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Research Article

EXAMINATION OF RELATIONSHIP BETWEEN ENERGY OF CONSUMPTION INPUTS AND PERFORMANCE OF TOMATO CROPS IN CULTIVATION UNDER PLASTIC IN DEZFUL CITY

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ABSTRACT
With regard to ascending population growth, rise of demand for agricultural products, providing modern form of energy, and their inconvenient use due to the lack of effective management, this economic part of agriculture has turned in to an energy-based part, and the pattern of energy consumption in this part(includingBioticor Abioticresources) have increased intensively. Now if energy consumption is to continue in this part, the only chance of producers for increasing the total product is using more inputs instead of expanding arable lands. This issue is accompanied with a wide range of environmental threats/risks. Thus in the present study, in order of estimating relationship between energy of consumption inputs and performance of tomato crops, Cobb -Douglas production function has been utilized. Required data have been collected through questionnaire from 105 farmers in Dezful, and using Random Sampling Method. Results of research show that from all types of energies involved in production, indirect energy has a much more contribution in production than direct energy; and non-renewable energy has much more contribution than renewable energy, too. Also results show that other variables such as manpower, machinery and seed have a significant positive effect in production, and variables such as chemical fertilizers, pesticides, irrigation water have a significant negative effect in production. Concerning machinery input has the most effect in performance of production, therefore, it is recommended to improve the level of availability to bank credit and cheap loans for farmers, in order to help them provide agricultural machinery.

Keywords: *Renewable Energy, Non-renewable Energy, Direct Energy, Indirect Energy*

INTRODUCTION
Progress and development of leading societies has been provided using energy in a wide range for reinforcement of modern production systems, since existence of energy sources is considered the cornerstone of development in all fields of production, which has a remarkable role in improvement of economy in societies. Accordingly, producers and consumers of energy must think deeply over the role that energy takes on for achieving to a sustainable development. Amount of consumption and waste of energy in Iran has been by far more than what is now in industrialized countries. Status of energy consumption in Iran is contrary to promotion and yield of energy in world (Bshrabady and Esmaeli, 2012). Such that according to energy balance, energy consumption in 2013 was equal to 2592.63 barrels of crude oil, 45.8 of it were used in agricultural district (Jodzadeh *et al.*, 2013). Agricultural district like other economic districts requires direct and indirect energy or renewable and non-renewable energy for development (Bshrabady and Esmaeli, 2012) sustainable usage o these energies results in efficiency and increase of production (Garavand *et al.*, 2010). In other words, sustainability of energy means gradual substitution of renewable resources instead of non-renewable resources (Alluvione *et al.*, 2011). During last decades, due to increasing growth of population, rise of supply for agricultural products, creating new forms of energy in agricultural district, and inconvenient usage of them owing to lack of proper management caused this economic district to turn in to an energy-oriented district. Energy consumption pattern for either alive or non-alive resources has enlarged extensively. Now if energy consumption in agricultural district is to continue, the only chance for producers to increase the total product is using more inputs instead expanding arable lands. This issue is accompanied with a wide range of environmental threats such as destruction of natural resources including soil, threat of increase of toxic

