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EVALUATION OF THE EFFICIENCY OF ORGANIC COTTON FARMERS: A CASE STUDY FROM TURKEY

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Abstract

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This paper examines the sustainability of organic cotton production systems as compared with conventional in terms of their economic profitability and technical efficiency. Showing the economic direction and technical efficiency of organic cotton farming is of great importance for guiding policy in relation to organic cotton in producing countries.

Though organic cotton has less environmental impact than conventional cotton, it costs more to produce. According to analyses of costs, conventional cotton farms in Turkey were shown to be at an advantage compared with organic cotton farms. Unit costs of organic cotton were calculated at \$1.04 kg^{-1}, whereas those of conventional production were \$0.85 kg^{-1}. Profit per unit area (ha) was \$299.74 for organic cotton, but \$616.59 for conventional production. However, no great difference was found between farms in terms of technical efficiency. According to VRS analysis of output and input-oriented data, average efficiencies were 94.90% and 94.18% respectively for organic cotton farms, and 92.62% and 93.27% respectively for conventional cotton farms. This is a cause for concern for the development of organic cotton production in Turkey. Among the principal reasons for the lack of development in organic cotton farming in Turkey are that **price premiums given** to organic cotton producers are low, farmers are not supported at the stage of changeover to organic production, and that farmers are unable to make long-term contracts.

Key words : organic cotton, sustainable cotton, economic sustainability, technical efficiency

Introduction

The ability to respond to customer demand is fundamental in the supply chain, which is managed based on customers' wishes. For this reason, some conventionally produced products have gradually been replaced with organic products in line with changes in customer demand. Cotton, a raw material of the textile and garment sector, is one of these. The certified production and consumption of organic cotton dates back to the early 1990s, when pioneers in the United States and Turkey started to create markets for cotton that was grown as a rotational crop on certified organic farms (Ton, 2007).

To avoid the negative impacts connected to conventional cotton production and the use of pesticides, cotton farmers need to change their production methods towards sustainable agriculture. Organic cotton production has proven its feasibility in many countries all around the world. It is the best solution to achieve long-term soil fertility, supports food security through crop rotation and helps farmers to achieve a better net income through very low input costs, organic premium and yields, which are potentially as high as in conventional production (Sanfilippo and Perschau, 2008).

Organic cotton production has grown to an estimated 0.55 percent of global production. According to a report entitled "Organic Cotton Farm and Fibre 2008"

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by the Organic Exchange, organic cotton production is being carried out in 22 countries in the world, on a total of 161 000 hectares (Anonymous, 2008a). In recent years, there has been a significant enlargement in the global market for organic cotton. Global retail sales of organic cotton apparel and home textile products reached $1.9 billion in 2007 and a $4 billion market in 2009. It is expected to reach $5.3 billion in 2010 (Anonymous, 2009a).

Organic cotton shows great benefits at various levels of the value chain - farmers, traders, retailers and consumers all benefit from the economic, social and ecological advantages of organic cotton projects (Anonymous, 2008b).

Among benefits to the farmer are: (i) maintenance or improvement of soil fertility, (ii) protection of health, (iii) improvement of economic situation and food security (providing an enhanced crop rotation with a range of different food crops, providing extra income thanks to the organic premium, producing according to strict environmental and social standards), (iv) access to dynamic markets (reducing their dependency on the fluctuating world market for conventional cotton, to get a better price for their product), and (v) effective logistical and technical support from producer organisations and networks.

Benefits to traders and retailers include participation in a dynamic market, traceability, risk and quality management, a contribution to ecological and social sustainability, image and credibility. For consumers, the benefits are buying a healthy product, traceability, having clear standards and transparent market information, and a more sensitive and positive idea of the environment and producers' livelihoods.

However, solid research is needed before we can say that all members of the value chain of organic cotton derive benefit, but it seems that this kind of research, especially at the farmers' level, has so far been insufficient. For example, even in the USA, where organic cotton production started much longer ago, it has been found that knowledge of profitability in the field of organic cotton production is severely limited (Funtanilla et al., 2009). It is noticeable here that the most-emphasised aspect of organic cotton production is sustainability. However, if it does not bring any economic advantage to farmers, it cannot be said to be sustainable.

