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Evaluation of Energy Consumption and Economic Analysis for Traditional and Modern farms of Broiler Production

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ABSTRACT: The main of this study was the survey of energy use and economic analysis of broiler production in Mazandaran province of Iran based on two levels of traditional and modern farms. So, the initial data were collected from each system by face-to-face questionnaire separately. Accordingly, the 70 broiler producers were considered for each system. The results revealed the total energy use and broiler yield of traditional farms were about 178343 MJ (1000 birds)$^{-1}$ and 2746 kg (1000 birds)$^{-1}$, respectively; while these items were about 188798 MJ (1000 birds)$^{-1}$ and 3071 kg (1000 birds) $^{-1}$ for modern farms respectively. Diesel fuel and feed had the highest share of total energy consumption for both of systems. The energy use efficiency was computed as 0.16 and 0.17 for traditional and modern farms, respectively. Also, the other indices were same in both of systems, approximately. Based on energy forms results, the rate of direct and non-renewable energy was more than indirect and renewable energy, respectively. With respect to economic analysis, the fixed cost of traditional farms was less than modern farms. Vice versa, the variable cost was more than in traditional farms comparing modern farms, significantly. The benefit to cost ratio was found 1.88 and 2.10 for traditional and modern farms, respectively. Finally, the selection of standard machinery, aviculture structure in building process, applying the appropriate electro motor and following from true diet in nutrition of broilers can improved the energy use and economic indices in the studied area.

Keywords: Benefit-cost ratio; Broiler production; Economic indices; Energy; Iran.

INTRODUCTION

The broiler production is very important in the recent years. They are rich sources for protein supply in the world. The major sources of protein in developing countries are beef, goat, mutton and poultry meats while other sources termed miscellaneous are egg and milk which have a bulk share of animal protein required by man. It is necessary to note that adequate consumption of meat is an indication of social and economic welfare (Ikeme, 1990). Energy, being the capacity to do work, is at the heart of all human activities, especially those concerning the production of goods and services. Energy is used in almost all facets of living and in all countries, and makes possible the existence of ecosystems, human civilizations and life itself. Different regions and societies adapt to their environments and determine their own energy resources and energy uses. The standards of life achieved in countries are often a function of energy related factors. On the other hand, energy can exist in many forms, and can be converted from one form to another with energy conversion technologies. We use energy carriers, produced from energy sources; in all aspects of living. Energy, economics, and the environment are mutually dependent. Agriculture is an energy user and energy supplier in the form of bio-energy and this subject represent close relationship between agriculture and energy. Currently, the productivity and profitability of agricultural productions depend upon energy consumption (Hemmati *et al.*, 2013). Now a days hens are inter-breaded, so chicks in a short period reach to desirable weight. The intensity of energy use on broiler farms is high and studies on input-output energy pattern on broiler farms are very important. Efficient use of agricultural product energies helps to achieve increased production and productivity and contributes to the profitability and competitiveness of agriculture sustainability in rural living (Heidari *et al.*, 2011a). The poultry meat and products comprise the main meals of people in Iran. North provinces of Iran are the one of most producer and consumer of broiler in this country (Anon, 2014). In recent years, many studies have focused on energy use of broiler production processes and in the worldwide. For examples, Atilgan and Hayati (2006) analyzed cultural energy on broilers reared in different capacity poultry houses of Turkey. Results of their study showed that increasing capacity of housings decreases cultural energy input up to certain capacity and indicated that increasing housing capacity without interfering with performance could be a means for energy conservation in sustainable agriculture.

Jekayinfa (2007) studied energy audit of poultry processing plants in south western Nigeria. Heidari *et al.* (2011b) investigated the energy use pattern and economic analysis of broiler production in Yazd province of Iran. Their results showed the Total input energy was calculated about 186886 MJ (1000 birds)$^{-1}$ while the outputenergy was about 27461 MJ (1000 birds) $^{-1}$. In another study, Nabavi-Pelesaraei *et al.* (2013a) determined the relationship between energy inputs and broiler yields in Guilan province of Iran. Amid *et al.* (2014) examined the energy and economics analysis of broiler production.

