AIN SHAMS UNIVERSITY

TENTH INTERNATIONAL CONGRESS
FOR
STATISTICS, COMPUTER SCIENCE, SOCIAL
AND DEMOGRAPHIC RESEARCH
30 MARCH — 4 APRIL 1985

AN ANALYSIS OF THE BUFFALO MILK RESPONSE UNDER THE CONVENTIONAL EGYPTIAN FARMING SYSTEM

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1985

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INTRODUCTION

The Dairy Buffalo is the main milk animal in Egypt. Buffaloes provide about two-thirds of total milk production, while native cattle produce about 30 percent. The share of milk produced by foreign cattle and crossbred cattle is at present insignificant. Milk is produced in Egypt under several different systems. The dominant structure is that of the traditional mixed agriculture farming system. This system produces more than 80 percent of total milk production [1]. This traditional system is characterized by very small herd size, typically comprising just one or two buffaloes and native cows [2]. Costs per kilogram of buffalo milk adjusted to a 4 percent fat basis, at shadow prices of inputs, is the cheapest at 15 piasters per Kilogram, 1981 prices[1].

Surprisingly, it was proved that the smaller the farm, the higher is the milk yield per head [2]. The extent of work of the buffalo or the native cow on farm during the milking period has, in general, a negative impact on milk yield. However, this depends upon the type of the animal, the type of the work and its relative intensity [3] and [4]. Surprisingly, a recent work [5] has shown from a milk production function of the traditional farm that only plaugh work done by a milk animal, depresses milk output and using a milk animal for irrigation has positive effect on milk production[4].

The present study is a further attempt to, accomodate and to analyse available hypotheses concerning the buffalo milk response under the traditional farm system. As such it forms a part of a broader study aimed at modelling the milk supply system in Egypt.

DATA BASE:

Data used in this study was processed from a livestock sample survey conducted in 1981(1). It covered 4 farm size classes (between less

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(1) Finacial support of this study was provided by the (ADS) Agricultural Development Systems (project) in Egypt-Ministry of Agriculture and USAID.

than one feddan to above 5 feddans), in 8 villages from 4 Governorates in lower Egypt (Nile Delta). These governorates are: Sharkia, Kaliobia, Monofia and Gharbia. The sample included 189 farms from which 163 farms were milk producers. However, some farms were excluded from the present analysis because of inconsistancy with respect to milk production data. The observations in the present analysis were the number of milk heads. The total observations for the buffalo milk response estimation were 240 heads.

METHODOLOGY:

The model used here is not a classical milk production function for inputs use optimization. It is in fact a micro-economic positive approach to milk response analysis. It aims to identify the significance of the effect of some specified variables and the direction of the effect (sign of the regression coefficients). The magnitude of the effect is not the principal concern of the paper. The model includes variables of both a techincal natures (e.g. Lactation number) and economical nature (e.g. farm sizes and region).

The model used OLS for multiple regression estimations. Some preliminary estimates were conducted before reaching the presented form in this study. Two separate functions for two regions within the sample were estimated. Application a covariance analysis of the two regions estimated model proved that the region has a significant effect. Farm size in quantitative term showed a negative relation with milk yield per head (either linear, log or quadratic), which indicates that the smaller farm size classes hold more productive animals. However, farm size is, in fact a management function. Therefore, it is better that it be introduced as a dummy variable. On the other hand, the lactation number in quantitative term, showed a significant positive effect on milk yield per head. However, because the data is of a cross-sectional type, the effect of the lactation number is not contineous over time. It causes up (or down) ward movements of the milk response surface. Consequantly, it was expressed as a dummy variable.

From all erliar trials, the final estimated milk response included three sets of dummy variables four dummy variables which are included to express the farm size effect, four dummy variables to express the lactation number and two dummy variables to express the region effect. It was seen that omitting the first dummy variable from each set would avoid the singularity problem of the $(X' X)^{-1}$ matris.

