ECONOMIC IMPACT OF SELECTED MILK PRODUCTION DETERMINANTS ON MILK PRODUCTION IN THE SUDAN: A CASE OF BELGRAVIA DAIRY FARM

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ABSTRACT

This study aimed at examining the impact of some of the main factors (ration composition, temperature, rainfall and milking numbers) affecting milk production on the quantity of milk produced by Belgravia farm during the period 1984-2002. Both primary and secondary data were used although secondary data was the main data sources. Secondary data was collected from Belgravia Dairy Farm's records and Metrological Corporation. Regression analysis technique was used to attain the stated objectives. The results of the selected multiple linear regression model revealed that the coefficients on forages for both Berseem (Medicago sativa) (0.037) and Abu-70 (Sorghum bicolor L Moench) (0.045) were found to be highly significant with positive signs; indicating that a unit increase in each of the independent variable (Berseem and Abu-70) increase milk production by the corresponding amount of elasticity. On the other hand, the impact of other explanatory variables (concentrates, temperature, rainfall and milking numbers) on milk production were found to be insignificant though got a negative sign, except the last one. This indicates that, concentrates used by Belgravia Dairy Farm were more than the required. Accordingly, to improve the farm milk production, rations are to be carefully prepared taking in mind the positive impacts of forages (Berseem and Abu-70) and negative effects of concentrates on milk production, that is, forages and concentrates are to be used economically.

الملخص:

هدفت هذه الدراسة لدراسة تأثير بعض أهم العوامل المؤثرة في إنتاج الالبان (تركيبة العليقة و درجة الحرارة وكمية الامطار وعدد مرات الحليب) علي كمية اللبن المنتج من مزرعة بلغرافيا خلال الفترة 1984–2002. أستخدم كل من البيانات الاولية و الثانوية الا ان الثانوية كانت اهم المصادر. جمعت

البيانات الثانوية من سجلات مزرعة بلغرافيا لانتاج الالبان وهيئة الارصاد الجوي. أستخدم أسلوب تحليل الإنحدار للوصول للأهداف المزكورة. أظهرت نتائج نموذج الانحدار الخطي المتعدد الذى تم إختياره أن معامل الأعلاف (كل من البرسيم وابو–70) كانت موجبة وعالية المعنوية. مما يعني ان زيادة وحدة واحدة لكل من العوامل المستقلة (البرسيم وأبو–70) علي حدة يزيد كمية اللبن المنتج بكمية المرونة المقابلة لكل منهما. من جهة اخري ، فان العوامل المستقلة الاخري (المركزات ، درجة الحرارة ، الامطار ، وعدد مرات الحلب) قد كانت ذّات تأثير غير معنوي ولكنها سالبة الميل عدا الاخيرة منها. هذا دليل علي ان كمية المركزات المستخدمة بواسطة هذه المزرعة أكثر من المطلوب. وعليه لزيادة الألبان المنتجة من هذه المزرعة لابد من إعداد العليقة بصورة جيدة واضعين في الاعتبار العلاقة الايجابية للاعلاف (البرسيم ة وأبو–70) والسلبية للمركزات مع كمية اللبن المنتج . بمعني اخر يجب إستخدام الاعلاف والمركزات بصورة إقتصادية.

INTRODUCTION

Sudan is the leading Arab and African country in terms of livestock resources. Its total livestock population, which scattered all over the country, was estimated in 2007 at 139 million heads, out of which there are 41, 51, 43 and 4 million heads of cattle, sheep, goats and camels, respectively (Table 1). The average annual growth rate of this sector was estimated in 2005 at 3.2% (HAC 2006).

Table 1. Sudan's total livestock number by state in 2007 (000 heads)

State	Cattle	Sheep	Goats	Camel
Northern	428	1955	2323	146
Kordofan	6594	10049	6248	1560
Darfur	8783	11194	9296	1005
Eastern	1497	3374	2970	1086
Central	11375	11062	8626	435
Southern	12226	12587	12837	0
Khartoum	234	431	635	6
Total	41137	50651	42938	4238

Source: MARF (2007)

Livestock sector plays a significant role in Sudanese economy, providing livelihood for large sectors of the population, enriching people diets with a high

source of proteins, vitamins and minerals and contributing up to 21% to the country's gross domestic product (GDP) (HAC 2006). Within livestock sector, dairy-production represents one of the major practiced activities. Milk-production and consumption in Sudan increased consistently over-time with cattle-milk constituting the lion share (Table 2). In 1999, the Sudanese per capita consumption of milk was estimated at 219.7 kg/annum (Ahmed 2006).
Despite the large numbers of dairy-animals in the country, yet the potential of this sector is not fully exploited, especially in terms of the need for further business-oriented integration of its production and supply activities in the economy. This implies the importance of directing dairy-producers towards efficient utilization of their limited resources with ultimate goals of boosting efficient functioning of this sector. Accordingly, the country adopted the Green Mobilization Program (GMP) in order to improve the country agricultural and livestock sectors, hence various policies for encouraging and improving modernized dairy sub-sector were set (HAC 2006).

