Estimation of energy consumption indicators in pistachio production of Khatam city-Yazd state

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ABSTRACT

Energy plays Important and central role in development and progress of nations. Whereas the agricultural sector was faced with the restrictions of resources - energy management is only way to more exploitation from energy resources. In this study the amount of energy consumed in the production of pistachio orchards and the effect surface that under cultivation on the efficiency of energy consumption in these units was estimated. Required information of this study in the form of a questionnaire and interviews with 49 growers of pistachio in Khatam city was collected randomly. Required information about the cultivation of pistachio orchards was divided. After determining the various energy indicators (energy ratio (ER) - added net energy (NEG) - energy intensity (EI) and energy percentage (EP) - the impact cultivation operating on three levels (first group includes gardens, 5/0 to 5/1 acre - second group gardens, 5/1 to 5/5 acres of gardens and the third group with a greater level of 5/5 acres) in a randomized complete block design on energy efficiency (energy ratio) was evaluated. the comparing of average also in the probability surface of 5 percent was in Danken test. By attention to the results - the energy ratio - energy percentage and net energy were calculated respectively with 72 / 0-03 / 0 and GJ / ha 89/86. The calculations show between inputs consumption in product of pistachio–the electricity used in irrigation systems has the maximum amount of energy and then chemical fertilizers are used in the second. Analysis of variance showed the effect of cultivation of energy efficiency was meaningless in 5% level, but gardens in first group are devoted to more energy that commonly caused by mismanagement of farming inputs and management of this group.

Key words:

Introduction

Energy plays Important and central role in development and progress of nations that can be said that in the absence of this, formation of modern civilization as it seem was impossible. In any society from traditional to industrial not only the price of energy- also the accessible to the energy is creating to crisis and energy management is the only way for greater utilization of existing fuels and energy sources. Managing In addition of short-term economic benefits –has the chance and enough time to transition to other fuels, and this concept provides a growing importance in the empowerment of mankind in the coming campaign against job creation - the promise of food security and future generations [6].

The agriculture sections as the most important section of producing nutritious materials of country not only the consumption of energy also the most important of offering energy. As we mentioned, agriculture section is faced to restriction of production resources and in other way the supporting of nutritious security of population is growing –we should created the balance between the uptake and utilization of production resources and agricultural production. In addition the process of generating resources must be such that the food need of current generation – also the next generation food security is not threatened. This is the basis of what today are called sustainable agriculture [3].

Economic production is the function of labor force - capital - natural resources - available energy and technology. In The economic sectors - energy and other resources is strongly consumed. So - both
natural resources are greatly reduced the amount of pollutants has increased dramatically. Energy consumption has been discussed due to its effect on the concentration of greenhouse gases and global warming. The best way to reduce the environmental risks of energy is increasing energy consumption.

Pistachio is one of the most important export agricultural products in Iran. Special status of non-oil exports in the economy of country and important role of pistachio in non-oil products is the need for more attention to the causes of this product. So the economic research is inevitable in the field of productivity analysis of pistachio production and ultimately identifies bottlenecks and failures related to the use of inputs in this product [2].

The purpose of this study is estimating the amount of energy consumed in the production of pistachio orchards in Yazd province and cultivation effects on energy efficiency in these units. Thus the required information was collected randomly in the form of questionnaires and meeting face of 49 pistachio growers in Yazd province.

Materials and Methods

The study has been conducted in Yazd province. Yazd is the second pole of Iranian pistachio producers after Kerman. Khatam is the largest and most important producer of pistachio acreage in Yazd province. In other cities of this province's is more or less pistachio produced and under cultivation, but not high. The Pistachio cultivation in the Khatam city are 15 881 hectares of trees and fertilized trees [4].

Needed Information of this study was collected from the pistachio gardens of Khatam city in Yazd province where is the most important producer of pistachios in Yazd province. For this purpose, the information was collected that related to two-year period. Questionnaire was designed to achieve the required information. These questionnaires were randomly selected for the initial test in interviews with 10 farmers and the necessary information was performed in final questionnaire. During this study, they used data that were existed in Yazd province Agricultural Jihad Organization. The number of existing operators and the energy required will affect the final energy balance. In this study they used simple random sampling method. The easiest method of sampling is random sampling [5]. From the following equation which is known to Cochran, used for determining the size of sample [1].

\[
N = \frac{t^2}{t^2 + (x/2)^2}
\]

Where:
- \(N\): sample size
- \(T\): 96/1
- \(N\): Size of community (sample)
- \(D\): the probability ideal accurate
- \(S\): population standard deviation

To estimate the standard deviation of a prototype a sample randomly selected that consist of 10 samples. Total input energy in the growth period was chosen as a function of input energy and standard deviation were calculated based on the sample size. By attention to the relationship 1 the sample size was 45 that to the accuracy of this amount were increased to 4.