With respect to above-mentioned, the main aims of the present study were the survey of energy use and economic analysis of broiler production in Mazandaran province of Iran. It should be noted, the previous studies didn't pay attention to production system; while these study investigated two levels of broiler production system including traditional and modern systems.

MATERIALS AND METHODS

A. Selection of case study farms and data collection

In north of Iran, Mazandaran province is the largest producer of broiler with 2072 active aviculture units and Ghaemshahr city with about 50% of total broiler production in this province is very important region. Mazandaran province is located in the north of Iran, within 3°47' and 38°05' north latitude and 50°34' and 56°14' east longitude (Anon, 2014). Accordingly, the present study was done in Ghaemshahr county of Mazandaran province of Iran. As noted above, this research was based on traditional and modern systems of broiler production. The breeder of poultry, number of broiler produced, implement and automation was the main indices for this classification. So, the data were collected for both of system, separately. With respect to high number of broiler production in the studied area, the random sampling method should be done for ease of computation, reduce errors and save time and costs.

This method was described by Kizilaslan, (2009):

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

where n is the required sample size; s is the standard deviation; t is the value at 95% confidence limit (1.96); N is the number of holding in target population and d is the acceptable error (permissible error 5%). For the calculation of sample size, criteria of 5% deviation from population mean and 95% confidence level were used. The result indicated the number of sample size of traditional and modern farms was 65 and 58, respectively. Nevertheless, the 70 units were considered in each system (totally 140 units) for achieving the more trust to the results of analysis and easier comparison of two systems.

B. Energy analysis

The chick, human labor, machinery (electric motor, steel and polyethylene), diesel fuel, feed (maize, soybean meal, di calcium phosphate, fatty acid, minerals and vitamins) and electricity as inputs are specified in order to calculate amount of usage and the outputs were broiler and manure. The amounts of each input were multiplied with the energy coefficient equivalent (Table 1) to calculate the energy use per 1000 birds.

Table 1: Energy equivalent of inputs and output in broiler production.

Items	Unit	Energy equivalent (MJ unit^{-1})	Reference
A. Inputs			
1. Chick	kg	10.33	(Heidari *et al.*, 2011b)
2. Human labor	h	1.96	(Nabavi-Pelesaraei *et al.*, 2013b)
3. Machinery			
(a) Electric motor	kg	64.8	(Chauhan *et al.*, 2006)
(b) Steel	kg	62.7	(Chauhan et al., 2006)
(c) Polyethylene	kg	46.3	(Heidari *et al.*, 2011b)
4. Diesel fuel	L	47.8	(Kitani, 1999)
5. Feed			
(a) Maize	kg	7.9	(Atligan and Hayati, 2006)
(b) Soybean meal	kg	12.06	(Atligan and Hayati, 2006)
(c) Dicalcium phosphate	kg	10	(Alrwis and Francis, 2003)
(d) Fatty acid	kg	9	(Berg *et al.*, 2002)
(e) Minerals and vitamins	m^3	1.59	(Heidari *et al.*, 2011b)
6. Electricity	kWh	3.6	(Mohammadshirazi *et al.*, 2012)
B. Outputs			
1. Broiler	kg	10.33	(Amid *et al.*, 2015)
2. Manure	kg	0.3	(Nabavi-Pelesaraei *et al.*, 2014)