In this framework it is important to determine the economic performance and efficiency of farmers growing organic cotton, which is being produced with such great economic expectations. In this way, policies regarding organic cotton can be managed in a suitable way. The fact that the world demand of organic cotton fibre currently outstrips supply makes the importance of this topic easier to understand.

Turkey was until recently the leader in organic cotton production, and still occupies an important position, and this study has been carried out on the economic performance and efficiency of its organic cotton farmers. In this study, which contains the results of work carried out in the Aegean Region of Turkey, a comparative analysis of organic and conventional cotton production has been made. To this end, analyses have been made of the costs and gross margins of farmers who mainly produce organic or conventional cotton. An analysis of technical efficiency has been carried out in addition to the costs and gross margins analysis in order to make a proper assessment of the farmers. Results obtained from the analysis have been compared with those of other organic cotton producing countries, problems facing farmers in Turkey and in other countries have been discussed, and suggestions have been made for the solution of these problems. At the start of the study, the environmental impacts of organic and conventional cotton production were examined in order to assess the contribution of organic cotton on sustainable agriculture.

Material and Methods

The basic material for this study comprises primary data obtained in a survey carried out in 2006. Alongside this, materials such as articles, research and statistics from a number of relevant sources have been used.

The survey work was carried out in the Aegean Region of Turkey, which is an important area for organic cotton production. Aydin, Izmir and Manisa were chosen as the three most important provinces in the region in terms of number of producers and production area and quantity.. In total these three provinces have 330 organic cotton farmers (53.52%), 25.02% of production area, and 27.01% of production quantity of organic cotton in all of Turkey (MARA, 2008). Sample volume was determined by the proportional sampling method as described below (Newbold, 1995):

$$n = \frac{Np(1-p)}{(N-1)\sigma^2_{\hat{p}_x} + p(1-p)}$$

where:
n= Sample volume
N= Population (330 organic cotton farmers)
p= ratio of organic cotton farmers (it shows the ratio of farms in the total farms which have the desired characteristics. to reach the maximum number of the sample size, p is accepted as 0.5)
1 – p = the ratio of farmers who do not produce organic cotton
Confidence interval = 90%
Standard error = 10%
σ_{px}^{2} : Variance

$$Z_{\alpha/2}\,\sigma_p = r \qquad 1.645\,\sigma_p = 0.10 \Rightarrow \quad \sigma_p = 0.06079$$

$$n = \frac{330 \cdot (0.5) \cdot (0.5)}{329 \cdot (0.06079)^2 + (0.5) \cdot (0.5)} \cong 57$$

Calculations indicated a sampling number of 57 organic cotton farmers who were selected as calculated by the proportional sampling method. The distribution by province of the organic farmers interviewed was determined in relation to the number of cotton farmers in the area. The number of farmers selected from each province was proportional to the total number of the number of farmers of that province (Table 1). Only 46 farmers accepted the request for interview. The reason for this lies in the intense competition in the organic cotton sector. The number of organic cotton farmers interviewed by provinces was 39 in Aydin, 5 in Izmir, and 2 in Manisa.

A separate sample volume of conventional cotton farmers was not calculated for the purpose of comparison with the organic cotton producers. This was done by taking into account the same sample volume calculated by provinces for organic farmers. The number of conventional cotton farmers interviewed by provinces was 50 in Aydin, 5 in Izmir, and 2 in Manisa.

A comparison was made in this study between organic and conventional cotton farms by analysing unit cost, gross margin, and technical efficiency. In the analysis, account was taken of data, which could be obtained effectively from the farms. Thus, 14 of the organic cotton farmers interviewed and 24 of the conventional farmers were included in the analysis.

Both for the organic and conventional cotton production, the distribution of the costs in total variable costs are different. In organic cotton production, total variable costs include seed, fertilizer, irrigation, biological control, fuel, labour, organic certification cost and other costs. The only difference in comparison with conventional production is that of pesticide costs instead of biological control and no organic certification costs.