The final purpose of study Energy is the estimating energy index. By using these indicators, the possibility of comparing the different systems is provided. These indices were used to calculate the following relations:

\[
ER = \frac{E_{out}}{E_{in}}
\]

\[
NEG = E_{out} - E_{in}
\]

\[
EP = \frac{Y}{E_{in}}
\]

\[
EI = \frac{E_{in}}{Y}
\]

Where:
- \(ER\): ratio of energy
- \(E_{out}\): energy output (MJ / ha)
- \(E_{in}\): the amount of input energy, (MJ / ha)
- \(NEG\): on the net energy (MJ / ha)
- \(EP\): energy percentage (Kg / MJ)
- \(Y\): yield (Kg / MJ)
- \(EI\): energy intensity (Kg / MJ)

To calculate the energy equivalent inputs and finally calculate the energy used in different operations, they used coefficients of equivalence that in resources were mentioned. These coefficients are given in Table 1.

<table>
<thead>
<tr>
<th>Information</th>
<th>Unit</th>
<th>Energy (MJ/unit)</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>1- Humanity power</td>
<td>H</td>
<td>1.96</td>
<td>(11)</td>
</tr>
<tr>
<td>2- Machines</td>
<td>H</td>
<td>62.70</td>
<td>(11)</td>
</tr>
<tr>
<td>3- Fuel</td>
<td>L</td>
<td>47.8</td>
<td>(14)</td>
</tr>
<tr>
<td>4- Chemical fertilizer</td>
<td>Kg</td>
<td>-</td>
<td>(11)</td>
</tr>
<tr>
<td>N</td>
<td>Kg</td>
<td>66.14</td>
<td>(11)</td>
</tr>
<tr>
<td>P2O5</td>
<td>Kg</td>
<td>12.44</td>
<td>(11)</td>
</tr>
<tr>
<td>K2O</td>
<td>Kg</td>
<td>11.15</td>
<td>(11)</td>
</tr>
<tr>
<td>5- Animal fertilizer</td>
<td>Kg</td>
<td>0.30</td>
<td>(11)</td>
</tr>
<tr>
<td>6- Pesticide</td>
<td>Kg</td>
<td>120</td>
<td>(11)</td>
</tr>
<tr>
<td>7- Electricity</td>
<td>kWh</td>
<td>11.93</td>
<td>(11)</td>
</tr>
<tr>
<td>8- Water</td>
<td>m³</td>
<td>1.02</td>
<td>(11)</td>
</tr>
<tr>
<td>9- Pistachio</td>
<td>Kg</td>
<td>24.88</td>
<td>(11)</td>
</tr>
</tbody>
</table>
On basis of given energy equivalent for input and output in Table 1 - Ratio of energy - energy percentage - the net energy and energy by using the above relations were calculated [11].

To obtain the values of each input and output, the information in the questionnaire were used. This information is including amounts of each of the inputs that are used in a course in one taken period. Different coefficients are mentioned for calculating the energy equivalent staffing. The base of research is studies in Iran and neighboring countries, and the ratio MJ / ha 96/1 was chosen. The total manpower used in different operations was calculated in different operations and by using the equation [5], the Human energy was calculated for the entire period.

\[ E_{la} = E_{la} \times t \]  
(5)

Where:
- \( E_{la} \): force energy (MJ / ha)
- \( E_{la} \): working energy equivalent (MJ / h)
- \( T \): staffing levels (h / ha)

To calculate the fuel energy in various crops operations, the average amount of fuel was calculated on various operations that the questionnaire was obtained by using equation [6] the energy value was calculated.

\[ E_{fuel} = Q_i \times E_i \]  
(6)

Where:
- \( E_{fuel} \): fuel energy (MJ / ha)
- \( Q_i \): the amount of fuel (L / ha)
- \( E_i \): Energy intensity of fuel (MJ / L)

After determining the various parameters of energy - the impact of cultivation on three levels was evaluated (first group includes gardens, 5/0 to 5/1 acre - second group gardens, 5/1 to 5/5 acres of gardens and the third group with a greater level of 5/5 acres) in a randomized complete block design on energy efficiency (energy ratio). The comparing of Average also on Duncan surface was done in the 5% level.

Available Data was used and analyzed into Excel 2007 and SPSS version 17 software.

Table 2: inputs and their energy.