The quantitative variables used are: Animal work, feeds and the dry period. In the model feed inputs were expressed as two aggregate variables: Energy (starch equivalent) and protein (Digestive protein). However, there was a multicolinearity between the energy and protein variables ($r = .91$). Therefore, they were substituted for a single aggregate variable (TDN kilograms) per head.

Earlier work suggests that the effect of animal work depends upon the type of work and its intensity. To accommodate this, three variables were introduced: Hours per day, Hours for irrigation and Hours for other farming operations (e.g. ploughing and threshing operations). Dry period was expressed as days per head.

Analysis of variance, t-test and the coefficient of determination were applied to test the significance and goodness of fit of the estimated regression model. The dependent variable was the milk yield per milk animal. The symbols of the model's variables and their measusrement units are presented in table 5. As shown earlier, preliminary estimations indicated to classify the data into two regions. Region 1 included 109 observations as milk buffaloes. Region 2 includes 131 observations as milk. buffaloes.Up to a significance level 0.10 was considered satisfactory for verifying difference of the estimated regression coefficient from zero, because it is a field cross-section data. Estimate of the regression constant (intercept), i.e. B_o expresses, practically, the average yield per head under 1st lactation, the smllest farm size (o $\leq$ to 1 feddan), and region 1-conditions.

ESTIMATED BUFFALO MILK RESPONSE:

Table 1 presents a definition for each variable included in the model. Table 2 presents the estimated parameters and their T-score of the buffalo milk response. The following sections of the study explains and analayses the effect of each variable on milk yield per buffalo. Estimated coefficient of determination "R^2" was 0.54, which is not low, considering the nature of the data and also it was significant because the extimated F ratio was 20.82. i.e, statistically, significant at $P \leqslant .01$. According to the R^2 value, the fitted model explains 54 percent of the variability of the milk yield per head.

FARM SIZE EFFECT:

Although the number of milking buffaloes on the farm increases as the farm size increase, as table 3 indicates, investigation of the estimated model in table 2 shows that the farm size effect on milk yield per head is negative. Larger farm size class holds less productive buffaloes. Milk buffaloes on farms of 1-3 feddans provide yields inferior to those on the smaller farms, the margin being around 281 kgs. For the larger farm size category (3-5 feddans) this margin exceeds 309 kgs. Average yields on the largest farm size class are inferior those on the smallest farms by a margin of around 356 kgs. All estimates (B_1. B_8 and B_9) were, statistically, significantat($P \leqslant .01$).

The question to be answered conserns the reasons for this surprising result. One possible explaination is that the genetic quality of small farm buffaloes is superior. If this explaination is correct, it implies that the breeding improvement program should be focused upon smaller farm sizes herd. Even if it is due to better management practicies of the smaller farms, this would also imply to focus on this category.

Investigation of the costs structure per milk buffalo from the same sample according to farm size class is presented in tables 4. This table, indicates that larger farm size uses green fodders more intensively, wheares smaller farm size uses much more grains, legumes, brans and concentrate feeds. On the other hand, smaller farm size purchases higher percentage of both individual and total feeds requirements (table 3). This shows that the smaller farm size insists to cover all feed requirements per milk buffalo, even from off-farm sources. Although table 4, shows that costs of the veterinary services per head increase as the farm size increases, the smaller the farm size the higher is the percentage of the farms that provide veterinary services to their milk buffaloes (table 3).

Gross output structure per milk buffalo (table 5), indicates that the smaller farm size uses the milk buffalo for workk less extensively than the milk buffalo with a larger farm size. Whereas, the milk buffalo with a small farm size obtains higher level of concentrate feeds and does less work effort for farm operations, it recieves less Energy and Digestive protein per year than the milk buffalo with a large farm size (table 3). This evidence may support the hypothesis that the genetic quality of the milk buffalo, holds by the small farm size, is superior.