Half of the total variable costs was applied to the annual credit interest rate (17.5%) for crop production in Turkey, and added to total variable costs (Kiral et al., 1999). After calculating the total of variable expenses for both conventional and organic cotton production, total production costs were calculated by adding together the charge for organic certification, general management or administrative costs (3% of total variable costs), land rent (5% of the value of the bare land), and depreciation for buildings, machinery and equipment. The reason for including the charge for organic certification in fixed costs is that charging is generally linked to units of land area, number, and therefore production. The control and certification organizations in Turkey generally charge according to the distance to the land to be certified and the associated costs of travel and accommodation, analysis and certification (Anonymous, 2009b). In calculating the costs of organic and conventional cotton production, the total variable and fixed costs for 1 hectare were divided by the quantity of cot-

Table 1
Distribution of farmers interviewed by provinces

Provinces	The number of farmers	% of total number	The number of farmers entering the sample	The number of farmers accepted the request for interview
Aydın	290	87.88	50	39
İzmir	28	8.48	5	5
Manisa	12	3.64	2	2
Total	330	100.00	57	46

ton produced in that area, to give the cost of production of 1kg of cotton.

Gross margin analysis was carried out in this study in order to compare the profitability of organic and conventional farms. Generally, the gross margins for any agricultural crop are determined by deducting variable costs from the gross farm income of a given crop for a given period (usually per year or per cropping season). They are not a measure of farm profit as they do not include capital (land, buildings, machinery, irrigation equipment etc.) or fixed costs (building and machinery depreciation, administration, insurance, rates, taxes etc.). However, they do provide a useful tool in terms of farm management, budgeting and estimation of the likely returns or losses of a particular crop (Anonymous, 2009c)

In order to determine the efficiency of farms engaged in the production of organic and conventional cotton, the widely-used Data Envelopment Analysis (DEA) method was employed., was used. DEA is commonly used to evaluate the efficiency of a number of producers. A typical statistical approach is characterized as a central tendency approach and it evaluates producers relative to an average producer. In contrast, DEA is an extreme point method and compares each producer with only the "best" producers (Anderson, 2011). Farrell (1957) proposed that the efficiency of a farm consists of two components: technical efficiency, which reflects the ability of a farm to obtain maximal output from a given set of inputs, and a locative efficiency, which reflects the ability of a farm to use the inputs in optimal proportions, given their respective prices and the production technology. These two measures are then combined to provide a measure of total economic efficiency (Coelli et al., 1998).

The most common efficiency concept is technical efficiency: the conversion of physical inputs (such as the services of employees and machines) into outputs relative to best practice. In other words, given current technology, there is no wastage of inputs whatsoever in producing the given quantity of output. An organization operating at best practice is said to be 100% technically efficient (Bhagavath, 2011).

In the Data Envelopment Analysis, the data were analyzed according to models, CRS (constant returns to scale) and VRS (variable returns to scale) and estimations were made according to both models. Efficiency results, both input and output oriented, were obtained according to the estimations of both models. In the input oriented model approach, target outputs can be obtained with minimal input use, therefore, a saving-oriented approach is required in the use of resources. The notation for the estimation according to input oriented CRS is given below.

$$\min_{\theta,\lambda} \theta,$$
$$\text{st.} -y_i + Y\lambda \geq 0$$
$$\theta xi - X\lambda \geq 0$$
$$\lambda \geq 0$$

Here, θ is a scalar and λ is Nx1 constants' vector. The obtained θ value i. shows the ratio of efficiency for each production unit. According to the definition of Farrel (1957), this value is between 1 and 0. θ =1 and means that the production unit is above the efficiency frontier. For each unit, θ value, the technical efficiency value, is obtained by solving the linear programming problem in N times for each unit.

In output-oriented analyses, the aim is to achieve the maximum output with the existing input. The notation for output oriented CRS assumption is given below:

$$\max_{\Phi,\lambda} \Phi,$$
$$\text{st.} - \Phi y_i + Y\lambda \geq 0$$
$$xi - X\lambda \geq 0$$
$$\lambda \geq 0,$$

When the convexity constraint, N1' λ=1, is added to this linear programming problem, an output oriented DEA model which is according to VRS is obtained. In this model profit maximization problem is solved as follows;

$$\max_{\lambda,yi} p_i y_i$$
$$\text{st.} - y_i + Y\lambda \geq 0$$
$$xi - X\lambda \geq 0$$
$$N1' \lambda = 1$$
$$\lambda \geq 0,$$

Here, p_i, represents a vector of vector input prices for the i-th farm and y_i, which is calculated through linear programming, represents the revenue- maximizing vector of output quantities for the i-th farm, given the output prices (p_i) and the input levels (xi) (Coelli et al., 2002).

In determining the efficiency of farms producing organic and conventional cotton, the first step was to determine input and output variables. These are set out in Table 2.

