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The effect of land size on total input energy of strawberry production in Iran

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ABSTRACT

In this study the effect of land size on energy use of strawberry production in Iran was investigated. The data were collected from 110 farmers in 13 villages growing strawberry in Kurdistan province of Iran. The land size was categorized into 4 groups. Total input energy for the first group, second group, third group, and last group was 60556.6 MJ ha^{-1}, 49313.5 MJ ha^{-1}, 49823.7 MJ ha^{-1}, and 37234.1 MJ ha^{-1}, respectively. The difference between mean values of first group and last group was significant at the 5% significance level. The difference between mean values of other groups was not significant at the 5% significance level.

Introduction

Strawberry is an herbaceous perennial plant having a compressed, shortened stem and produces stolons. The fruit is an achene attached to a juicy, enlarged receptacle. It is one of the most popular fruits in the world and per capita consumption is increasing annually. Strawberry is the most popular yogurt flavor in many countries. Fruits are eaten raw or used in making juice, desserts, jam, syrup and wine (Biswas *et al.*, 2007).

Strawberry is an important small fruit, grown throughout the world. It is deep red in color with unique shape and flavor. The major strawberry producing countries of the world are USA, Spain, Japan, Poland, Korea and Russian Federation. The estimated production of strawberries in the world during 2007 was 5822 thousand tons (Sharma *et al.*, 2009).

The energy concept is perceived differently among scientists, engineers, economists, environmentalists, natural securities analysts, farmers and consumers. Various segments within agriculture view the energy situation differently, depending on whether they are net consumers or net producers of energy (Karkacier and Goktolga, 2005).

Energy use is one of the key indicators for developing more sustainable agricultural practices. Wider use of renewable energy sources, increase in energy supply and efficiency of use can make a valuable contribution to meet sustainable energy development targets (Streimikiene *et al.*, 2007).

Calculating energy inputs of agricultural production is more difficult than in the industry sector due to the high number of factors affecting the production (Salami *et al.*, 2010a).

Relationship between farm size and productivity in developing countries is one of the oldest issues in the academic arena for analyzing the agrarian structure (Thapa, 2007). The most frequently cited phenomenon is an inverse relation between farm size and yield per acre (Feder, 1985).

Sen explained the inverse relationship with labor dualism, where given the same technology, small-scale farmers have lower opportunity costs of their labor than operators of large farms (Sen, 1962). Deininger and Feder applied agency theory analysis on this subject. When a farm is small and labor markets are not functioning, small-scale farms use only family labor (Deininger and Feder, 2001). Hence, in the terminology of principal-agent theory, the principal and his family members supply all of the labor for the farm.

These family members have a strong incentive to work because they share the farm output directly and in the long run can expect to inherit the farm.

Here monitoring and incentive problems are minimal and excess family labor would push the value of the marginal product below the off-farm wage thus may result the inverse relationship (Taylor and Adelman, 2003).

Bhalla and Roy and Benjamin suggested that unobserved land quality is positively related to farm productivity but inversely related to farm size, which might explain the inverse relationship between farm size and productivity as well (Bhalla and Roy, 1988; Benjamin et al., 2002).

Heltberg claimed that Bhalla and Roy's conclusions are undermined by their use of district aggregate data (Heltberg, 1998). However, using farm level data obtained in Haryana, India, Carter found a significant within-village inverse relationship between farm size and productivity (Carter, 1984).

The majority of studies of agricultural productivity in developing countries support the view that there is an inverse relationship between productivity and farm size (Berry and Cline, 1979; Barrett, 1996). If correct, land reform could contribute to improving both equity and efficiency in agriculture. Most of these studies, however, are based on partial measures of productivity such as yield which are biased in favor of small producers.

The aim of this study is to determine the effect of land size on energy use of strawberry production in Iran.