While, on the other hand, this may be partially explained by looking at the inputs combination and the buffalo reproductive performance on the smaller farm sizes, it also requires explaination in economic terms. On small farms, the agricultural land endowment is limited and with it, the expected crops income is low. Family size density per feddan is high [2], while labor aboundance coexists with capital scarcity . Accordingly, expantion of livestock activities such as fattening, broiler production, or even purchasing of additional milk cattle is rarely feasible. Consequently, the small farmer tends to expand output by vertical means. This can be achieved by holding a stock of more productive milk buffaloes. Subtraction of the total costs per head (table 4) and the total return per head (table 5) shows that the income generated (normal profit) from a head of the milking buffaloes increases as the farm size decreases. Wheares the smallar farm size obtains L.E. 168 per milk buffolo, the largest catigory obtains L.E. 132.

REGIONAL EFFECT:

The estimated milk response model, table 2, indicates that the regional effect adds, significantly, (at $P \leqslant .01$) about 608 kilograms of milk to the productivity of the milk buffalo per head. It means that the buffaloes in the second region are more productive than the first region. Investigation of the characteristics of both regions shows that the second region, in comparison with the first, enjoys locational advantages through, being very close to a big urban market (Tanta City) and, also, its approximitly to the Cairo-Alexandria Country high-way. The producers of the second region, thus, face relatively high sale prices for milk products and lower transportation costs. The level of infra-structure in this village is, relatively, advanced. These marketing facilities provide considerable incentives to expand the milk supply of the buffalo milk on the traditional farm in an intensive form, in terms of higher yield per head. This type of intensification could be explained in terms of costs and returns. From table 6, the total costs per milk buffalo in the region No. 1 was around L.E. 319.6, whereas it was only L.E. 203 in the region No. 2. The gross output value per milk buffalo was around L.E. 529.2 and L.E. 727.4 in the region No. 1 and No. 2, respectively (table 7). The difference between the total costs and the gross output results is the normal profit. It was L.E. 209 per milk buffalo in the region No. 1 and L.E. 524.4 per milk buffalo in the region No. 2.

Some evidences could be discussed, concerning higher productivity of the milk buffalo in the second region. Table 7 shows that the buffalo in region No. 2 is almost specialized in milk production. Milk output is around two-thirds of total output and the animal does not work extensively on the farm as the value of animal work is less than 5 percent of the total output per head (L.E. 33.4). In the region No. 1, milk output value is only 54 percent of the total output and the imputed value of the work per unit buffalo is around 12 percent of the total output (L.E. 62.2).

Another evidence is raised from investigation of the feed use pattern per milk buffalo. Table 6 shows that the buffalo milk producers in the second region use, almost entirely, green fodders (mainly berseem) during the milking season. The green fodders quantity per head reaches about 10.5 tons, whereas in the first region it is only about 6.5 tons per head. In addition to that they use straw and little concentrate feed mix in summer. This feed use pattern depresses much the costs per milk buffalo, in comparison with the first region.

On the other hand, the marketing facilities in the second region do not only provide incentives to expand milk supply in an intensive form (higher yield per head) but it also provides incentives to expand the number of milking heads on farm. In the first region the average number of milking heads per farm is 1.14 heads, while in the second region the average number is 3.68 heads.

LACTATION NUMBER EFFECT:

The estimated milk response model in table 2, proves that the buffalo milk yield per season increases over successive lactations at a decreasing rate (estimates B_{10}, B_{11} and B_{12}). The effects of the higher order lactations above the second lactaion were statistically significant.

From the estimated parameters it could be concluded that the incremental increases in the milk yield over successive lactations are as follows: from the first to the second 47 kilograms, from the second to the third 45 kilograms, from the third to the higher order lactations the increase is around 7 kilograms. This low aggregate increase after the third lactation suggests that after the fourth lactation the total milk yield decreases. In the other words, the highest yield is at the fourth lactation.