Additionally potential improvement analyses were made for the farms producing organic and conventional cotton, depending upon model estimations. In these analyses, potential improvement ratios were calculated based on output target values for the inefficient farms to be upgraded to efficient references in the group.

Table 2
Input and output variables of farms producing organic and conventional cotton used in data envelopment analysis

Organic cotton farms	Conventional cotton farms
Output	Output
Production value of cotton ($)	Production value of cotton ($)
Inputs	Inputs
Farm size (ha)	Farm size (ha)
Seed cost ($)	Seed cost ($)
Fertilizer cost ($)	Fertilizer cost ($)
Biological Control ($)	Pesticide cost ($)
Fuel cost ($)	Fuel cost ($)
Labor cost ($)	Labor cost ($)
Other variable Costs ($)	Other variable Costs ($)

Results and Discussion

Socio-Economic Characteristics of Organic Cotton Farmers

In the cotton farms examined, the average age of the farmers was 48.83 years, and they had received 6.58 years of education. They had an average of 27.48 years of experience in cotton production, which was almost equal to the time they had spent in agricultural activities (28.89 years). The length of experience of organic production of the farmers on these farms was 7.39 years.

It was found that the great majority (84.78%) of farms were practicing conventional and organic cotton production together. Nevertheless, 15.22% of farms were practicing entirely organic agriculture. Examining the land use of the cotton farms studied, it was found that they had a crop pattern which showed great variety. Along with cotton, space was given on the farms to the cultivation of other field crops, fruits, vegetables, olives and vineyards. As for the distribution of amounts of total land area between different crops, land distribution showed that organic cotton production occupied a large proportion, 43.71%, of total land under cultivation (Table 3). Field crops other than cotton were also seen: wheat, barley, maize (for grain and silage), common vetch (*vicia sativa*, for seed and silage), and alfalfa.

Average annual gross income on organic cotton farms studied was $41 720.27, and income from organic cotton constituted 42.21% of total farm income (Table 4). Average annual income from other crops was 38.33% of total farm income. In addition, it was found that 14.87% of total farm income came from livestock husbandry, and 4.17% from government supports and non-agricultural activities.

Analysis of Production Cost and Gross Margin

In this section, production costs are calculated and gross margins analyzed with the purpose of determining the economic performance of farms engaged in organic cotton production in comparison with those producing conventional cotton. Details of unit production costs of organic and conventional cotton are presented in Table 5 where the unit cost for organic cotton was calculated as \$1.04 kg^{-1} and that for conventional cotton as \$0.85 kg^{-1}. Comparing the cost factors of these two different modes of production, it is shown that the costs of fertilizer and fuel form an important part of the costs of organic cotton production. This is because more effort is needed to care for the soil in organic cotton production in order to increase its fertility.

Additionally, it was found that the selling price of organic cotton was \$0.60 kg^{-1} on average, and that of conventional cotton \$0.54 kg^{-1} (Table 6). These data show clearly that producers of both organic and conventional cotton suffer a financial loss, and that the size of the loss is somewhat greater in the case of organic cotton. Although the price of organic cotton is 11.11% higher than that of conventional cotton, the difference in production cost is 22.35%.

When an analysis was made of gross margins in order to compare profits obtained from cotton production by farms producing organic and conventional cotton, fixed expenses were not included in the calculation of farms' profitability. According to the analysis of gross margin, obtained by subtracting variable costs from gross production value, farms suffered a loss of $610.02 ha for organic cotton and $386.41 ha for conventional cotton (Table 6). When gross margins obtained per unit

Table 3
Pattern of land use on organic cotton farms examined (ha), %

Pattern of land use	Land under cultivation, ha	%
Other field crops (conventional)	4.747	26.70
Other field crops (organic)	3.348	18.83
Cotton (organic)	7.770	43.71
Cotton (conventional)	0.087	0.49
Cotton (transition from conventional to organic cotton.)	0.017	0.10
Olives (organic)	0.409	2.30
Olives (conventional)	0.126	0.71
Vineyards (organic)	0.511	2.87
Vegetables (organic)	0.326	1.83
Vegetables (conventional)	0.177	1.00
Fruits (conventional)	0.252	1.42
Fruits (organic)	0.007	0.04
Total	17.777	100.00

area (ha) were added to government support payments, the profit obtained per unit area (ha) was $299.74 for organic cotton, and $616.59 for conventional cotton.

