ESTIMATION OF RESOURCE USE EFFICIENCY IN BROILER FARMS: A MARGINAL ANALYSIS APPROACH

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ABSTRACT

This study aimed at determining the economic efficiency of resource use in broiler farms in Jordan. Determining economic resource-use efficiency will provide practical tools for decision makers to apply production policies needed to improve broiler production. The marginal analysis procedure was applied to evaluate the economic efficiency of the investigated farms and to determine the optimum input to use. The economic efficiency of resource use was determined by computing the ratio of the Marginal Value Product (MVP) to the Marginal Factor Cost (MFC). A multiple regression model for the corresponding inputs was developed to obtain the parameters for the measurements (elasticities) of resource use efficiency of factor inputs. The results of the study revealed that the utilization of the investigated input factors was inefficient since the ratio of MVP to MFC is more or less than unity for all the included inputs. Government should provide subsidized inputs to farmers along with proper extension services, which will help in enhancing productivity and profitability. In addition, subsidized credit facilities to farmers may catalyze this process. In addition, farmers need to adjust the usage of the resources, appropriately. Feed, labor, and equipment should be re-adjusted downwards.

Key words: Resource use efficiency, broiler farms. input elasticity, marginal procedure, marginal physical product, marginal factor cost.

I. INTRODUCTION

Among other poultry sub-sectors broiler production as a meat source is with great importance (Iman and Reza, 2012). In Jordan, as a developing country, the agricultural sector assumes greater importance. Poultry sub-sector is vital within the

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agricultural sector in the country. This sub-sector is with specific economic importance due to its high contribution in the value of the livestock sector. Among other poultry production sub-sectors, broiler production is one of the most important economic activities to the smallholder farmers in Jordan. In general, poultry production, overcome other livestock production sectors in many economic advantages such as higher rate of capital turnover, ease of management, and quick return to investment (Haruna and Hamidu 2004). In broiler production as well as other agricultural sectors, the core of economic efficiency is the resource-use efficiency. It means that given a certain level of inputs, broiler producers should be able to achieve maximum profit. It is obvious for resources a business purchases that the less it spends to produce a given amount of output, the greater its profitability. This implies that for producers to achieve their goals in earning more profit the available resources used in production should be efficiently utilized. Inefficient use of these resources and technologies by producers will end in more cost-effective efficiency improvement to increase output (Effiong, 2005; Ike, 2008). The importance of resource efficiency in increasing production has been widely recognized by researchers (Ike, 2008; Okoye, 2006; Ike and Inoni, 2006; Nwaru, 2005).

Economic efficiency refers to the use of resources to maximize production (Steven, 2003). It is the allocation of resources to their highest valued use. An economically efficient situation is that when production proceeds at the lowest possible per-unit cost of resource or it is an economic state in which every resource is optimally allocated. The result of achieving economic efficiency is that production of a unit of good is at the lowest possible cost. It is often subjective and very important to measure economic efficiency in different agricultural activities; broiler production is not an exception. Economic efficiency measures were the main issue to be addressed in many literature of poultry production analysis (Cooper et al., 1999; Briec and Lemaire, 1999; Ray, 1997; Färe and Grosskopf, 1997).

Few studies investigated the economic efficiency of livestock sub-sectors in Jordan. However, only two or three of these studies concentrated at broiler sub-sector. None of them determined the economic efficiency of resource use in broiler production. Thus, this study aimed at determining the economic efficiency of resource use in broiler production in Jordan. Determining economic resource-use efficiency will provide practical tools for decision makers to apply production policies needed to improve broiler production. In order to evaluate the economic efficiency of the investigated farms and to determine the optimum input to use, we applied two marginal concepts; they are the Marginal Value Product (MVP) and the Marginal Factor Cost (MFC).

II. MATERIALS AND METHODS

A. Broiler Production

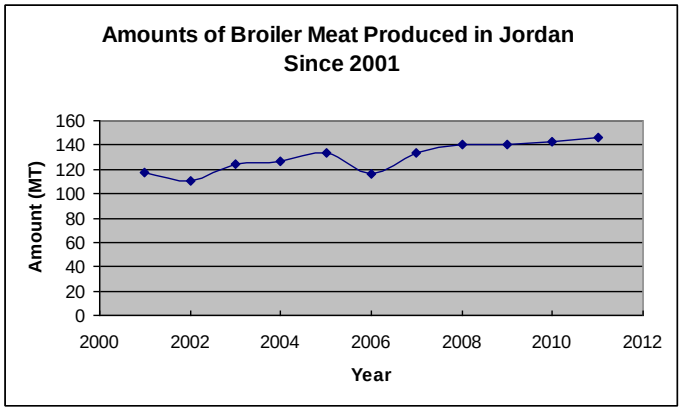
According to the records of the Department of Statistics (DoS, 2011), the total quantity of broiler meat produced in the country was 146000 metric tons with a value of 325,988,710 Jordan Dinars (one JD = 1.4 USD). These figures indicate the importance of broiler sub-sector in the country. The total amounts of broiler meat

produced in Jordan since 2001 are presented in table 1. The amounts in table 1 are shown in graph 1.