Based on the energy equivalents of the inputs and output (Table 1), the surveyed data including energy resources can be computed for two levels of traditional and modern broiler farms. Specifically, the energy indices including energy use efficiency (energy ratio), energy productivity, specific energy, net energy and energy intensiveness were calculated(Mandel, 2002; Banaeian *et al.,* 2010; Taki *et al.,* 2013):

$$E_{eue} = E_o / E_i \qquad \ldots(2)$$
$$E_p = O_p / E_i \qquad \ldots(3)$$
$$S_e = E_i / P_o \qquad \ldots(4)$$
$$N_e = E_o - E_i \qquad \ldots(5)$$

where, E_{eue} is energy ratio (energy use efficiency); E_o is energy output (MJ (1000 birds) $^{-1}$); E_i is energy input (MJ ha^{-1}); E_p is energy productivity (kg MJ^{-1}); O_p is output production (kg (1000 birds) $^{-1}$); S_e is specific energy (MJ kg^{-1}); P_o is broiler output (kg (1000 birds) $^{-1}$), N_e is net energy (MJ (1000 birds) $^{-1}$).

The energy input of traditional and modern farms were examined as direct and indirect, and in renewable and nonrenewable forms. Direct energy includes human labor, diesel, and electricity while indirect energy covers chick, machinery and feed. On the other hand, renewable energy includes chick, human labor and feed; used to describe energy sources that are replenished by natural processes on a sufficiently rapid time-scale. So they can be used by humans more or less indefinitely, provided the quantity taken per unit of time is not too great. And non-renewable energy includes machinery, diesel fuel and electricity that used to describe energy sources that exist in a limited amount on Earth. Thus all available material could eventually be completely used up in the production period (Royan *et al.,* 2012).

C. Economic analysis

In this study, the economic analysis of broiler production was investigated in Mazandaran province of Iran based on traditional and modern farms. The economic analysis was done by survey of economic indices. These indices covered gross return, net return, benefit-cost ratio (BC) and productivity. It should be noted; the computation of mentioned indices depended on broiler yield, gross production value, variable cost production, fixed cost production and total production cost. The net return was calculated by subtracting the total cost of production from the gross value of production per 1000 birds. The gross return was calculated by subtracting the variable cost of production.

The benefit-cost ratio was calculated by dividing the gross value of production by the total cost of production per 1000 birds. The economics indices can be calculated by following formulas (Mohammadshirazi *et al.,* 2012):

$$\text{Gross production value} = \text{B}roiler\ \text{yield (kg (1000 birds)}^{-1}) \times \text{B}roiler\ \text{price (\$ kg}^{-1}) \qquad \ldots(6)$$

$$\text{Gross return} = \text{G}ross\ \text{production value (\$ (1000 birds)}^{-1}) \times \text{V}ariable\ \text{production cost (S (1000 birds)}^{-1}) \qquad \ldots(7)$$

$$\text{Net return} = \text{G}ross\ \text{production value (\$ (1000 birds)}^{-1}) \times Total\ \text{production cost (\$ (1000 birds)}^{-1}) \qquad \ldots(8)$$

$$\text{BC} = \frac{\text{Gross production value (\$ (1000 birds)}^{-1})}{\text{Total production cost (\$ (1000 birds)}^{-1})} \qquad \ldots(9)$$

$$\text{Productivity} = \frac{\text{Broiler yield (kg (1000 birds)}^{-1})}{\text{Total production cost (\$ (1000 birds)}^{-1})} \qquad \ldots(10)$$

Basic information on energy inputs of broiler production were entered into Excel 2013 spreadsheets and SPSS 20.0 software program.

RESULTS AND DISCUSSION

A. Analysis of input-output energy use in broiler production

The quantity of inputs and outputs with their energy equivalent of traditional and modern broiler farms is given in Table 2. Based on the results, the total energy consumption of traditional and modern farms was found about 178343 and 188798 MJ (1000 birds) $^{-1}$, respectively. Modern farms had the more impalements and variety of machinery. These items causative high rates of energy use for machinery and diesel fuel in modern farms comparing traditional farms. Moreover, the broiler yield of traditional and modern farms was 178343 and 188798 kg per 1000 birds, respectively. As can be seen, the increasing of energy inputs can be increased the yield in broiler production. Also, the rate of manure in modern farms was more than traditional farms. So, it can be said, the relation of manure and yield is directly. In other words, the increasing of broiler yield can be increased the manure output in farm system. Another important point of results was the more consumption of inputs which independent technology such as chick, human labor and feed in traditional farms comparing modern farms in production processing.