Table 4
Distribution of average annual gross income of organic cotton farms examined by ıncome sources

Income sources	Average income per farm, $	%
Cotton (organic)	17 609.68	42.21
Cotton (transitional and conventional)	176.15	0.42
Other crops (organic)	8 207.47	19.67
Other crops (conventional)	7 786.75	18.66
Livestock husbandry	6 202.36	14.87
Other income sources (government supports and non-agricultural activities, etc.)	1 737.86	4.17
Total	41 720.27	100.00

$1 = 1,4294 Turkish Lira (average exchange rate for 2006)

Table 5
Production costs of organic and conventional cotton farms

	Organic farms	Std. error	Conventional farms	Std. error	t-test for Equality of means
Average Yield (kg ha^{-1}) (1)	3 650.60	217.57	4 119.80	173.05	0.102
COST ITEMS					
Seeds	60.44	7.28	72.13	4.12	0.141
Fertilizers	557.86	155.24	228.07	16.30	*0.010
Pesticides	-	-	76.89	10.47	
Biological Control	51.98	11.90	-	-	0.136
Fuel	737.72	59.84	463.48	44.51	0.749
Irrigation	90.95	22.56	108.44	13.89	0.542
Labor	1 048.90	68.03	1 326.09	63.80	*0.011
a) cultivation of the soil	47.36	-	89.69	-	
b) sowing	8.40	-	20.01	-	
c) maintenance	393.45	-	399.61	-	
d) harvest	585.14	-	782.29	-	
e) transportation to market	14.55	-	34.49	-	
Other Costs	27.21	23.76	125.93	13.93	**0.064
Interest on Variable Costs	225.32	-	210.09	-	
Total Variable Costs (2)	2 800.38	-	2 611.10	-	
Organic Certification	10.98	-	-	-	
Adminisrative Costs	84.01	-	78.33	-	
Land Rent	696.87	-	618.37	-	
Depreciation	189.17	-	174.13	-	
Total Fixed Costs (3)	981.03	-	870.83	-	
Total of All Costs 4=(2+3)	3 781.42	-	3 481.93	-	
Unit Cost ($ kg^{-1})**=4/1**	1.04	-	0.85	-	

*significant at the 5 percent level; **significant at the 10 percent level

Organic cotton unit costs and gross margins obtained per unit of land area show variation between producing countries. For example, while the unit cost of organic cotton in Turkey is \$1.04 kg^{-1}, this is 6.12 times more than in India, another important organic cotton producer, where the equivalent figure is \$0.17 kg^{-1} (Jackson, 2005). At the same time, no great difference is observed between these two countries in terms of the market prices of organic cotton (Table 7). Gross margins per hectare obtained in India are very high relative to other countries. Thus, while gross margins per hectare in India are \$1 721.44 (Jackson, 2005), this figure is \$299.74 in Turkey (Adanacioglu, 2009), \$296.64 in Mali (Lakhal et al., 2008), and \$296.34 in Greece (Tzouvelekas et al., 2001). This advantage for India has led to its position of as an important world producer. In Turkey, the yield obtained per hectare is high compared with other countries, but this advantage has not been reflected in costs and gross margin. Among the reasons for this could be the lack of technical and input support for farms producing organic cotton, poor farmers' organizations, limited organization of the market, and absence of relevant non-governmental organizations (NGOs). In some organic cotton, producing countries such as Mali, cotton production and marketing are organized by NGOs such as Helvetas, where technical support is provided to producers and the government provides inputs free.

Results of Technical Efficiency Analysis

In order to make a sound evaluation of organic and conventional cotton farmers, a technical efficiency analysis was carried out alongside the cost and gross margin analysis.

Technical efficiencies of farms producing organic and conventional cotton as both input-oriented (IO) and output-oriented (OO) are given in Table 8. Efficiency values are grouped into 10% frequency ranges, and the number of farms in each efficiency range is given. Looking at the frequency distribution of efficiency rates for input and output-oriented, it can be seen that the number of fully efficient (100%) farms is high, both in farms producing organic and conventional cotton. Minimum efficiency rates were 69.40% (CRS te o,i) for organic farms, and 63.53% (CRS teo,i) for conventional farms.