Table 1; Quantities of broiler meat produced in Jordan since 2001

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Production (1000 Metric Ton)	117	110	124	127	133	116	133	140	141	143	146

Source: Ministry of Agriculture (MoA), 2012.



Source: Prepared by researchers.

B. Sampling and data collection

A combination of simple random and purposive sampling procedures was followed in the present study. These procedures were followed to be sure that all categories of broiler farms according to size were represented in the sample. Farms were categorized into subgroups based on their capacity. Data collection involved the use of questionnaire complimented with interview schedule. A questionnaire was constructed and interviews were carried out to elicit information from farmers. The questions of the questionnaire were included to determine the needed information with focus on the use of inputs. Information was also obtained on personal characteristics of the sample farmers. A sample of 100 broiler farms was surveyed. However, data from 78 interviewers were used in the analysis. The other 22 were excluded due to lack of information.

C. Analytical framework

1. Resource use efficiency index

The present study applied the marginal analysis procedure to achieve its objectives in estimating the economic efficiency of the resource use in broiler production farms. This procedure is the most suitable one in this regard (Taru et al., 2010). Several studies adopted this procedure to achieve similar objectives. Estimating the resource efficiency using the marginal analysis procedure depends on comparing a computed Marginal Value Product of the variable inputs (MVPs) with their respective acquisition cost or the Marginal Factor Cost (Oladeebo and Ezekiel, 2006). The Marginal Factor Cost, usually abbreviated MFC, is the unit input price or the market price of the input (Pxi). The MFC measures the addition to total cost of an additional unit of an input. The MVP is the change in the value of output per unit change in

input. To compute MVP, the Average Physical Product and the Marginal Physical Product first obtained. Average Physical Product, usually abbreviated APP, is the output produced per unit of input used. APP is found by dividing total physical product by the quantity of the variable input. The Marginal Physical Product, usually abbreviated MPP, is the change in the quantity of total product resulting from a unit change in a variable input. MPP is found by multiplying APP with elasticities of factor inputs obtained from a regression model for the used inputs. The Marginal Value Product of the variable inputs (MVPs) then obtained by multiplying MPP with the unit price of the output (Py). The economic efficiency of resource use was determined by the ratio of MVP to MFC. The optimum amount of a variable input to be used when the ratio (r) of MVP to MFC is equal to one. In this situation, concerning resource use, the farmer maximizes his profits. Here the resource is efficiently used, that is optimum utilization of resource hence the point of profit maximization. If r is <1; reveals that MVP < MFC, the resource is excessively used or over utilized hence decreasing the quantity use of that resource increases profits. Finally, If r > 1; reveals that MVP > MFC, the resource is under used or being underutilized hence increasing its rate of use will increase profit level.

2. Multiple Regression Model

Broiler production technology could be specified by the linearized stochastic production function representing Cobb-Douglas production technology. Related to this specification a multiple regression model for the corresponding inputs was developed to obtain the parameters for the measurement (elasticities) of resource use efficiency of factor inputs. Several studies (Gani and Omonona, 2009; Fasasi, 2006; Alene, 2002 and Anene, *et al.,* 2010) used Cobb Douglas production function to measure resource use efficiency. In this model, the factor inputs donated X_1 to X_8 representing; number of day old chicks (X_1), amount of labor (X_2), cost of veterinary services, drugs, and vaccines (X_3), cost of feeds (X_4), farmer experience in poultry production (X_5), education level of the farmer (X_6), and cost of poultry equipment (X_7), The implicit form of the model is as follows (equation 1);

$$Y = f(X_1 , X_2 , X_3 , X_4, X_5, X_6 , X_7, U) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where

Y = quantity of broiler meat produced (Tons)
X_1 = number of day old chicks
X_2 = labor input (hrs)
X_3 = cost of veterinary services, drugs, and vaccines (JDs)
X_4 = cost of feeds (JDs)
X_5 = farmer experience (years)
X_6 = farmer education level
X_7 = cost of poultry equipment (JDs)
μ = stochastic error term

Among other fitted functional forms, the double log form was chosen based on goodness of fit depending on the highest value of adjusted R^2 and F-value. The form is presented below (equation 2):

$$lnY = ln\beta + \beta_1 lnX_1 + \beta_2 InX_2 + \beta_3 lnX_3 + \beta_4 lnX_4 + \beta_5 lnX_5 + \beta_6 lnX_6 + \beta_7 lnX_7 + \beta nlnXn + U_i \text{……..(2)}$$

Where
ln = Natural logarithm
β= constant
Y, X_1, X_2 … X_7, and *Ui* is as defined in equation (1).