Table 2. Estimated amount of milk production in the Sudan 2002/06 (1000 Tons)

Years	Cattle	Sheep	Goats	Camel	Total
2002	5445	464	1347	42	7298
2003	5494	464	1384	45	7387
2004	5384	475	1500	46	7405
2005	5480	487	1519	48	7534
2006	5274	492	1437	50	7253

Source: MARF (2007)

Although, Khartoum state holds the lowest numbers of cattle compared with other states (Table 1), but it represents the major modernized dairy production center specialized in commercial milk production. Belgravia is the oldest modern farm specializing in dairy production in the Sudan (Ahmed 2006). It was established by the British colonial in 1907 in order to supply the British army with milk and milk products. In 1982 the farm was handed over to Sudanese armed forces. Since then the farm was supplying the arm forces with milk and milk products at subsidized prices. The farm management always adopts different strategies for improving their farm's production. Recently, the farm was faced with financial problems as milk produced by the farm showed

continuous fluctuation in quantity. These instabilities in milk-production could be attributed to constant increase in factors of production over-time. In view of the fact that feeding costs represent the highest running cost item for most of the dairy farms (50-70%) (Abdel Magid 1986; Abdel Rahman and Ahmed 2007), accordingly, this factor should be given the utmost care and used in an optimal manner. Optimization of feed composition could be done by determining and quantifying the most limiting factors that affect milk production. Apart from ration-quantity there are many other factors affecting milk production in Belgravia farms. Among these factors are: environmental factors, mostly rainfall and temperature. As an increase in temperature beyond certain level usually disturbs dairy-cows and leads to sizeable reduction in milk production. Further, an increase in temperature above 38 C^{o} greatly reduced feed intake (by more than 60% from the normal condition) (Sheerer and Beede 1990). On the other hand, rainfall in the Sudan fluctuates consistently over-time. Rainfall usually related to high relative humidity and high relative humidity disturbs animal and depresses milk production accordingly, any increase of rainfall beyond certain level negatively affects milk production

Accordingly, this study was carried out to examine the impact of some of the main factors affecting milk production; ration composition, environmental factors and milking practices on the quantity of milk produced by Belgravia farm during the period 1984-2002.

METHODOLOGY

This study was conducted at Belgravia Dairy Farm, Khartoum North, Sudan. The total number of the farm's herd in 2001/02 season, which were entirely hybrid (Kenana and/or Butana Friesian mix), was 260 heads. The herd was composed of (40%) milking cow, (42%) dry cow, (10%) heifers, (7%) calves and (1%) reproductive bulls. The feeding practice adopted at Belgravia farm, when this study was conducted, was feeding a lactating cow twice/day with concentrates (6 kg), Abu-70 (*Sorghum bicolor L Moench*) (18 kg) and Berseem *(Medicago sativa*) (2 kg). The remaining numbers of herd were fed once a day with concentrates and twice a day with Abu-70. The concentrates composed of wheat bran (43%), sorghum grains (16%), groundnuts cake (27%), molasses (5%),

groundnuts hull (7%) and salt (2%). The farm devoted almost all of its land (230 feddan) to cultivation of abu-70. The farm's annual average production of Abu-70 was 1115 tons, that is, the average yield/feddan was 5.5 tons. But, nevertheless, the total production of the farm's forages from Abu-70 and Berseem did not meet the herd total requirements which amount at 3234 tons/annum. The farm bridges this gap through purchasing Abu-70 and Berseem from the market (Birima 2004).

This study was based on both primary and secondary data, although secondary data represents the main data source. Data on average monthly milk produced per cow, average monthly number of milking cow/day, monthly consumed quantities of forages (Berseem and Abu-70) and concentrates, average monthly temperature and rainfall for the period 1984-2002 were collected from Belgravia farm's records, Central Bureau for Statistics and the Meteorological Corporation.

To assess the effect of the range of aforementioned milk production determinants at Belgravia Dairy Farm for season 2001/02 on the milk production, regression analysis technique was carried out. Linear, semi log, double log (Cobb - Douglas), exponential and square root functional forms were fitted to the same pool of explanatory variables and milk production. The regression function was written in the following form (Olayide and Heady 1982):

$$\mathbf{Y=a+ b_1 X_1+b_2X_2+\ldots\ldots\ldots +b_nX_n+ e}$$

Where:

Y=dependant variable

$X_{1-}.X_n$=independent variables

$b_1\ldots\ b_n$ =coefficients to be estimated

a= the intercept.

n= total number of the independent variables

e=an error term which assumed to be normally distributed

The linear functional form was, however, selected for interpretation.