According to CRS and VRS analysis of input and output-oriented, average technical efficiency values came out higher for organic cotton farms. According to the results of CRS analysis of input and output-oriented, average efficiency in organic cotton farms was 91.87%, and in conventional farms 89.62%. According to VRS analysis of output and input-oriented, average efficiencies were 94.90% and 94.18% respectively for organic farms, and 92.62% and 93.27% respectively for conventional farms.

Despite lower profit margins and slightly higher production costs, average efficiency rates of organic cotton farms were only slightly higher than those of conventional farmers. A possible explanation may be that lower profit margins and the restrictions imposed on the types of inputs permitted may have forced organic producers to be more cautious regarding the use of their inputs (Tzouvelekas et al., 2002).

Elsewhere in the world, many studies have been carried out with the aim of determining the efficiency of farms engaged in the production of cotton, but most of these were concerned only with conventional cotton production. The results of some of these studies were found to be relevant in evaluating the efficiency of cotton production. According to the results of efficiency analysis of cotton farms carried out in the Viotia region of Greece, the rates of technical efficiency of organic farms was found to be 71.63%, and that for conventional farms was 80.40% (Tzouvelekas et al., 2001). In another study conducted in the Messinia, Achaea, Corfu and Heraklion regions of Greece, technical efficiency rates were determined as 74.62% for organic cotton farms and 71.57% for conventional farms (Tzouvelekas et al., 2002). In four districts in the American state of Texas, the technical efficiency rate for conventional irrigated farms was calculated as 80% according to CRS, and 70% for non-irrigated farms (Chakraborty et al., 2002). In various studies of conventional cotton farms in the Aegean region of Turkey, the technical efficiency rate according to CRS was found to be 67.70% in Menemen district (Gunden and Miran, 2001), and 83.90% in Soke district (Akturk and Kiral, 2002). These results show that organic cotton farms in Turkey work more efficiently than those in other countries, and that conventional cotton farms operate at close to the same efficiency rates.

Both CRS and VRS models showed that levels of costs and production values could be in a better state for cotton production on farms producing organic and conventional cotton, and in this way potential improvement values were found (Table 9). As can be seen from Table 9, suggestions for improvement of output and inputs are in the direction of a reduction in all variables apart from production values. In particular, expenses relating to fertilizer, fuel, seed and biological control or chemicals must be reduced largely than other inputs.

In general, conventional farms need improvements with regard to both inputs and outputs somewhat more than organic farms. For example, with regard to output-oriented CRS analysis, conventional farms need to raise cotton production values by 12.14% in order to achieve full efficiency, while the equivalent figure for organic

Table 6
Gross production value and gross margin of organic and conventional cotton farms

	Organic farms	Conventional farms
Yield (kg ha^{-1}) (1)	3 650.60	4 119.80
Price (\$ kg^{-1}) (2)	0.60	0.54
Gross Production Value (\$ ha^{-1}) (1 X 2) = 3	2 190.36	2 224.69
Variable Costs (\$ ha^{-1}) (4)	2 800.38	2 611.10
Gross Margin (\$ ha^{-1}) (5 = 3 – 4)	-610.02	-386.41
Government Subsidies* (6)	909.76	1 003.00
Sum of Gross Margin and Subsidy (\$ ha^{-1}) (5 +6)	299.74	616.59

*direct payments for organic agriculture : 20.99 \$ ha^{-1} ; premium payment for cotton : 0.24 \$ kg-^{1}

Table 7
Yield, price, unit cost and gross margin of organic cotton in various countries

	Year	Yield, kg ha^{-1}	Price, \$ kg^{-1}	Unit cost, \$ kg^{-1}	Gross margin, \$ ha^{-1}
Turkey*	2005/06	3650.60	0.60	1.04	299.74
Greece**	1995/96	2180.00	1.23	1.28	296.34
India***	2003/04	2750.00	0.58	0.17	1721.44
Mali****	2005/06	788.00	0.50	0.12	296.64

Source: * Adanacioglu, 2009; *** Jackson, 2005; **Tzouvelekas et al., 2001; **** Lakhal et al., 2008

Table 8
Frequently distribution of output-oriented and ınput-oriented technical efficiency for organic and conventional cotton farms