<table>
<thead>
<tr>
<th>Inputs</th>
<th>Per Hectare</th>
<th>Energy (MJ/unit)</th>
<th>Percent %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1- Humanity power (h)</td>
<td>532.41</td>
<td>1043.53</td>
<td>.63</td>
</tr>
<tr>
<td>2- Machines (h)</td>
<td>46.28</td>
<td>2901.89</td>
<td>1.75</td>
</tr>
<tr>
<td>3- Fuel (L)</td>
<td>125.59</td>
<td>6003.22</td>
<td>3.63</td>
</tr>
<tr>
<td>4- Chemical fertilizer (Kg)</td>
<td>351.01</td>
<td>13549.12</td>
<td>8.19</td>
</tr>
<tr>
<td>N</td>
<td>172.35</td>
<td>11399.32</td>
<td>6.89</td>
</tr>
<tr>
<td>P2O5</td>
<td>122.33</td>
<td>1521.82</td>
<td>0.92</td>
</tr>
<tr>
<td>K2O</td>
<td>56.32</td>
<td>627.98</td>
<td>0.38</td>
</tr>
<tr>
<td>5- Animal fertilizer (Kg)</td>
<td>15635.48</td>
<td>4609.64</td>
<td>2.84</td>
</tr>
<tr>
<td>6- Pesticide (Kg)</td>
<td>17.32</td>
<td>2067.98</td>
<td>1.25</td>
</tr>
<tr>
<td>7- Electricity (Kwh)</td>
<td>110392.32</td>
<td>123980.35</td>
<td>74.96</td>
</tr>
<tr>
<td>Total input energy</td>
<td>-</td>
<td>165392</td>
<td>100.00</td>
</tr>
</tbody>
</table>

Results and Discussion

In Yazd province usually harvested is in late summer or early autumn. In Table 2, the average of consumer inputs - their energy content and the consumption percentage of each of them are determining. Also the percentage of each these inputs also shown in Figure 1. The results of study in the area showed that the total energy consumed in a harvest is GJ / ha 40/165. For calculating the output energy, the amount of pistachio yield was assumed in each per acre. Whereas the pistachio nuts in the study area are sold dried and packaged, the weight of dry pistachios is that moisture is about 15%, the energy was calculated by multiplying the energy content. The average yield of pistachio in area was calculated about kg / ha 3116. Mirzaei Khalilabad was calculated the average performance of pistachio in the Rafsanjan about kg / ha 45900 [13]. The Equivalent energy product which is obtained by multiplying the product in its energy equivalent has respectively GJ / ha 21/1525.

As it is indicated in Table 2 - Maximum amount of electricity needed to power the irrigation system built in the traditional area of irrigation efficiency (about 70%). The reason of high consumption of electricity energy is the low surface of water and using the traditional methods by low outputs in area. The Average depth of wells is about 140 meters and about 90% of farms use flood in irrigation. Use of modern irrigation methods such as drip irrigation, which are very efficient, can reduce the input energy. Due to water shortage in the region and high energy prices, use this type of system to be felt strongly in the region. Fertilizers with 8% of energy after the electricity are the second inputs and nitrogen fertilizer among the three types of commonly used fertilizers in the region, has the greatest share of energy consumption. One reason for high consumption of chemical fertilizers in the country is given subsidies to these inputs and although the low price of them is so important that in addition of consumed energy and price, it causes many problems such as pollution of soils - saline soil - groundwater pollution and ... .
Chemical pesticides are consumed only 1% of energy in producing pistachio. The share of power human in input energy of producing pistachio is very low and in fact the lowest energy consumption that related to these inputs (63%). In Many other studies also reported that human energy are the lowest average of energy consumption among others inputs.

A rate of energy that is as a factor for investigating the efficiency of energy used in producing the products, for this product is respectively 72/0. This rate indicates that the input energy per MJ 72/0 MJ of energy produced. To improve the performance of this index, we can raise or reduce energy input, or both. In Studies for different products - the proportion of different energies has been reported, for example: 21/2 for sugar beet [10] - 25/1 for potatoes [7] - 6/1 for the apple tree. The survey results showed that for different products, obtained different rate of energies in different regions which is indicative of different conditions.

Energy Efficiency was obtained kg / MJ 03/0 which shows each of about 0.03 MJ / kg. This power of energy in this study is MJ / kg 25/86 that was produced for each kilogram of dry nuts, 25/86 MJ of energy is spent. Added Pure Energy is MJ / ha 86894 – that indicating that the energy is lost in producing pistachio. Khalilabad Mirzaei reported that in producing pistachio in Rafsanjan, the added pure energy is positive [13].

Table 3: Average energy index in pistachio production.