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Materials and Methods

In this study, the data were collected from 110 farmers in 13 villages growing strawberry in Kurdistan province, Iran by using a face-to-face questionnaire in August-September 2009. The province is located in the west of Iran, within 34° 44´–36° 30´ north latitude and 45° 31´–48° 16´ east longitude. The total area of the Kurdistan province is 2,820,300 ha. The average rainfall of the province is 450 millimeters (Salami *et al.*, 2009).

The total land area cultivated for strawberry crop was 3800 ha in Iran and this amount was 2500 ha in Kurdistan province in 2007. In this year, the total production of strawberry was 38500 tones, while this amount was 30951 tones in Kurdistan province, thus about 80% of total strawberry production in Iran was obtained from Kurdistan province [18, 19].

By using the simple random sampling method (Eq. 1) the sample size was determined (Salami *et al.*, 2009).

$$n = \frac{N * s^2 * t^2}{(N-1)d^2 + s^2 * t^2} \qquad (1)$$

In which n is the required sample size, s is the standard deviation, t is the t value at 95% confidence limit (1.96), N is the number of holding in target population and d is the acceptable error (permissible error 2.8%).

The energy equivalent of inputs and output (Table 1) were used to estimate the energy values.

The land size was categorized into 4 groups. The first group (G_1) was the lands that were lower than 0.2 ha. The second group (G_2) was the lands that were 0.2 ha. The third group (G_3) was the lands that were between 0.2 and 0.5 ha, and the last group (G_4) was the lands that were higher than 0.5 ha.

The differences among the total input energy for production of this crop were investigated by univariate analysis of variance at the 5% significance level. Differences between mean values for the various treatments were tested by LSD method ($P < 0.05$).

Results and Discussion

The energy used for the strawberry production in this study was 49617.2 MJ ha^{-1}. Nitrogen fertilizer consumed 30.8% of total input energy followed by irrigation energy (28.3%) during production period. Total energy output was 17236 MJ ha^{-1}, and the average annual yield of strawberry farms was 9071.6 kg ha^{-1}. It is shown (Table 2) the machinery was the least demanding input energy for strawberry production with 290.7 MJ ha^{-1} (only 0.6% of the total energy input), followed by ecesis with 1455.8 MJ ha^{-1} (2.9%).

Total input energy for G_1, G_2, G_3, and G_4 categories was 60556.6 MJ ha^{-1}, 49313.5 MJ ha^{-1}, 49823.7 MJ ha^{-1}, and 37234.1 MJ ha^{-1}, respectively. The total input energy for each category is shown (Figure 1). According to the results (table 3), the difference between mean values of G_1 and G_4 was significant at the 5% significance level. The difference between mean values of other groups was not significant at the 5% significance level.

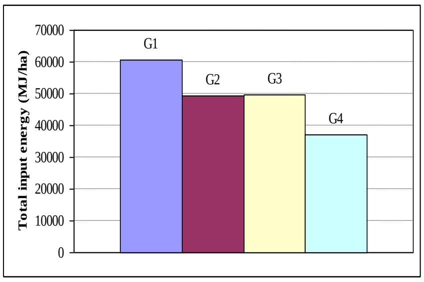

Figure 1: Total input energy for different categories

Energy used for human labor was 3298.1 MJ ha^{-1} and 1419.7 MJ ha^{-1} for G_1 and G_4, respectively. Energy used for nitrogen fertilizer was 27261.7 MJ ha^{-1} and 10083.2 MJ ha^{-1} for G_1 and G_4, respectively. Energy used for phosphate fertilizer was 2623.7 MJ ha^{-1} and 1319.8 MJ ha^{-1} for G_1 and G_4, respectively, and finally the energy used for manure was 17699.5 MJ ha^{-1} and 6980.6 MJ ha^{-1} for G_1 and G_4, respectively. These were the proofs for the difference between mean values of G_1 and G_4 categories. As it's obvious the amount of energy used for human labor, nitrogen fertilizer, phosphate fertilizer, and manure for the G_1 category is higher than G_4 category. Because of limited presentation of human labor and higher demand for this input in G_4 category, the presentation of human labor for G_1 is easier than G_4, because the amount of human labor required for the operations for G_1 is lower that G_4. Also the labors wages are high and this is the second limitation for the presentation of human labor.

