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A Model for Pre-Estimation of Production of Organic Cotton in Iran; Case Study of Khorasan Province

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Abstract: Organic farming and organic production methods have got much importance in agriculture not only from environmental point of view but also from economic and social stand points; in this research keeping in mind this significance of organic farming an applied model is presented to estimate the cotton production in organic farms of Khorasan province, Iran. Production of organic cotton is obtained through surveys of 241 farms, partial elasticity of production of different inputs were derived from Cobb-Douglass production function. The results revealed that the cotton production decreased by 34.2% when the chemical factors were eliminated. The drop off yield in organic fields in large farms (more than 10 ha) is higher than small (less than 5 ha) and medium (5 to 10 ha) size farms due to uses more chemicals and fertilizers. The yield is 1.60 and 1.34 (t ha^{-1}) for insured and non-insured farms, respectively. Also, the maximum yield in customary system is for mild region (3.044 t ha^{-1}), while the minimum is in warm region (1.48 t ha^{-1}). Finally, planning for financial support (subsidy), extension, providing non-chemical inputs to compensate the related production loss and this approach for a better planning and evaluating the organic products are recommended.

Key words: Organic product, sustainable agriculture, organic cotton, farm size, economics, modeling

INTRODUCTION

Organic farming is one of several approaches to sustainable agriculture (Bateman, 1993; Koocheki *et al*., 1997; Dalgaard *et al*., 2001; Rigby and Cáceres, 2001; Koocheki, 2004; Hole *et al*., 2005; Lund, 2006; Widmer *et al*., 2007). The organic agriculture can effect environment and help in conservation of non-renewable resources as well as improving food quality (Dehghanian *et al*., 1996; Clark *et al*., 1999; Delate and Cambardella, 2002; El-Hage Scialabba and Hattam, 2002; Bengtsson *et al*., 2005). Many countries recognized the potential agricultural benefits and effort to expand the area under organic practices through direct financial supports to farmers or indirectly via research and expansion or providing market infrastructure for marketing of organic products (Clark *et al*., 1999; Entz *et al*., 1999; Brumfield *et al*., 2000). Nowadays, the organic production and will to transfer to organic practices is rapidly expanding among European farmers (Greene, 2000).

The main question which is faced by organic farmers and those who wish to shift to organic farming is that whether organic farming is profitable or not? Although some of organic farmers are motivated by economic objectives most of them are inspired by more than economic intentions, their aim is to optimize land, animal and plant interactions, preserve natural nutrient and energy flows and enhance biodiversity, all of which contribute to sustainable agriculture (Padel, 1994a; Dehghanian *et al*., 1996; Delate, 2002; Scialabba, 2003; Bengtsson *et al*., 2005; Fuller *et al*., 2005; Lampkin *et al*., 1987; Eyhorn *et al*., 2007; Gabriel and Tscharntke, 2007). The problem with economic appraisal of organic farming is that appraisal is done on the basis of individual benefits and not on the basis of social and environmental benefits (Hanson *et al*., 1997; Gunnarsson and Hansson, 2004). This resulted in lack of knowledge on the part of farmers who potentially wish to shift to organic practices. Unfortunately, while appraising organic farming methods environmental impacts as well as social and economic effects on rural life and community which makes organic farming a viable option is not taken in to account properly (Lohr, 1998; Stolze *et al*., 2000; Pimentel *et al*., 2005; Qadir *et al*., 2007; Niggli *et al*., 2007).

Another reason which makes the organic farming a viable option is expansion of international market for organic products (Murphy, 1992; Midmore, 1993; Padel, 1994a). Those countries which due to different reasons have no proper and well developed market for organic products and hence no demand for such type of products exists but possibility of production of this type of products are at hand enjoy comparative advantage in

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production of organic products. Therefore, in such type of countries organic farming can be branded as a source of exports and foreign exchange earning.

However, as many organic farms supplying the domestic market have to develop their own marketing channel and process the product, this may mean more local employment in rural areas, as well as potential for eco-tourism (El-Hage Scialabba and Hattam, 2002; Fuller *et al*., 2005; Gabriel and Tscharntke, 2007).

Moreover, most of the farmers recognized that with shifting to organic farming and use of less chemical inputs agriculture becomes more striking as it is going to be more synchronized with environment, nature and consumer's taste and preference which in the long run can resulted economic, social and cultural factors in rural society change for better which can bring about more job and life satisfaction (Bateman, 1993; Padel, 1994a, b; Niggli *et al*., 2007). Clark *et al*. (1999) compared the conventional system to the organic systems for tomato, safflower, maize and bean products in an agricultural systems project. They concluded that the yields of the organic products and were comparable even higher than conventional yields.

