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Investigation energy balance Indices by seed chemical compounds in corn production in north of Iran

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ABSTRACT

Energy optimization and sustainable farming are main goals of the all developed countries. Optimum use of energy is very vital for agricultural productions section. This method in an agricultural product system is the energy consuming in product operations and energy saving in produced crops. In this article, evaluation of energy indices under rain fed farming corn in north of Iran (Guilan province) was investigated. Data were collected from 72 farms by used a face to face questionnaire method during 2011 year in Guilan province. By using of consumed data as inputs and total production as output, and their concern equivalent energy balance, and energy balance indices were calculated. The average yield of corn was found to be 2375 kg/ha and its energy balance equivalent was calculated to be 5290699 MJ/ha. Energy balance efficiency (energy output to input energy ratio) for seed in this study was calculated 1.62, showing the affective use of energy in the agro ecosystems corn production.

Key words: Energy balance indices, Iran, Corn, Yield.

INTRODUCTION

Goal of sustainable agriculture is to use energy more efficiently in crop production. Energy use is one of the key indicators for developing more sustainable agricultural practices and also is principal requirements for sustainable agriculture. Also, the use of energy flow is method of estimating agricultural development and permanent production in agricultural areas, and this is one of the most important subjects in agricultural ecology. In different parts of the world, the energy input to output ratio is calculated in different agricultural ecosystems. Energy optimization and sustainable farming are main goals of the all developed countries. In developing nations, there is a higher amount of energy wastage. According to rising population and reducing source of energy in these countries, a long-term plan should be established to reduce wastage of energy. So effective use of energy in agriculture can be main way to help these countries towards development and prevent economical dependence to other nations. In agriculture, a wide range of modern and traditional energy forms are used directly on the farm, e.g. as tractor or machinery fuel, and in water pumping, irrigation and crop drying, and indirectly for fertilizers and pesticides. Other energy inputs are required for post-harvest processing in food production, packaging, storage, transportation and cooking. Corn (Zea mays L.) is one of the important cereal crops in the world and Iran after wheat and rice [2,6]. Humans have found ways to secure their food from the Earth's land, beginning more than a million years ago with the hunter-gatherers. One of the major factors that caused humans to move from hunting and gathering to slash-and-burn agricultural production was the continual expansion of their population. About 10000 years ago and after human began to agricultural activity; total population on the earth was 1 million people. Once fossil energy supplies became available about 200 years ago, intensive agricultural production developed [11]. The crop yield is a function of energy input. Depending on the environmental conditions, crops convert only 0.5-5% of the photosynthetic active radiation (PAR) into biomass [7]. Sources of energy other than solar radiation, wind, etc. were summarized as support energy [1]. Input of support energy into agricultural systems increase the proportion of solar energy that is captured by the plants. Support direct energy is required to perform various tasks related to crop production

processes such as for land preparation, irrigation, harvest, post harvest processing, transportation of agricultural inputs and outputs. In other word, direct energy includes fuel and electricity which are directly used at farm [7]. Indirect energy is not directly consumed at the farm. The major items for support indirect energy are the energy used in the manufacture, packaging and transport of fertilizers, seeds, machinery production and pesticides [10]. Nowadays, energy has an influencing role in the development of key sectors of economic importance such as industry, transport and agriculture [5]. Agriculture requires energy as an important input to production. Agriculture uses energy directly as fuel or electricity on the farm, and indirectly in the fertilizers and chemicals produced off the farm. An increase in the worldwide average air and ocean temperatures, prevalent snow and ice melting and rising levels of sea waters have been attributable to anthropogenic greenhouse gas emissions, where the agriculture is playing a significant role [9]. So efficient use of energy resources is one of the major assets of eco-efficient and sustainable production, in agriculture [13]. Shakibai and Koochekzadeh [12] show that energy consumption in Iran agricultural section will have an increasing trend as shown before and it warns the authorities that in a case where the price of energy increases in Iran, the prices will have a huge increase in the agricultural section and this has a negative effect on State competitive power. The main aim of this study was to determine energy use in corn production, to investigate the efficiency of energy consumption and energy balance indices analysis of corn in Guilan province of Iran.