The selected functional form was as follows.

$$Y=a+ b_1 X_1+b_2X_2+b_3X_3 +b_4X_4+b_5X_5 +b_6X_6$$

Where:

Y=average amount of milk produced (tons/month).
X_1=average monthly number of lactating cows
X_2=average consumed quantities of Berseem (tons/month)
X_3= average consumed quantities of Abu-70 (tons/month)
X_4= average consumed quantities of concentrates (tons/month)
X_5= average monthly temperature (C^o)
X_6= average monthly rainfall (mm)
b_1, b_2, b_3, b_4, b_5 and b_6 are coefficients to be estimated
a= the intercept.

The selection was based on the magnitude of the coefficient of multiple determination, R^{-2}, the significance of t-value, the overall significance of the F-value and the correct signs of the parameters.

RESULTS AND DISCUSSION

The results of the selected linear functional form is presented in Table 3.

Table 3. Regression coefficients of the milk linear production function in Belgravia farm

Variable	Regression coefficient	T-value	Significance level
Number of lactating cows	0.23	1.19	0.2453
Consumed quantities of Berseem	0.37**	4.39	0.0002
Consumed quantities of Abu-70	0.45**	3.22	0.0039
Consumed quantities of concentrates	-0.34	-0.28	0.7807
Temperature	-0.22	-1.02	0.3204
Rainfall	-0. 02	-0.91	0.3741
Intercept	1.38**		0.000

R-square=0.94
F-ratio=541.39 (0.0000)
**T- value which significant at 1% level.
* T- value which significant at 5% level.

From Table 3, the R^{-2} was 0.94 percent. This implies that 94% of the total variation in milk production was explained by the explanatory variables in the model. This indicates a high degree of association between the independent and

the dependent variables. The F-statistics was 541 and is highly significant, implying that the independent variables were collectively important in explaining the variation in the dependent variable (milk production).
The resulted regression equation is therefore:

$$\mathbf{Y = 1.38 + 0.23X_1 + 0.37X_2 + 0.45X_3 - 0.34X_4 - 0.22X_5 - 0.02X_6}$$

The regression analysis results revealed a positive and significant relationship between consumed quantities of Berseem and Abu-70 and milk production per month at 0.0002 and 0.003 probability levels, respectively. This means that consumed quantities of Berseem and Abu-70 are significant at 99.9% confidence level in explaining the variation in milk production. This result shows that a one unit increase in each of the consumed quantities of Berseem and Abu-70 will increase the milk production by 0.3725 and 0.4490 tons/month, respectively. In other words, the amounts of these two forages given to the milking cows were less than the recommended. The main reason for that could be due to the shortages in the quantities of Berseem and Abu-70 produced by the farm. This confirms what Abdel Rahman and Ahmed (2007) mentioned; there is a positive relationship between consumed quantity of forages and milk production. Accordingly, to improve the farm milk production, rations are to be carefully prepared taking in mind the positive relation between forages (Berseem and Abu-70) and milk production. So, in order to increase milk production (milking herd) forages are to be increased to levels that do not harm production, (see theory production function). Treatment of forages (particularly dry one) with Urea would also improve milk production (Ahmed 2000; Abdel Rahman and Ahmed 2007).
The coefficient on consumed quantities of concentrates was found to be insignificant and got a negative sign. This means that the quantity of concentrate utilized by Belgravia Dairy Farm in feeding their milking cows was more than the recommended. That is, concentrates used by the farm might be at the third stage of the production function (Olayide and Heady 1982). The insignificance impact of this factor on milk production could be attributed to the fact that, at low level of forages, milking-cows use the concentrates instead of forages to satisfy their basic requirement rather than producing milk (Abdel

Rahman and Ahmed 2007). Accordingly, the farm administration should adopt the recommended amount of the feed-mix.

The coefficients on the environmental factors (temperature and rainfall) were found to be negative but insignificants. The negative relation between milk production and temperature could be due to the fact that increasing temperature usually increase cows' requirements of drinking water and decreases their feed intake, hence, reducing their milk production. This comes in line with Beeds et. al. (1993) as they mentioned that, an increase in temperature disturbs dairy-cows in terms of digestion, nutrients absorption, mineral and water metabolism and acid-base balance, hence negatively affects their milk production. On the other hand, the reasons for the negative relation between milk production and rainfall might results from the fact that high rainfall raise relative humidity and inversely affect farms' yard leading cows to become in a continuous restlessness, hence, greatly reduced their milk production. This comes in conformity with Folly et al. (1973) who reported that the increase of relative humidity above certain level, which associated with rainfall, decreases the volume of blood that provides the udder gland with the required energy and reduces the secretion of some hormones like prolactin, hence milk productions falls down. The insignificant levels for both environmental factors (temperature and rainfall) could be attributed to adaptation and acclimatization of Belgravia cows' breeds to Sudanese environmental conditions (more than 100 years old farm). The results of the study suggest that, the farm's management should take all the required measures in rehabilitation of the farm's shaded areas and ground floors, taking in mind measures of good ventilation during hot weather and floods aversion during rainy seasons.

The coefficient on the number of milking/cow was found to be highly insignificant with a positive sign. The insignificant level could be to the fact that regardless of the number of milking cows/day there will be a specific amount of milk produced/cows/day, other factors remain constant.

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