Table 2: Amounts of inputs, outputs and their energy equivalences in traditional and modern farms of broiler production.

Items	Unit	Quantityper unit for traditional farms (Unit (1000 birds)$^{-1}$)	Total energy equivalent for traditional farms (MJ (1000 birds)$^{-1}$)	Quantityper unit for modern farms (1000 birds)	Total energy equivalent for modern farms (MJ (1000 birds)$^{-1}$)
A. Inputs					
1. Chick	kg	55.88	577.25	51.74	534.46
2. Human labor	h	118.92	233.08	100.15	196.29
3. Machinery	kg	-	152.83	-	341.18
4. Diesel fuel	L	2123.80	101517.73	2328.53	111303.57
5. Feed	kg	-	62682.30	-	59232.45
6. Electricity	kWh	3661.03	13179.71	4774.98	17189.94
The total energy input	MJ	-	178342.90	-	188797.91
B. Outputs					
1. Broiler	kg	2746.26	28368.82	3071.14	31724.87
2. Manure	kg	2440.48	732.14	2841.56	852.47

Fig. 1 displays the share of each input in total energy consumption for traditional and modern farms. The results showed the share of inputs was similar in two levels of traditional and modern systems. Diesel fuel (with near 60%) had the highest share in broiler production in both of systems; followed by feed and electricity. Moreover, the lowest share of total energy use was belonged to human labor, machinery and chick, respectively.

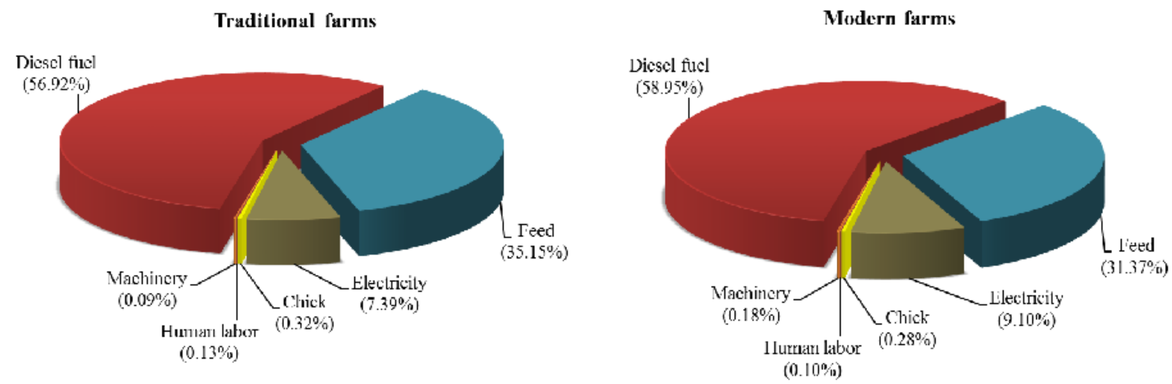

Fig. 1. The share of each input in total energy consumption of traditional and modern farms of broiler production.

Fig. 1. The share of each input in total energy consumption of traditional and modern farms of broiler production. In similar results of this study, Heidari *et al.* (2011b) reported the diesel fuel and feed had the highest share in broiler production of Yazd province, Iran. In another study, Amid *et al.* (2015) reported the highest share of energy consumption was belonged to fuel and feed.

B. Analysis of energy indices and forms in broiler production

Based on traditional and modern systems of broiler production, the results of energy indices are illustrated in Table 3. The results indicated that the energy use efficiency of traditional and modern farms was calculated as 0.16 and 0.17, respectively. In other words, the modern farms have the better condition for broiler production in energy point of view. Energy productivity and specific energy was the same for both of systems, approximately. Moreover, the net energy was negative for both of systems; while the absolute value of net energy of modern farms was more than traditional farms. Therefore, it can be concluded that energy is being lost in broiler production, thus there was not high efficiency in usage of energy at research area.