The amount of nitrogen fertilizer, phosphate fertilizer, and manure used for crop production in G_1 category was significantly higher than G_4. Preparation and application of these inputs are difficult. One of the most important reasons is that application of these inputs is performed by human labor without using any machinery, so it's so difficult to spread these inputs in a wide range with limited human labor. Thus utilization of these inputs in the agricultural operations for strawberry production in Iran decreases by enlarging the land size.

Conclusions

The purpose of this study is to determine the effect of land size on energy use of strawberry production in Iran. The data were collected from 110 farmers in 13 villages growing strawberry in Kurdistan province of Iran by using a face-to-face questionnaire in August-September 2009. The land size was categorized into 4 groups (G_1, G_2, G_3, and G_4). Total input energy for the strawberry production in this study was 49617.2 MJ ha^{-1}. The energy used for G_1, G_2, G_3, and G_4 categories was 60556.6 MJ ha^{-1}, 49313.5 MJ ha^{-1}, 49823.7 MJ ha^{-1}, and 37234.1 MJ ha^{-1}, respectively. The difference between mean values of G_1 and G_4 was significant at the 5% significance level. The difference between mean values of other groups was not significant at the 5% significance level.

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Table 1: Energy equivalent of inputs and output in strawberry production

Particulars	**Unit**	**Energy equivalent (MJ.unit^{-1})**	**Ref.**
A. Inputs			
1. Human labor	h	1.96	(Singh and Mittal, 1992; Erdal et al., 2007)
2. Machinery	kg		
Tractor	kg	138	(Kitani, 1999)
Plow	kg	180	(Kitani, 1999)
Disk Harrow	kg	149	(Kitani, 1999)
3. Diesel fuel	L	56.31	(Singh and Mittal, 1992; Erdal et al., 2007)
4.Fertilizers			
(N)	kg	78.1	(Kitani, 1999)
(P)	kg	3.5	(Salami *et al.*, 2010b)
5. Manure	kg	0.3	(Erdal et al., 2007)
6. Ecesis	kg	0.8	(Erdal et al., 2007)

Table 2: Amounts of inputs in strawberry production in Iran

Inputs	**Quantity per unit area (ha)**	**Total energy equivalent (MJ.ha^{-1})**	**%**
A. Inputs			
1. Human labor (h)	1128.5	2211.8	4.5
2. Machinery (h)	4.7	290.7	0.6
3. Diesel fuel (L)	37.4	2106	4.2
4. Chemical fertilizers (kg)			
Nitrogen (N)	425	15268.6	30.8
Phosphate (P)	518.3	1814.1	3.7
5. Manure (kg)	41353.8	12406.1	25
6. Ecesis (kg)	1819.7	1455.8	2.9
7. Irrigation (m^3)	31250	14064.1	28.3
Total energy input (MJ)	-	49617.2	100

Table 3: Differences between mean values for the various treatments by LSD method

Multiple Comparisons					
Dependent Variable:Total input energy					
	(I) Land type	(J) Land type	Mean Difference (I-J)	Std. Error	Sig.
LSD	x<0.2	x=0.2	11243.0900	8794.00753	0.205
		0.2<x<0.5	10732.8782	8591.81941	0.215
		x>0.5	23322.4322*	9034.98386	0.012
	x=0.2	x<0.2	-11243.0900	8794.00753	0.205
		0.2<x<0.5	-510.2118	8591.81941	0.953
		x>0.5	12079.3422	9034.98386	0.185
	0.2<x<0.5	x<0.2	-10732.8782	8591.81941	0.215
		x=0.2	510.2118	8591.81941	0.953
		x>0.5	12589.5540	8838.31012	0.158
	x>0.5	x<0.2	-23322.4322*	9034.98386	0.012
		x=0.2	-12079.3422	9034.98386	0.185
		0.2<x<0.5	-12589.5540	8838.31012	0.158

*. The mean difference is significant at the 0.05 level.