gases in atmosphere, elimination of variety of microorganisms in soil, and disruption of food chains in agricultural ecosystems (Jadidi *et al.,* 2010). Importance of examining determination of energy consumption pattern led to widespread study and investigation of this issue in global level. Septa *et al.,* (2013) in a research about examining energy amount of consumable inputs in production of tomatoes showed that diesel fuel energy, irrigation water, chemical fertilizers, and machinery have a significant and positive effect on product's performance. Also, energy used for production in farming conditions has a more efficacy and efficiency than greenhouse conditions. Kick *et al.,* conducted a research with the purpose of determining consumption of energy inputs in production of irrigated and non-irrigated wheat in Turkey. Results show that ratio of input and output energy for these products equals 30.80 and 2.51, respectively. Of total used energy, 77% is related to non-renewable energy, and only 23% is related to renewable energy (Septa *et al.,* 2013). Ghahderijani *et al.,* (2013) conducted a research in order of examining balance of input and output energy in production of wheat in Esfahan. According to results, whole of input and output energy in inputs equals to 31.5 and 44.6 Mega Jules (MJ), respectively. Also, results of regression analysis showed that energy of irrigation water, seed, chemical fertilizers and machinery have positive and significant effect on performance of product (Ghahderijani *et al.,* 2013). Gholami and Sharifi calculated energy of consumption inputs for production of major agricultural products in Iran, from 1980 to 2005. Results showed that the whole of input energy has increased from 55.64 Mega Jules (MJ) in hectare in 1980 to 150.71 MJ in hectare in 2005. In this research it became clear energy efficiency has been reduced from 5.85% in 1980 to 3.55% in 2005, which shows that input energy has a more quick increase than output energy (Gholami and Sharafi, 2009). Dezful, in Khuzestan province in which tomatoes production was ranked fourth in Iran, through production of more than 30 tons in hectare in 1392, includes about 75-80% of total production in Khuzestan. As well due to development of cultivation under plastic in the city, this kind of crop has been selected as a sample product through this cultivation method. The purpose of current research is calculation of energy of consumed energy in agricultural district, and examining how energy consumption is considered among renewable and non-renewable energies.

MATERIALS AND METHODS

In this research, energy of consumption inputs in a classification has been divided in to direct and indirect energies, and in another classification it has been divided in to renewable and non-renewable energies. Direct energy means amount of energy of inputs that leads to energy production during process of planting, storage and harvesting of crop, which includes variables of manpower and irrigation water in this study. Whereas, variables such as seed, machinery, fertilizers (Nitrate, phosphate, and potassium) and chemical poisons which cannot lead to direct energy production, have been included among indirect energies. But some of these variables such as seed, water and manpower, which are renewable while farming, are known as renewable energies, and some of these inputs which are not renewable are known as non-renewable energy, i.e. variables such as chemical fertilizers and machinery (Ramezani and Zibae, 2011). In this research, for calculating amount of consumed energy during various operations or calculating existing energy content in inputs, different formulas and equivalents have been used which are referred as follows:

Energy of Machinery

$$EID = TW \times CED / UL \times h \times RU \qquad (1)$$

In order of calculating energy share of machinery in every field operation, it is assumed that amount of used energy for producing considered tool will be paid off during its useful lifetime, and also is calculated according to following equation:

In abovementioned equation, EID stands for indirect energy of machinery for performing every field operation based on Mega Jules in hectare (MJ/Ha). TW indicates weight of machinery in terms of Kilogram, CED indicates production machine's production energy of machine in terms of Mega Jules in Kilogram (MJ/Kg), UL indicates useful lifetime of machinery in terms of hours (ha), h indicates working

hour of machinery during each field operation in terms of hours in hectare (h/ha) and RU indicates weight of machinery in terms of kilogram (Kg) (Khambalkar *et al.,* 2010).

Energy of Manpower

In this step, assuming that in under study field, each person works 5 hours a day, energy of workers is estimated in terms of Mega Jules in hectare based on the following equation:

$$LABEN = LABOUR \times LABENF \qquad (2)$$

In this equation, LABEN indicates energy of worker in terms of Mega Jules in hectare, LABOUR indicates number of workers, LABENF indicates energy of per worker (MJ/n) (Karale *et al.,* 2008).

Energy of Chemical Fertilizer

$$EID = RATE \times MATENF \qquad (3)$$

Since chemical fertilizers are among the most important inputs of agriculture, and also have a remarkable effect on product performance, so in order of calculating energy of these fertilizers (Nitrogen, Phosphorous, Potassium) the following equation will be used:

where EID indicates energy of fertilizer in terms of Mega Jules in hectare (MJ/ha), RATE indicates weight of chemical fertilizer in hectare (kg/ha), MATENF indicates energy of per kilogram fertilizer in terms of Mega Jules in hectare (MJ/kg) (Gevao *et al.,* 2007).

Energy of Poison

According to study of Ann (2011), energy of chemical fertilizers is identified from following equation:

$$CE = EF \times AR \qquad (4),$$

where CE indicates energy of used poison in terms of Mega Jules in hectare (MJ/ha), EF indicates amount of poison consumption in farm in terms of liter in hectare (L/ha), and AR indicates existing energy in per unit of poison (Ann, 2011).