PREDICATIONS OF THE BUFFALO MILK YIELD:

Most of the available estimates for buffalo milk yield in the literature are from experimental data. There are only few estimates for buffalo milk yield from field data [1, 2, 3 and 6]. However, these estimates were aggregate averages and did not show the effect of different structural variables on such yield. Using the estimates of the response model in table 2 it is possible now to predict the milk yield per head per season for each farm size class, in each region and across successive lactations (table 8). From this table, the minimum milk yield is 942 kilograms (first region, first lactation and farm size above 5 feddans). The maximum milk yield is 2005 kilograms (second region, fourth lactation with a farm size of less than one feddan). The difference between the minimum and the maximum is 1063 kgs. Of this difference 608 kilograms is attributable to the region effect, 356 is due to farm size and 99 kgs is due to lactation season. Accordingly, 57.2% is due to economic incentives (the locational advantage of the region No. 2), 33.5% is due to management effect (smaller farm size holds higher producible buffalo), and only 9.3% can be attributed to the lactation season order effect. This result suggests that the economic policy should concentrate on improving the marketing conditions and the management efficiency of the buffalo milk production in the traditional regions.

ANIMAL WORK EFFECT:

From the estimates in table 2, there are three variables that express the milk buffalo share in farm operations and their effects on the milk yield. Intensity of the work (hours/day) has a negative effect but it is insignificant, (even at $P \leqslant .10$). Other farming operations (such as, pulling a traditional plough or working a traditional threshing machine) have also a negative effect on milk yield per head but the effect is insignificant, because the farmer, usually does not use, extensively, the milking buffalo for such hard work. Irrigation work (operating a sakia) has a positive effect and it is significant at $P \leqslant .10$. Directions of the work effect were the same as those established in an earlier paper by Soliman and El-Shenawy [4].

The positive effect of the Sakia operation on milk yield per buffalo head is possible, as the work is relatively light. It may stimulate the milk secretion, as if the effect of the daily routine exercise.

FEED EFFECTS:

With respect to the milk feed respnse estimates (table 2) it seems that raising the feed consumption per head (TDN) raises the milk yield. One additional kilogram of starch equivalent raises the milk yield by 0.25 kgs.

The effect is highly significant at $P \leqslant .01$. Clearly, this aspect requires further investigation. To introduce feed inputs in natural form seems more useful for response analysis. To use a curvilinear or even a non-linear form is needed.

DRY PERIOD EFFECT:

Effect of the dry period length on milk yield is significantly ($P \leqslant .01$) negative, the longer the dry period the lower is the total milk yield per season (table 2). This is reasonable physiologically as longer dry periods are, obviously, associated with shorter milking seasons (days in milk) per head.

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Table 1: Symbols and Definition of the Variables Included in the Milk Response Model per Head.

Symbol	Definition of The variable
The Dependent variable	
M	Milk yield in Kilograms per season per Milk Buffalo.
Independent variables	
X1	Dry period per head in Days.
X2	Working Hours per day
X3	Working Hours for irrigation (sakia operation)per year
X4	Working hours for other operations (to pull plough or thresher)
X5	Feeds consumed per head per season as TDN(kgs)
A2	A dummy variable = Farm Size (1< to 3 feddans)
A3	A dummy variable = Farm Size (3< to 5 feddans)
A4	A dummy variable = Farm Size (> 5 feddans)
S2	A dummy variable = 2nd lactation.
S3	A dummy variable = 3rd lactation.
S4	A dummy variable = 4th lactation and above
R2	A dummy variable = the second region.

Table 2: Estimated Model For Milk Response of Buffaloes on Egyptian Traditional Farm.

Dependent Variable: M = Kilogram of Milk produced per head per season, N = 240, R^2 = 0.5449 and F = 20.8168.