Range, %	Organic farms				Conventional farms			
	CRS		VRS		CRS		VRS	
	TEo	TEi	TEo	TEi	TEo	TEi	TEo	TEi
<20	0	0	0	0	0	0	0	0
21-30	0	0	0	0	0	0	0	0
31-40	0	0	0	0	0	0	0	0
41-50	0	0	0	0	0	0	0	0
51-60	0	0	0	0	0	0	0	0
61-70	1	1	0	1	2	2	2	2
71-80	1	1	2	1	6	6	3	1
81-90	3	3	2	2	1	1	2	4
91-100	3	3	0	0	5	5	2	2
Full Efficient	6	6	10	10	9	9	14	14
Mean	91.87	91.87	94.90	94.18	89.62	89.62	92.62	93.27
Minimum	69.40	69.40	77.56	69.73	63.53	63.53	66.36	68.59
Maximum	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Standard Deviation	9.66	9.66	8.33	9.84	12.87	12.87	11.43	10.70

CRS: Constant returns to scale, VRS: Variable returns to scale
TEo: Output oriented technical efficiency, TEi: Input oriented technical efficiency

farms is 8.68%. At the same time, in order to achieve full efficiency, organic farms need to reduce production area by 5%, seed costs by 18.79%, fertilizer costs by 19.95%, costs of biological control by 15.58%, fuel costs by 11.59%, labour costs by 6.43% and other costs by 13.98%. The equivalent necessary cost reductions for conventional cotton farms are land area 3.36%, seed 22.24%, fertilizer 9.82%, pesticides 13%, fuel 15.78%, labour 8.77%, and other costs 14.87%.

Looking at the distribution of farms in the output-oriented CRS analysis with regard to ways in which they could achieve full efficiency by improvements in production values, it can be seen that 9 (64.29%) organic cotton farms and 14 (60.87%) conventional cotton farms could potentially achieve full efficiency with a 10% improvement in production values (Figures 1 and 2). There are no farms in the high efficiency level ranges which are suggested for improvement among either the organic or the conventional farms.

Conclusions

The increasing world demand for organic cotton fibre has attracted the attention of many cotton-producing countries. Therefore, assessment of the economics and technical efficiency of organic cotton farming is of great importance in directing the policies of these countries in relation to organic cotton production. Results

Table 9
Total ımprovements ratios in farms producing organic and conventional cotton

Variables	Organic farms				Conventional farms			
	CRS (input-oriented) %	VRS (input-oriented) %	CRS (output-oriented) %	VRS (output-oriented) %	CRS (input-oriented) %	VRS (input-oriented) %	CRS (output-oriented) %	VRS (output-oriented) %
Production value of cotton $	0.00	0.00	8.68	7.77	0.00	0.00	12.14	12.67
Farm size (ha)	-8.60	-10.47	-5.00	-6.69	-8.72	-10.49	-3.36	-4.97
Seed cost $	-18.17	-13.87	-18.79	-12.34	-20.31	-15.26	-22.24	-15.60
Fertilizer cost $	-18.74	-16.28	-19.95	-17.16	-12.83	-13.30	-9.82	-9.76
Biological Control/ Pesticides cost $	-16.22	-13.44	-15.58	-13.50	-14.57	-17.80	-13.00	-16.72
Fuel cost $	-13.35	-17.44	-11.59	-14.03	-15.74	-18.50	-15.78	-20.07
Labour cost $	-9.81	-11.65	-6.43	-8.63	-12.32	-9.80	-8.77	-5.44
Other variable Costs $	-15.11	-16.85	-13.98	-19.89	-15.52	-14.85	-14.87	-14.76

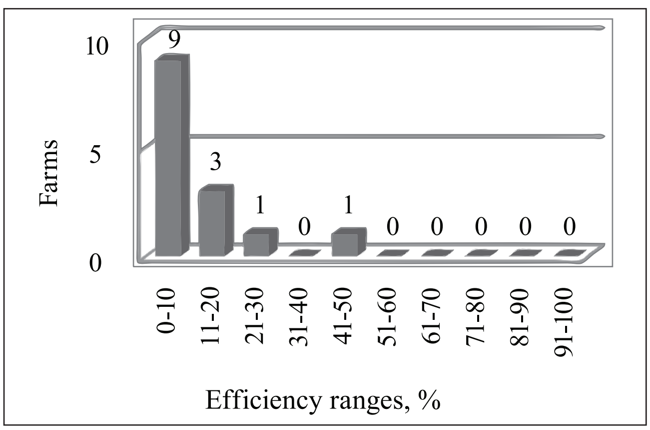

Fig. 1. Distribution of farms which are subject to potential ımprovement in organic cotton production value