Energy of Seed

Another important input includes consumed seeds in production of tomatoes. According to this, energy of this input can be written as follows:

$$DF = S \times N \qquad (5)$$

In this equation, DF indicates energy of consumed seed in terms of Mega Jules in hectare (MJ/ha), S indicates amount of consumed energy in hectare (L/ha), and N indicates energy of consumed poison (MJ/L) (Gevao *et al.,* 2007).

Energy of Water

To determine required energy for increasing and compressing required water in per hectare following equation will be used:

$$DF = ygHQ \Big/ \varepsilon_p \varepsilon_p \qquad (6)$$

where DE indicates direct energy in terms of Jules in hectare (J/ha), y indicates density of water (1000 kg/m^3), g indicates acceleration/speed of gravity (m/s^2), Q indicates the total amount of required water for a product in a growing season in terms of cubic meters in hectare (m^3/ha), H indicates dynamic head of well, and Ɛp indicates total efficiency of energy and power conversion (usually for electric pumps it ranges from 0.18 to 0.2) (Jadidi *et al.,* 2010).

In current study, in order of to examine relationship between energy of input and performance of production, Cobb-Douglas function has been used. The reason of using this function is simplicity of estimation of possibility of substitution between factors in the process of production. In mentioned function, manpower (X1), machinery (X2), phosphate (X3), Nitrate (X4), potassium (X5), poison (X6), seed (X7), and irrigation water (X7) are included in the following equation:

$$\ln Y_i = \beta_1 \ln X_{i1} + \beta_2 \ln X_{i2} + \ldots\ldots\ldots + \beta_j \ln X_{ij} + \varepsilon_i \qquad (7)$$

In this equation, all energies of inputs were determined as direct energy (DE), indirect energy (IDE), renewable energy (RE), and non-renewable energy (NRE). So, to acquire such coefficients in the process of production, we can define abovementioned equation as equation (3)

and (4):

$$\ln Y_i = \beta_1 \ln DE + \beta_2 \ln IDE + \varepsilon_i \qquad (8)$$

$$\ln Y_i = \gamma_1 \ln RE + \gamma_2 \ln NRE + \varepsilon_i \qquad (9)$$

In these equations, β_1 and β_2 are coefficients of direct and indirect energies, γ_1 and γ_2 are coefficients of renewable and non-renewable energies (Pimentel, 2009).

In this study, to estimate relationship between energy of inputs and performance of tomatoes products in Dezful, 105 questionnaires were examined using random sampling, and Cochran formula was used as follows:

$$n = \frac{z^2 pq / d^2}{1 + \frac{1}{N}\left| z^2 pq / d^2 - 1 \right|} \qquad (10)$$

In this equation, n indicates number of required sample (105), N indicates number of population (146), Z indicates amount of normal standard for standard unit (1.96), p indicates proportion of existing features in society (population) (0.5), q indicates percentage of people lacking features in society (0.5), and d indicates amount of allowed error in society (0.05).

RESULTS AND DISCUSSION

Content of energy relating to inputs in production of tomato was calculated in the study period, and with regard to mentioned explanations, results are reported in table 1.

Table 1: Energy of require inputs for Tomatoes production

Inputs	Equal Energy (MJ/ha)
Energy of Manpower	11.046
Energy of Machinery	1265
Energy of Phosphate	2664
Energy of Nitrate	1467
Energy of Potassium	2440
Energy of Poison	3108
Energy of Seed	243.36
Energy of Irrigation Water	2534.31

Reference: Calculation of Researches

According to obtained information, total of consumed energy in production of this crop equals to 137.2.716 Mega Jules, and the highest amount of energy belongs to inputs of fertilizers, chemical poisons, irrigation water, and seed, respectively. It seems that repeatedly usage of these inputs has led to this issue, and the least amount of belongs to inputs of machinery and manpower. In table 2, distribution amount of energy for inputs has been reported compared with total of consumed energy.