MATERIALS AND METHODS

Data were collected from 72 farms by used a face to face questionnaire method during 2011 year in Guilan province (north of Iran). The random sampling of production agro ecosystems was done within whole population and the size of each sample was determined by using bottom Equation [8]:

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

In the formula, 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. In order to indicators of energy balance, Basic information on energy inputs were entered into Excel spreadsheets and then energy balance equivalent were calculated according table 1 [3, 4]. By using of consumed data as inputs and total production as output, and their concern equivalent energy, indicators of energy balance were calculated. Energy input include human labor, machinery, diesel fuel, chemical fertilizers, poison fertilizers, machinery depreciation for per diesel fuel, and seed and output yield include yield of corn. Direct energy covered human labor and diesel fuel, used in the corn production while indirect energy consists of seed, chemical fertilizers, poison fertilizers, and machinery energy. Renewable energy consists of human labor and seed; and nonrenewable energy includes chemical fertilizers, poison fertilizers and machinery energy [8, 10].

Analysis of energy balance in corn production

The inputs used in corn production and their energy balance equivalents and output energy balance equivalent are illustrated in table 1. About 20 kg seed, 1 L chemical poison, 270 h human labor, 12 h machinery power and 110 L diesel fuel for total operations were used in agro ecosystems corn production on a hectare basis. The use of nitrogen fertilizer, phosphorus fertilizer and potassium fertilizer were 115, 21, and 25 kg per one hectare respectively. Also 92.4 L depreciation power in this system was used. The total energy balance equivalent of inputs was calculated as 5290699 MJ/ha. The highest shares of this amount were reported for chemical fertilizer (40.28%), machinery (20.41%), diesel fuel (19.20%) and depreciation for per diesel fuel (16.74%). The energy inputs of human labor (2.55%), chemical poison (0.51 %) and seed (0.30 %) were found to be quite low compared to the other inputs used in corn production (table 1). The highest percent of compositions (72%), Amounts (1710 kg/ha), production energy (6840000 kcal/ha) and production energy to consumption energy ratio (1.29) in corn were obtained from starch as compared with fat and protein, The lowest consumption energy to production energy ratio (0.77) in corn was obtained from starch as compared with fat and protein (table 2).

Evaluation indicators of energy balance in corn production

The consumption energy (5290699 kcal/ha), production energy (8550000 kcal/ha), energy per unit (3500 kcal), production energy to consumption energy ratio (1.62) and consumption energy to production energy ratio (13.15) of corn production were shown in table 2. Energy balance efficiency (production energy to consumption energy ratio) in this study was calculated 1.62, showing the affective use of energy in the agro ecosystems corn production.

Division of energy balance in corn production

This means that the amount of output energy is more than input energy and production in this situation is logical. Direct, indirect, renewable and non-renewable energy forms used in corn production are also investigated in table 3. The results show that the share of direct input energy was 21.76% (1151070 MJ/ha) in the total energy input compared to 78.24% (4139629 MJ/ha) for the indirect energy. On the other hand, nonrenewable and renewable energy contributed to 97.15% (5139699 MJ/ha) and 2.85% (151000 MJ/ha) of the total energy input, respectively.

Table 1. Amounts of inputs and their equivalent energy balance from calculated indicators of energy balance

Parameter	Unit	Quantity per hectare	Energy balance Equivalents	Total energy balance equivalents
Inputs				
Human labor	h/ha	270	135000.00	2.55
Machinery	h/ha	12	1080000.00	20.41
Diesel fuel	L/ha	110	1016070.00	19.20
Nitrogen	Kg/ha	115	2024000.00	38.26
Phosphorus	Kg/ha	21	66990.00	1.27
Potassium	Kg/ha	25	40000.00	0.76
Poison	L/ha	1	27170.00	0.51
Seed	Kg/ha	20	800	0.30
Depreciation for per diesel fuel	L	92.4	9583	16.74

Table 2. Analysis of energy balance indices in corn production

Item	Percent of compositions	Energy per gram (kcal)	Amounts (kg/ha)	production energy (kcal/ha)	Production energy/ Consumption energy	Consumption energy/ Production energy
Protein	9	4	214	855000	0.16	6.19
Fat	4	9	95	855000	0.16	6.19
Starch	72	4	1710	6840000	1.29	0.77
Item	Grain yield (kg/ha)	Consumption energy (kcal/ha)	Production energy (kcal/ha)	Energy per unit (kcal)	Production energy/ Consumption energy	Consumption energy/ Production energy
	2375	5290699	8550000	3500	1.62	13.15

Table 3. Division of energy balance in corn production

Item	Unit	Corn
Yield	Kg/ha	2375
Direct energy	Mj/ha	1151070 (21.76%)
Indirect energy	Mj/ha	4139629 (78.24%)
Renewable energy	Kg/Mj	151000 (2.85%)
Nonrenewable energy	Mj/ha	5139699 (97.15%)

CONCLUSION

Application correct management including the using new irrigation methods, suitable agricultural machinery and time as well as proper use of inputs; can reduce the energy consumption. Thus, increased crop yield per unit area and will improve energy use efficiency.

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