The studies related to change in yield through shifting from conventional agriculture to organic farming do not show stable results because these results change depending on product and location. Furthermore, while investments, research and development efforts are more focused on conventional agriculture rather than organic farming comparing these two systems from stand point of yield is not so sensible (Koocheki *et al*., 1997; Koocheki, 2004). However, many of studies revealed that yield experiences significant decrease during transition period (1-4 years) and then, it will increase to primary level or even more after transition period (Dobbs and Smolik, 1996; Entz *et al*., 1999; Brumfield *et al*., 2000; Delate *et al*., 2001; El-Hage Scialabba and Hattam, 2002; Gunnarsson and Hansson, 2004; Sartori *et al*., 2005). These studies showed that yield deceasing of organic products in transition period is about 16.7 to 50%.

Khorasan province is one of the most important cotton production centres of Iran. With increasing importance of organic production systems as due to high cost it is not possible to examine different aspects of organic farming via greenhouse research in this research an endeavour is made to develop a model to estimate yield reduction in real farm situation due to shift from conventional agriculture to organic farming practices. As the estimation of parameters of this model is done under the real farm situation, the results are more accurate than greenhouse experiments results then, we compare organic and conventional cotton in three climate regions, two group of insured and non-insured farms and three size of farms.

MATERIALS AND METHODS

In this research, a model has developed to estimate the organic cotton productions. In this research emphasise is more on methodology rather than results. Since organic agriculture is a production system in which there is no usage of chemicals, pesticides as well as other regulators (Koocheki, 2004). In order to estimate the organic production of cotton there is need to purge the chemical fertilizers, herbicides and pesticides effects from production function. For this propose at first a Cobb-Douglas production function (1) is estimated:

$$Y_{cp} = A\sum_{i=1}^{8} X_i^{\alpha_i} e^u \qquad (1)$$

Where, Y_{cp}, X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8, A, u, α_i are cotton production, labor (person-day), acreage (ha), seed (kg), Water (number of irrigation rotatio.n), chemical fertilizers (kg), pesticides (L), manure (t), machinery (h), coefficient of technology, random error term and parameters, respectively.

The factor elasticities (α_i) derived from estimation of production function. Value of factor elasticity revealed the amount of influence that specific factor has on production. Therefore, with purging the portion related to chemical factors from present production function (purifying the production) we can obtain cotton organic production of cotton. As on the basis of definition, the organic production will derived via washing out the chemical influences.

$$Y_{op} = Y_{cp} - (E_{fe} \times Y_{cp} - E_{pe} \times Y_{cp}) = Y_{cp}\left[1-\left(E_{fe} + E_{pe}\right)\right] \qquad (2)$$

Where, E_{fe}, E_{pe}, Y_{op} and Y_{cp} are the chemical fertilizers elasticity, pesticides elasticity, organic production and conventional production, respectively. In this way, the organic production can be calculated by using the developed model. And also, the percentage of production reduction (in organic situation) is computable via following formula:

$$\text{Production reduction percentage} = \frac{Y_{cp} - Y_{op}}{Y_{cp}} \times 100 \qquad (3)$$

Data were collected via a stratified random sampling. The cross-sectional data were gathered from 241 cotton farmers in Khorasan (North, South and Razavi) provinces on 2004-2005.

RESULTS AND DISCUSSION

Table 1 shows the results of Khorasan cotton production function. The variables X_1 (labor), X_5 (chemical fertilizers), X_6 (chemical pesticides and herbicides) and X_7 (manure) are statistically significant. The coefficient of determination (R^2) reveals that 35.6% of variation in cotton production can be explained by labor, chemicals and manure factors. The factor elasticity for labor, acreage, seed, water, chemical fertilizers, pesticides, machinery and manure are 0.0718, 0.079, 0.079, 0.125, 0.152, 0.235, 0.107, 0.052 and 0.038, respectively. The estimated elasticities show that chemical fertilizer has maximum and the manure has minimum elasticity. Also, the farmers use labor, chemical fertilizers, pesticides and manure factors in second stage of production function.

The results show that the yield of organic cotton and conventional one are 1.578 and 2.412 ton ha^{-1}, respectively (Table 2).

Comparing these two figures point toward a 34.2% decline in production of organic cotton. This result is comparable with findings of many researchers about yield deceasing of organic products in transition period is about 16.7 to 50% period (Dobbs and Smolik, 1996; Entz *et al*., 1999; Brumfield *et al*., 2000; Delate *et al*., 2001; El-Hage Scialabba and Hattam, 2002; Gunnarsson and Hansson, 2004; Sartori *et al*., 2005). However, we shall note that in most of the cases of shift from conventional agriculture to organic farming farmers have experienced a 1 to 4 years yield reduction phase which is known as transition phase during which soil will increase its biological activities from its initial low level and consequently yield starts to grow again.