Table 2: Percentage of direct energy, indirect, renewable energy and Non-Renewable

	Size of Farm	
	One Hectare or less	**More than one Hectare**
Direct Energy	17	21
Indirect Energy	22	40
Renewable Energy	10	22
Non-Renewable Energy	20	48

Reference: Calculation of Researches

As it is seen in table, from total of consumed energy, the most contribution is dedicated to indirect and non-renewable energies, and the least contribution is dedicated to direct and renewable energies. This issue clarifies instability of agricultural system in regarded area. Dagistan *et al.*, (2009) found these results in their study. In the following, results of Cobb-Douglas estimation have been illustrated in table 3 for appraising the effect of consumed energies on performance of tomato product. According to this table, amount of R^2 indicates that 61% of changes in the crop performance have been described by independent variables.

Table 3: Appraising effect of consumed Energies on Performance

Independent Inputs	Coefficients	t - statistics
Fixed element	15176	2.06**
Energy of Manpower	0.37	3.12**
Energy of Machinery	2.07	2.08**
Energy of Phosphate	-0.18	-1.64

Reference: Calculation of Researches

With regard to positive and significant relationship between manpower and crop performance, production capacity of this input declares that 1% of rise in mentioned variable (due to reduction of spent time for various steps of production) results in 0.37% of increase in crop performance. However, 1% of increase I machinery input due to decrease of costs results in 2.07% of increase in production amount compared with current situation. Therefore, it can be said that effect of machinery input on crop performance is more than manpower. Some research conducted by Musavi *et al.*, (2010) and Ibrahim (2011) declared such results, but energy of input in fertilizer, and chemical poisons has negative and significant effect on crop performance. In other words, with increase of potassium fertilizer, in addition to increase of costs, and elimination of arable land and soil, crop performance reduces to 1.98%. In other words, these inputs in studied area have been used more than what is required. Pimantel (2009) in his research has found this negative effect. The negative and significant effect of seed input showed that using increase of seed's density, in addition to decrease of competitiveness, crop performance reduces to 52%. Results of Ramedani *et al.*, (2011) showed this negative effect. Another variable which has negative effect on crop performance is input of irrigation water. In other words, with increase of this input due to extreme use, and decrease of oxygen in soil, crop performance reduces to 19.4% (Jadidi *et al.*, 2010). Rahbari *et al.*, (2013) achieved to the same results, too.

Conclusion

This study was done in order of calculating consumed energy of inputs, and also calculating its effect on tomatoes performance in Dezful. Results showed that total consumed energy for production in one hectare is 13732.716 Mega Jules, which equals to 12058.3 Giga Watt hour of used energy in power generation. Results of research showed that the most amount of consumed energy dedicates to inputs of fertilizers, chemical poisons, irrigation water, and seed, respectively; and the least amount dedicates to inputs of machinery and manpower. With regard to results acquired from production of this crop, contribution of indirect energy is more than direct energy, and contribution of non-renewable energy is more than renewable energy. In other words, extreme consumption of non-renewable and indirect resources in common agricultural systems, plus their physical, chemical and biologic effects on soil is along with long term side effects on ecosystem, which results in instability of these agricultural systems. In this concern, in order to minimize consumed energy during bed preparation operation, there is a persistent need to a proper management, including depth of plow, decrease of seed density, setting a convenient time schedule for irrigation, and optimum usage of fertilizer and chemical poisons. Also, according to results of estimated model, energies of manpower and machinery have a significant and positive effect on crop performance, while energies of potassium fertilizer, seed and irrigation water have a significant and negative effect on crop performance, since input of machinery has the most effect in increase of crop performance, thus it is recommended that to improve availability of bank credits and

cheap loans for farmers and beneficiaries in order of preparing agricultural machines. Also, results showed that inputs of chemical poisons and fertilizers have the most effect in reduction of crop performance. Accordingly, it is recommended to dedicate a convenient level of fertilizer input (Nitrogen in particular) to cultivation of tomatoes, and also to provide a good awareness for farmers about proper application of agricultural inputs by holding educational courses, in order to prevent decrease of soil fertility, and prevent erosion and destruction of physical, chemical texture of soil.

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