Nabavi-Pelesaraei *et al.* (2013a) reported the energy use efficiency of broiler production was 0.11 in Guilan province of Iran. In another study, the energy ratio was calculated as 0.18 for broiler production in Ardabil province of Iran by Amid *et al.* (2015). So, it can be said the energy ratio in Mazandaran province is good comparing other provinces of Iran, approximately. Also Table 3 shows the results of energy forms including direct, indirect, renewable and non-renewable energies under two levels of traditional and modern farms. Accordingly, the rate of direct and non-renewable energy was more than direct and renewable energy for both of traditional and modern farms. The high rate of diesel fuel and electricity consumption had the highest effect in achieving results.

Table 3: Energy indices and forms of traditional and modernfarms of broiler production.

Items	**Unit**	**Traditional farms**	**Modern farms**
Energy use efficiency	-	0.16	0.17
Energy productivity	kg MJ^{-1}	0.02	0.02
Specific energy	MJ kg^{-1}	64.94	61.47
Net energy gain	MJ $(1000\ birds)^{-1}$	-149974.08	-157073.03
Direct energy	MJ $(1000\ birds)^{-1}$	114930.53	128689.80
Indirect energy	MJ $(1000\ birds)^{-1}$	63412.37	60108.10
Renewable energy	MJ $(1000\ birds)^{-1}$	63492.63	59963.21
Non-renewable energy	MJ $(1000\ birds)^{-1}$	114850.27	128834.70
Total energy input	MJ $(1000\ birds)^{-1}$	178342.90	188797.91

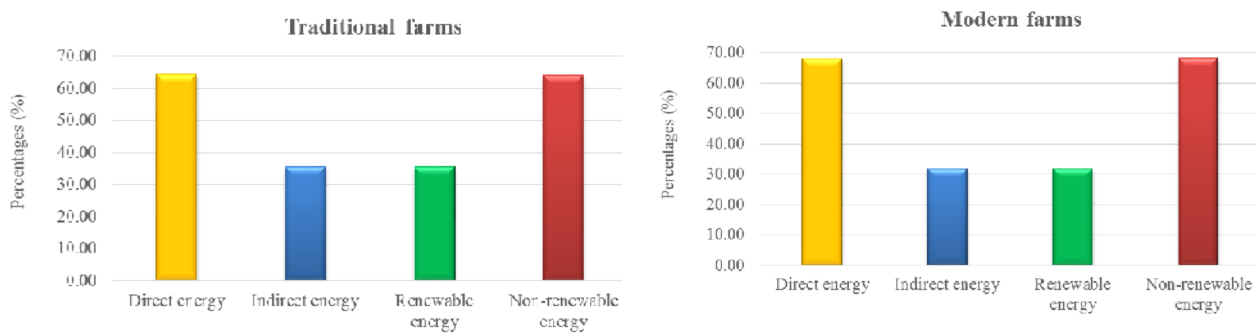

Fig. 2. The distribution of energy forms of traditional and modern farms for broiler production.

Based on traditional and modern farms, the share of each energy forms in total energy use is demonstrated in Fig. 2. The results indicated that the between direct and indirect energy, the share of indirect energy in both of systems (near 65%) was more than direct energy, significantly. In another category, the share of non-renewable was more than renewable energy for both of system (near 65%). In several studies in Iran, researchers reported the share of direct and non-renewable energy was more than that indirect and non-renewable energy, significantly (Heidari *et al.,* 2011a; Nabavi-Pelesaraei *et al.,* 2013a; Amid *et al.,* 2015).