III. RESULTS AND DISCUSSION

A. Production function estimates

The estimated form of the developed Cobb-Douglas production function for broiler farms is given in Table 2.

Table 2. Estimated Cobb Douglas production function for broiler farms

Factor	Coefficient	t-value
Constant	9.8661	4.1047*
X_1 (number of day old chicks)	1.0312	10.257**
X_2 (labor input)	0.6541	2.6412*
X_3 (cost of veterinary services, drugs, and vaccines)	0.0754	0.5714**
X_4 (cost of feed)	- 0.2359	- 3.0013**
X_5 (farmer experience)	0.9873	1.7492*
X_6 (farmer education level)	0.5027	7.0283*
X_7 (cost of equipment)	- 3.4782	- 4.0281**

**Significant at 1% level; *Significant at 5% level;
R^2 = 0.837 Adjusted R^2 = 0.853 F = 214.02*.
Source: authors' computation.

The results of the production function estimates showed that the included explanatory variables explained 84% of adjusted variability observed in broiler production in the sample. The remaining 16% was because of residual error. The results also showed that any increase in any of the included variables except the cost of feed and the cost of equipment would lead to an increase the quantity of broiler meat produced. The effect of all the included variables was significant at 1% or 5% levels of significance. Variables of total number of day old chicks, cost of cost of veterinary services drugs, and vaccines, cost of equipment, and cost of feed are with the most significant effect.

Cost of feed and cost of equipment are negatively related to the dependent variable (quantity of broiler meat produced). The implication of this negative relation is that an increase in each of these variables would lead to a decrease in the quantity of broiler meat produced. A 1% increase in cost of feed will end in decreasing the quantity of broiler meat produced by 0.24% and a 1% increase in cost of equipment will end in decreasing the quantity of broiler meat produced 3.5%. The estimated coefficients in the production function are the inputs elasticities of production. These elasticities are presented in table 3.

Table 3. Elasticities of factor inputs

Factor	Elasticity
X_1 (number of day old chicks)	1.0312
X_2 (labor input)	0.6541
X_3 (cost of veterinary services, drugs, and vaccines)	0.0754
X_4 (cost of feed)	- 0.2359
X_5 (farmer experience)	0.9873
X_6 (farmer education level)	0.5027
X_7 (cost of equipment)	- 3.4782

Source: authors' computation**.**

B. Resource use efficiency

Economic efficiency of resources use in broiler production was determined using the ratios of their Marginal Value Product (MVPs) to the Marginal Factor Cost (MFC). The results of economic efficiency of resources are presented in table 4 below.

Table 4; Resource Use Efficiency Indicators

Factor	MVP	MFC	Efficiency	Description
X_1 (number of day old chicks)	146.87	93.75	1.57	underutilized
X_2 (labor input)	0.6781	3.125	0.217	over utilized
X_3 (cost of veterinary services, drugs, and vaccines)	33.825	1.337	25.29	underutilized
X_4 (cost of feed)	- 490.62	750	- 0.654	over utilized
X_5 (farmer experience)	-------	-------	-------	
X_6 (farmer education level)	-------	-------	-------	
X_7 (cost of equipment)	- 2.4625	1.500	- 1.641	over utilized

Source: authors' computation**.**

Comparison of the ratios of the MVP to MFC for each input factor shows that two resulting ratio were greater than unity; number of day old chicks and cost of veterinary services drugs, and vaccines, indicating that these two inputs were under used or being underutilized on the farms during the production process hence increasing their rate of use will increase output and profit level. Three resulting ratios were less than unity; labor input, cost of feed, and cost of equipment indicating that these inputs were excessively used or over utilized hence decreasing quantity of the inputs use will increase output and profit level. This confirms the hypothesis that and profit level. This confirms the hypothesis that resources are not efficiently utilized.

IV. CONCLUSIONS

The paper concludes that total number of birds, amount of labor, cost of veterinary services, drugs, and vaccines, cost of feeds, farmer experience in poultry production, education level of the farmer, and cost of poultry equipment significantly influenced broiler meat production in Jordan. However, cost of feed and cost of equipment negatively affected broiler meat production. Marginal analysis of input showed that

farmers were inefficient in their production practices concerning the above-mentioned factors as indicated by the ratio of marginal value product (MVP) and marginal factor cost (MFC). The ratio revealed that the utilization of these factors is inefficient. Feed and equipment costs were actually underutilized in the production process indicating that farmers are not using these two inputs efficiently. The same conclusion could be derived regarding the other used inputs since they are over utilized. To address this issue, government should provide subsidized inputs to farmers along with proper extension services, which will help in enhancing productivity and profitability. In addition, subsidized credit facilities to farmers may catalyze this process. In addition, farmers need to adjust the usage of the resources, appropriately. Feed, labor, and equipment should be re-adjusted downwards.

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