<table>
<thead>
<tr>
<th>Indexes</th>
<th>Unit</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy ratio</td>
<td>-</td>
<td>0.72</td>
</tr>
<tr>
<td>Energy efficiency</td>
<td>(kg/MJ)</td>
<td>0.03</td>
</tr>
<tr>
<td>Energy Severity</td>
<td>(MJ/kg)</td>
<td>86.25</td>
</tr>
<tr>
<td>Added Pure Energy</td>
<td>(MJ/ha)</td>
<td>-86.89</td>
</tr>
</tbody>
</table>

The effect of size of land on efficiency of energy consumption for pistachio product in this section the effect of size factor of land on energy efficiency (energy ratio) was evaluated in a multi-year pistachio production. In this regard, we used from the analysis of variance in completely randomized block design. The acreage of orchards was divided into three groups. The first group includes gardens, 5/0 to 5/1 acre - second group gardens, 5/1 to 5/5 acres of gardens and the third group with a greater level of 5/5 ha. Total energy consumption for various inputs in the garden of the three groups was calculated and the results are shown in Table 4. As can be seen in gardens, the first group has more energy consumption, that usually due to lack of proper management of input consumption in this group. Energy consumption by increasing with gardens to gardens and orchards of third group showed decrease process and the third group are allocated to the lowest energy consumption. These results are consistent with the results of some others research.

Table 4: The total amount of input energy and rate of energy in the three levels of gardens sizes.

<table>
<thead>
<tr>
<th>-</th>
<th>0.5 to 1.5 Hectare</th>
<th>1.5 to 5.5 Hectare</th>
<th>More than 5.5 Hectare</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total input energy(MJ/Hec)</td>
<td>218609.76</td>
<td>146072.84</td>
<td>130048.60</td>
</tr>
<tr>
<td>Energy ratio</td>
<td>0.419</td>
<td>0.799</td>
<td>1.046</td>
</tr>
</tbody>
</table>

Yilmaz and colleagues reported that with increased farm level, the amount of energy is reduced and small farms of 5 hectares -more than 25% of farms larger than 1/12 hectares. Taking advantage of improved inputs and using machines to comply with the ground conditions of the most important reason is to reduce energy consumption in the plantations.

The result of analysis of variance input energy for three orchards groups are shown in Table 5. As can be seen in the table, however, consumption of
inputs and thus the input energy in three different orchards were different, but this difference was not meaningful as statistically significant at 5% level.

<table>
<thead>
<tr>
<th>Source of changes</th>
<th>Degree of freedom</th>
<th>Sum of cubes</th>
<th>Sum of squares</th>
<th>Mean of squares</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area of garden</td>
<td>2</td>
<td>2.452</td>
<td>1.226</td>
<td>1.63²*</td>
</tr>
<tr>
<td>Error</td>
<td>46</td>
<td>34.556</td>
<td>0.751</td>
<td>-</td>
</tr>
<tr>
<td>Sum of total</td>
<td>48</td>
<td>37.008</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Muezzin investigated affect of land size in energy efficiency for sugar beet production in the Boroujerd city. Results showed that 1% of land area in the energy efficiency level is significant and increasing farm productivity increases. Mechanized operations as the major performing at high levels of culture are the most important factor in improving the energy efficiency [10]. Qahdarijani announced with increasing size of farms, the operations of farms potatoes and wheat, energy efficiency is increased [5].

Conclusions and suggestions:

The average yield was estimated at 3225 kg per hectare during the production process. Pistachio production in the energy region of 72/0 and the energy efficiency kg / MJ 03/0 was obtained indicating that for each of about is 0.03 MJ / kg.

The investigating Effect of cultivation on the yield indicates that although the amount of energy in the different groups of gardens different - but this difference as statistically form is not meaningful. Gardens with a lower level have higher energy consumption.

The following suggestions are offering for improving energy use in the manufacture of products:
- Doing applied research about determination of average of pistachio need to elements by attention to this that chemical fertilizer are allocating big share of consumption energy in producing pistachio, by this work provide the probability of saving in energy consumption and increasing energy efficiency. Also from large consumption of chemical fertilizer is avoided that have a damage affect of environment. Animal manures can be a good alternative for chemical fertilizers.
- Developing automated services companies in the region due to the high price of used cars in producing pistachio, the chance of buying this car are not for most farmers in this region that this is providing some problems in the field of mechanized production. The existing of automated services can help companies to perform various operations in a timely manner to prevent losses and increase the performance.
- The exact registration of amount of inputs consumed and the prices for pistachio gardens is recommended for more accurate and more practical results.

References

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