In the next stage, production of organic and conventional cotton and percentage of decrease in production of organic cotton on the basis of acreage, climate and insurance were compared with each other.

Table 3 revealed that the maximum conventional cotton yield with 1.64 ton is for large scale (more than 10 ha). Also, the percentage reduction for the organic cotton yield in small (less than 5 ha), medium (5-10 ha) and large (more than 10 ha) scale is 34.20, 34.17 and 34.27, respectively. The maximum value is in large scale due to uses more chemicals and fertilizers.

According to Table 4, the maximum yield in customary system is for mild region (3.044 t ha^{-1}), while the minimum is warm region (1.48 t ha^{-1}).

The results revealed that the yield will be 1.60 and 1.34 t ha^{-1} for insured and non-insured farms, respectively. The percentage of the reduction is about 16% in each group. As a result, the mean cotton yield in organic customary cases is higher than non-insured cases (Table 5).

Table 1: Results of Khorasan cotton production function regression

Variable		Unit	Parameter	t-value
A	Constant	-	-1.7120	5.71*
X_1	Labour	Man-day	0.0718	3.51*
X_2	Acreage	ha	0.0790	1.40
X_3	Seed	kg	0.0790	1.24
X_4	Water	No. of rotation period	0.1520	1.56
X_5	Chemical fertilizer	kg	0.2350	4.88*
X_6	Chemical Pesticide	L	0.1070	2.73*
X_7	Manure	t	0.0520	1.86***
X_8	Machinery	h	0.0380	1.27
R^2			0.3560	
$\bar{R}^2$			0.3330	
F			16.0010*	

*: Significant in %1 level, ***: Significant in %10 level

Table 2: Decreasing cotton production in organic case

System	Mean yield (t ha^{-1})
Organic	1.587
Conventional	2.412
Percentage of decrease	34.200

Table 3: The organic and conventional cotton yield in acreage levels

System	Acreage (ha)	Mean yield (t ha^{-1})
Organic	Less than 5	1.588
	5 to 10	1.550
	More than 10	1.637
Conventional	Less than 5	2.410
	5 to 10	2.358
	More than 10	2.490
Decrease percentage	Less than 5	34.200
	5 to 10	34.170
	More than 10	34.270

Table 4: The organic and conventional cotton yield in climatic regions

Climatic region	System	Mean yield (t ha^{-1})
Cold	Organic	1.73
	Conventional	2.63
	Decrease percentage	34.18
Mild	Organic	2.00
	Conventional	3.04
	Decrease percentage	34.23
Warm	Organic	1.48
	Conventional	2.25
	Decrease percentage	34.22

Table 5: The organic and conventional cotton yield in insurance state farms

Insurance state	System	Mean yield (t ha^{-1})
insured	Organic	1.60
	Conventional	2.43
	Decrease percentage	34.20
Non-insured	Organic	1.34
	Conventional	2.04
	Decrease percentage	34.31

In next stage, the manure elasticity is increased as a scenario to determine how increase the cotton production with respect to increase the manure share in production. Table 6 revealed the simulation results due to increasing the manure share in cotton production to substitute by chemical fertilizers. On this basis, the manure significant affects on cotton production, but the average production won't be considerable by increasing in manure elasticity. As a result, the organic and customary productions are the same whereas the manure elasticity increases by 0.53.

Table 6: Simulation an increase share of manure in cotton production

Elasticity	Production (t ha^{-1})
0.052 (base)	1.587
0.07	1.616
0.09	1.648
0.11	1.680
0.13	1.713
0.15	1.747
0.17	1.781
0.19	1.816
0.53	2.420

The next point is that the Iranian cotton production is about 85000 ton. While there is 110000-115000 ton cotton demand from textile industry. Thus, country faced with 30000-35000 ton cotton deficit. By shifting to organic system of production, the total cotton production will be 55930000 ton which shows a decrease of 34.2% from initial level of production that means an annual shortage of 54000-59000. Regarding to a 40000 ton cotton inventory, we need to import 15000-20000 ton cotton for covering the factories' necessity.

With respect to results, supporting the farmers in primary stage for organic agriculture (transition phase); through credit facilities and extension services, etc will encourage farmers to shift to organic products and decrease imports. Therefore, we suggest planning for financial support for example subsidy payment for organic cotton in transition period, extension and providing non-chemical factors to compensate the related production loss. And also, suggest this approach use for a better planning and evaluating the organic products.

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