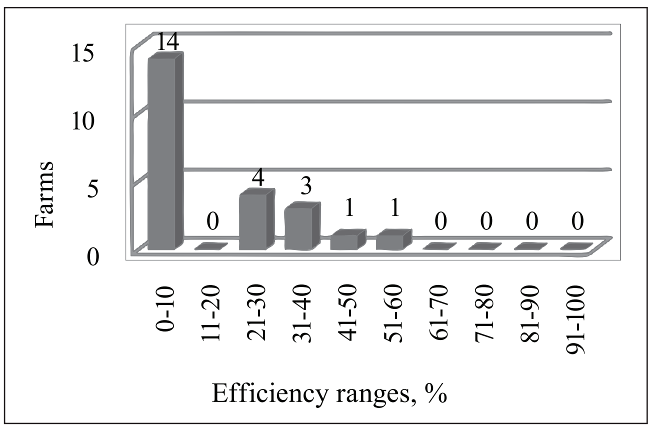

Fig. 2. Distribution of farms which are subject to potential ımprovement in conventional cotton production value

obtained in this study show that not every country is deriving benefit from organic cotton production, and it is clear that Turkey is one such country. In fact, analysis of costs and gross margins shows that the conventional cotton farms had a greater advantage.

Organic cotton farms in Turkey are at a disadvantage in terms of unit cost and gross margin compared to conventional farms. Thus, looking at the number of farms producing organic cotton in the 6 years between 2002 and 2007, a general decline can be seen. Taking the number of organic cotton producers in 2002 (380) as a base, the number in 2007 (71) shows a reduction of around 81% (MARA, 2008).

These negative developments in organic cotton farms have meant that Turkey, which was for a long time the leader in world organic cotton production, has ceded that position to India. The reduction in organic cotton producers is a problem of economics (Olgun et al., 2008). The two most important factors are that the production cost of \$1.04kg^{-1} is less than the selling price of \$0.60kg^{-1}, and that the premiums paid by contracting firms (11.11%, organic \$0.60kg^{-1}, conventional \$0.54kg^{-1}) are very low. Among the principal reasons for this are that there is no technical or input support for farms producing organic cotton either at the stage of changeover to organic management or at the production stage, that no producers' organizations have been established, that the market is not organized, that there are no NGOs, and that crops produced in rotation with cotton cannot be sold as organic. Largely organic cotton producers in many other countries in the world also encounter these problems faced by organic cotton farmers in Turkey. For example, among the biggest problems faced by organic cotton producers in the USA are that prices are low, farmers are not supported at the stage of changeover to organic production, and that farmers are unable to make long-term contracts (Pick, 2006).

For resolution of these issues, financial support for producers at the stage of changeover to organic cotton production, the provision of technical information support and long-term contracts for producers is all of great importance. It is felt that one solution could be for the government to introduce compulsory regulation.

The production of organic cotton must be viewed in a comprehensive or holistic way, as the management of a system that integrates various elements together, including social, environmental, economic, and technological aspects (Ferrigno and Lizarraga, 2009). In order for organic cotton production to be sustainable in the long term, the sources of risk must be properly identified and the methods used to manage these risks must be properly chosen.

Though the focus naturally may be on cotton as the main crop of interest, projects should also consider the relevance of crops grown in rotation with cotton for income and subsistence, and for the sustainability of the farming system (Eyhorn, 2005). In organic cotton rotation; determining proper products for the area, which are able to market, make an increase on farmers' income and conveying information to the farmers are quite important (Artukoglu et al., 2009). If crops produced in rotation with cotton could be marketed as organic products by the companies involved, producers' views of organic cotton production could change significantly.

It is thought that NGOs could have an important role in the solution of the problems encountered by organic cotton farmers (Adanacioglu, 2009). As stated above, in some countries such as Mali where organic cotton is produced, the production and sale of organic cotton is organized by NGOs such as Helvetas, technical support is provided to farmers, and the government provides inputs free. These NGOs play a very important part in the development of the organic cotton sector, and it is hoped that they will act as a catalyser. Thus, the establishment and extension of this kind of organization and, from the point of view of the organization of producers, the establishment and extension of this kind of organization are of great importance. In this way, conventional cotton farmers may start to move over to organic production.

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