)	21.75 (5.85)
Information score	8.41 (7.99)	5.00 (3.78)
Credit access (%)	62.50	17.91

Figures in parentheses are standard error.

According to some researchers, there was a positive size-efficiency relationship (Pinherio, 1992; Curtis, 2000; Morrison, 2000; Latruffe et al., 2002), while others reported the opposite (Schultz, 1964; Lau and Yotopoulos, 1971; Sidhu, 1974; Huang and Bagi, 1984; Squires and Tabor, 1991).

Family size and off-farm income were also insignificant variables, indicating that the smaller family without off-farm income was more efficient than the larger family having off-farm income (Table 3).

5. Policy recommendations for farms

Based on the results of the comparative efficiency analysis, the technically efficient vegetable farms carried out their activities on larger areas with a relatively high level of working capital. However, their relative labor use was lower than on inefficient farms. In addition, the farmers' profile for efficient farms was more satisfactory than for inefficient ones. Farmers on these farms were better educated, more experienced and younger. The number of contacts with information sources such as extension services, private firm advisers and cooperatives by efficient farms was greater than by inefficient farms. Similarly, there was a higher level of womens' participation in efficient farms compared to inefficient ones. Efficient farms also had higher gross farm income, both per hectare and per person, and better access to credit than inefficient farms (Table 5).

In the light of these research results, it seems that substantial decreases in inputs or gains in outputs could be attained by using the existing technology on vegetable farms. Under these circumstances, the policy implications are clear. Policy makers should focus on (i) enhancing farmers access to information via the provision of better extension services and farmer training programs, (ii) integrating women into the training and extension programs, (iii) raising the educational level of farmers, and (iv) providing farmers with greater access to credit in order to reduce technical inefficiency.

It is suggested that farmers' training and extension programs should be provided in the research area for improving the technical efficiency of individual farms up to at least the level of the best vegetable farms. Demiryürek (2000) noted a positive correlation between efficiency and total information score that reflects the extent of contact with relevant sources of information. Farmers who transform their production system to more efficient methods (new technology adoption, changing production function etc.) more extensively seek and contact information sources such as extension officers, research staff and other private firm advisers. However, the nature of the relationship between efficiency and contact with extension staff is not clear. It seems likely that well-informed farmers already know the answers to some existing problems.

Farmer training and extension activities are relatively low cost methods of achieving increases in productive efficiency (Ellis, 1993). However, increases have been strongly dependent upon the effectiveness of the presentations by research and extension organizations. Hence, future programs for farmers' training and extension should focus on human resource development and be directed to peer leader farmers open to transforming their farms to a more market oriented basis. Focusing on disease management, input quality, cooperation among farmers, marketing efficiency in farmer training and extension programs, and integrating women into training and extension programs may also help to increase efficiency in the research area.

The strategy of providing farmers with greater access to credit would require government support through an adequate legal and regulations framework. A government-supported pilot program which reduces the transaction costs of providing credit to farmers would have the potential to increase efficiency.

Raising the education level of vegetable farmers is a difficult task for policy makers. However, public investment in physical infrastructure (roads, communications, etc.) may contribute to improving the education level of vegetable farmers.

6. Conclusions

This study derived the technical efficiency indices for vegetable farms in the Samsun province of Turkey by using the stochastic production frontier approach. The mean technical efficiency of farms was 0.82, indicating that there are opportunities to gain substantial additional output or decrease inputs, given the existing technology of vegetable farmers in the research area.

Farm level explanatory variables were used to explore inefficiency determinants. The inefficiency effect model showed that factors such as schooling, experience, credit use, womens' participation and information score negatively influenced technical inefficiency, while age, family size, off-farm income and farm size showed a positive relationship with inefficiency.

Based on the results, the authors of this study propose strategies such as providing better extension services and farmer training programs, integrating women into the training and extension programs, raising the educational level of farmers, and providing farmers with greater access to credit, in order to increase the technical efficiency of vegetable farms in the Samsun province.

Acknowledgements

The authors are grateful to Gregory Thomas Sullivan from Ondokuz Mayis University in Samsun, Turkey for his editorial assistance, and anonymous referees for their constructive comments and suggestions on the text.

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