Estimating Milk Production Function Per Cow at Alhira Agricultural Project

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ABSTRACT

The main objective of this research paper is to estimate a milk production function per cow during a period of twelve months in 1989. Cobb-Douglas function was used to show the relationship between the dependent variable (milk production per cow), and the independent variables (concentrate intake per cow, green forage intake per cow, and dry forage intake per cow). All relevant data were collected from the official records of Alhira Agricultural Project for Poultry and Milk Production. The ordinary least square technique was used as an econometric tool to estimate the proposed multiple regression function. The green forage, and dry forage intake per cow had almost the same effect on milk production per cow. The estimated milk production function was homogenous of a degree less than one, and showed a decreasing return to scale.

INTRODUCTION

Understanding the characteristics of the dairy industry is important in specifying milk production function, and determining factors that affect milk production. Milk production needs a number of specialized inputs such as dairy cows, machinery, buildings, and management. Once specialized inputs are employed in milk production, they become relatively fixed assets. Dairy farmers can adjust milk production in the short run by changing feeding practices and culling rates. Major production increases involve increase in the size of the milking herd. It takes about 3 years from the decision to breed a cow until the offspring begin to lactate.

The production function in general is a physical and biological concept. It shows the maximum amount of output that could be produced from different quantities of the relevant inputs. One of the basic reasons for estimating agricultural production function is to provide information for agricultural economists and policy makers in giving recommendations to farmers in making their individual decisions.

The milk production function hypothesized in this paper was mainly based on logic and the theory of production which indicates that the amount of feed intake per cow (concentrates, green forage, and dry forage) plays an important role in determining the level of milk production in the short run.

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The main objective of this paper was to estimate a milk production function per cow. Additional objectives included:

1) Identifying and determining the effect of the important factors influencing milk production per cow.

2) Estimating the partial and total elasticity of production.

3) Estimating the degree of homogeneity and returns to scale.

MATERIALS AND METHODS

Researchers are usually faced with decisions, when constructing any multiple regression model, deciding on the set of explanatory variables, and determining a functional form of the relationship. Economic theory and logic provide useful insights for the choice of the set of independent (explanatory) variables. The use of any specific functional form implies some assumptions about the underlying relationship between the dependent and independent variables]. Based on literature review and economic theory, Cobb-Douglas production function was used in this paper, because of its convenience in interpreting elasticity of production. The use of this function involves simple computations and estimation of its parameters involves fewer degrees of freedom.

The variables that were considered in this analysis are defined as follows:

Y = average milk production per cow in liters/month.

X_1 = average quantity of concentrates consumed per cow in Kg./month.

X_2 = average quantity of green forage consumed per cow in Kg/month.

X_3 = average quantity of dry forage consumed per cow in Kg/month.

The theoretical function used in this study expressed in algebraic form is as follows:

$$Y = AX_1^{\alpha_1} X_2^{\alpha_2} X_3^{\alpha_3} e^{\mu_t}$$

Multiple regression was used as an econometric tool to estimate the proposed function based on monthly time series data of the year 1989. Natural logarithm was used for the original data to transform the non-linear function to a linear one for ease of estimation by using ordinary least square (OLS). The function to be estimated was:

$$\text{Ln } Y = \text{Ln } A + \alpha_1 \text{ Ln } X_1 + \alpha_2 \text{ Ln } X_2 + \alpha_3 \text{ Ln } X_3 + \mu_1$$

All the variables defined earlier were collected from the official records of Alhira Agricultural Project for Poultry and Milk Production.

RESULTS AND DISCUSSION

The results of the estimated milk production function are reported in Table 1.

Table 1 – Estimated Milk Production Function.

Dependent Variable	Independent variables				F-Ratio	R^{-2}
	Intercept	Ln X_1	Ln X_2	Ln X_3		
Ln Y	3.261	0.288	0.169	0.167	3.4	0.40
	(2.796)*	(2.129)	(2.689)	(1.944)		

(*) The number in parathesis below each coefficient is t-ratio.

The estimated coefficients of the various variables were significant at 5 percent level. Adjusted R^2 was 0.40 which means that about 40 percent of the variation in the logarithm of the dependent variable (milk production per cow) is explained by the logarithm of the explanatory variables included in the model. F-ratio was 3.4 which means that none of the coefficients of the expalanatory variables was to be equal to zero.

It was expected that an increase in the feed intake per cow would result in an increase in milk production per cow. Therefore it was expected that the signs of the coefficients of the various variables were to be positive. The estimated milk production function per cow in its Ln-form could be expressed in its original Cobb-Douglas form as follows:

$$Y = 26\ X_1^{0.288}\ X_2^{0.169}\ X_3^{0.167}$$

As expected, the concentrate intake per cow is the most important determinant of milk production per cow. The results indicate that for a one percent increase in the quantity of concentrate intake per cow, provided that other factors remain constant, milk production per cow will increase by 0.288 percent. Therefore the factor (concentrate) elasiticity is 0.288. The green and dry forage intake per cow almost had the same level of influence on milk production per cow. The factor elasiticity of green forage is 0.169 and the factor elasiticity of dry forage is 0.167.

The function coefficient (total elasiticity of production) (1). Which measures the proportionate change in output, resulting from a unit proportional change in all inputs is 0.624. Therefore, the estimated milk production function per cow exhibits constant proportional returns, and homogenous function of degree less than one. The function therefore, exhibits a decreasing return to scale.

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تقدير دالة إنتاج الحليب للبقرة بمشروع الهيرة الزراعي

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المستخلص

تهدف هذه الورقة البحثية إلى استنتاج دالة إنتاج الحليب للبقرة، وحساب مرونات الإنتاج الجزئية والكلية، بالإضافة إلى تحديد أثر كل من المدخلات التي تؤثر على إنتاج الحليب للبقرة. ولأجل تحقيق هذه الأهداف تم تجميع بيانات شهرية عن عام 1989 لكل من متوسط الإنتاج الشهري من الحليب للبقرة، ومتوسط استهلاك العلفة المركزة للبقرة، ومتوسط استهلاك الأعلاف الخضراء للبقرة، ومتوسط استهلاك الأعلاف الخشنة للبقرة. وقد تم تجميع هذه البيانات من السجلات الرسمية بمشروع الهيرة الزراعي لإنتاج الدواجن والحليب.

وتم استخدام دالة كوب ـ دوغلاس لتحديد نوعية العلاقة التي تربط بين المتغير التابع (متوسط إنتاج الحليب للبقرة) والمتغيرات المستقلة (العلفة المركزة والأعلاف الخضراء والأعلاف الخشنة). وتم أيضاً استخدام طريقة المربعات الصغرى لتقدير معلمات المتغيرات المستقلة.

وتوضح نتائج هذه الدراسة بأن الكمية المستهلكة من الأعلاف المركزة تعتبر من أهم المدخلات التي تؤثر على إنتاج الحليب للبقرة. ويأتي بعدها في الترتيب كل من الأعلاف الخضراء والأعلاف الخشنة. كما توضح النتائج أن مرونة الإنتاج الكلية لكل من الأعلاف المركزة والأعلاف الخضراء والأعلاف الخشنة كانت 0.624 مما يعني أن الدالة الإنتاجية متجانسة بدرجة أقل من الواحد الصحيح وبالتالي تتصف بتناقص عائدات السعة.

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