According to results, the high rate of diesel fuel, feed and electricity sources was main problem of broiler production in energy point of view. So, it's suggested the select of standard machinery, appropriate electro motor for electrical impalement and following from true program for broiler's diet can be reduced the energy consumption for both of traditional and modern farms. In other hands, the secure of heat was the main reason of diesel fuel use in the production processing. Accordingly, the use of standard structure in aviculture building can be save the diesel fuel consumption for heating, significantly.

C. Economic analysis results of broiler production

The economics of broiler production depends on numerous factors like: meat quality, marketing costs, environment conditions, etc. Prices of broilers are established and controlled by the government (Heidari *et al.,* 2011b). The total cost of broiler production and the gross value of its production were calculated and shown in Table 4 based on traditional and modern farms. The results indicated the quantity of economic indices was similar for both of systems but the economic position of modern farms was better than traditional farms.

With respect to more broiler yield in modern farm, the gross production value was more than traditional farms about 4000 $ per 1000 birds. It should be noted, the fixed cost in modern farms was more than traditional farms. Vice versa, the traditional farms had the more variable cost comparing modern farms. However, the total production cost was computed as 1878.15 and 1879.30 $ $(1000\ birds)^{-1}$, respectively.

For determination of economic efficiency for traditional and modern farms the benefit to coat ratio was calculated. The results revealed the benefit to cost ratio of traditional and modern farms was found as 1.88 and 2.10, respectively. So, it can be said the modern farms was the more efficiency from economic analysis point of view. The application of agriculture mechanization in broiler production can be improved the energy efficiency and economic profit, significantly but this items need to true policy of pricing and economic position of agricultural systems.

Table 4: Economic indices of traditional and modern farms of broiler production.

Items	Unit	Traditional farms	Modern farms
Yield	kg (1000 birds)$^{-1}$	2746.26	3071.14
Sale Price	\$ kg^{-1}	1.28	1.28
Gross production value	\$ (1000 birds)$^{-1}$	3530.90	3948.61
Variable production cost	\$ (1000 birds)$^{-1}$	1333.49	1183.96
Fixed production cost	\$ (1000 birds)$^{-1}$	544.66	695.34
Total production cost	\$ (1000 birds)$^{-1}$	1878.15	1879.30
Total production cost	\$ kg^{-1}	0.68	0.61
Gross return	\$ (1000 birds)$^{-1}$	2197.41	2764.65
Net Return	\$ (1000 birds)$^{-1}$	1652.75	2069.30
Benefit to cost ratio	-	1.88	2.10
Productivity	kg \$$^{-1}$	1.46	1.63

CONCLUSION

Based on the present study the following conclusions are drawn:

1. The total energy consumption of traditional and modern farms was calculated as 178342.90 and 188797.91MJ (1000 birds) $^{-1}$, respectively; while, the broiler yield was found about 2746 and 3071 kg (1000 birds) $^{-1}$ for traditional and modern farms, respectively.
2. The highest share of energy consumption was belonged to diesel fuel and feed for both of systems. The electricity was in the next step of highest consumer input.
3. The results of energy indices showed energy use efficiency was 0.16 and 0.17, respectively. Also, the other indices were same in both of systems, approximately. Moreover, the net energy was negative; which indicated the energy inputs was inefficient in broiler production in the studied area.
4. The energy forms analysis results illustrated the direct and non-renewable energy was more than indirect and renewable energy, respectively. Moreover, the share of direct and indirect energies was about 65% and 35% in both of systems, respectively and the share of renewable and non-renewable energies was found about 32% and 68%, respectively.
5. With respect to economic analysis, the benefit to cost ratio was computed as 1.88 and 2.10 for traditional and modern farms. Also, the traditional farms had the less total production cost but the modern cost had the better position from economic profit point of views.
6. The decreasing of diesel fuel, feed and electricity can be save the energy consumption and increased the benefit of broiler production. For this purpose, the selection of standard machinery, aviculture structure in building process, applying the appropriate electro motor and following from true diet in nutrition of broilers can improved the energy use and economic indices in the studied region.

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