Independent Variable	Regression Coefficient	Regression Coefficient Estimate: B_i	T-Score	Significant level of B_i
X1	B1	- 1.0422	- 4.6891	P .01
X2	B2	- 7.9241	- 0.9426	NSS
X3	B3	- 0.3158	1.4948	P< .10
X4	B4	- 2.1663	- 0.6581	NSS
X5	B5	0.2326	2.6274	P< .01
A2	B7	-280.7124	- 3.4708	P< .01
A3	B8	-309.2202	3.4661	P< .01
A4	B9	-356.2691	- 4.1763	P< .01
S2	B10	47.3248	0.7380	NSS
S3	B11	91.904	1.5699	P< .10
S4	B12	98.9570	1.6583	P< 0.5
R2	B13	608.4303	11.1039	P< .01
X_0	B_0	1297.8789	11.9296	P< .01

Table 3: Number of Heads Per Farm, Percentage of Farms that provide vetrinery service and The Feed inputs Level of the Milk Buffaloes According to Farm Size Class.

Comparison	Farm Size Class in Feddans			
	0 < Fe 1	1 < Fe 3	3 < Fe 5	> 5
Average Milk Buffalo Heads per farm.	0.95	1.21	[illegible]	1.5[illegible]
Percentage of the farms that provide vetrinery service	45	28	32	26
Starch Equivelant per Milk Buffalo per year (kgs.)	1062	1291	1415	1375
Digestive protein per Milk Buffalo per year (kgs.)	262	286	330	345
Purchashed feeds as % of Total feed costs	69.1	40.4	22.6	30.5

Table 4: Costs per Milk Buffalo on A traditional farm According to farm size class (Value in L.E)

Farm Size Class	Feed Costs					Labor Costs			Vetrinery Service Costs	Interest for fixed capital	Other costs	Total Costs
	Green Fodders	Straws	Grains, legumes & Brans	Concent-rate feed Mix	Total	Hired Labor	Family Labor	Total				
0<To 1	82	35	21	34	172	3.0	37.5	40.5	1.75	65	11	340
1<To 3	99	55	21	26	201	3.7	45.5	49.2	2.3	75	3	337
3<To 5	114	50	19	20	203	4.5	38.0	42.0	4.0	82	6.5	390
>5	127	77	15	20	239	5.5	44.5	50.0	4.8	92	6.0	343

(1) It is a mixed processed concentrate feed composes of: Cotton seed cake, yellow corn, brans, mollases and minirales.

Table 5; Gross Output per Milk Buffalo on A traditional farm according to farm size class (Value in L.E)

Farm Size Class (Feddans)	Milk Output		Farm Work Output		Meat Output(i)				Manure		Total Value
	Value	%	Value	%	Calf Crop	Net Inventory change	Total Value	%	Value	%	
0<To 1	288.23	56.9	42.13	8.3	77.26	94.85	172.11	33.9	5.09	.9	507.56
0<To 3	260.63	51.0	64.76	12.7	83.81	95.32	179.13	35.1	6.39	1.2	510.91
3<To 5	267.58	49.2	95.00	17.5	93.05	81.06	174.11	32.0	7.43	2.3	544.12
>5	199.29	42.0	118.22	24.9	81.18	69.58	150.76	31.76	6.36	1.34	474.63

(I) [Calf Crop value + the Annual Growth value] per milk-Buffalo.

Table 6: Level of Feed Inputs use and total costs per Milk Buffalo per year By Region.

Region	Feed use levels Kilograms per Heae				Total Costs Per Head Per Year L.E.	Average Number of Milking buffaloes per form
	Green Fodder	Straws	Grains, Legumes & Brans	Concentrate Feed Mix		
Region (1)	6555	779	171	617	319.7	1.19
Region (2)	1049	994	0.00	212	203.0	3.68

Table 7: Gross Output Structure per year per Milk Buffalo by Region.

Region	Milk production		Animal Milk		Meat output(1)		Manure		Total Output
	L.E.	%	L.E.	%	L.E.	%	L.E.	%	
Region (1)	286.2	54.1	62.2	11.8	174.8	33.0	6.0	1.1	529.2
Region (2)	490.8	67.5	33.4	4.6	190.0	26.1	13.2	1.8	727.4

(1) The sum of calif crop and net inventory change of the live animals.

Table 8: Estimated Milk Yield per Buffalo in Kilograms According to Farm Size Class and Region Across Lactation Number.

Farm Size Calss Feddan	Typical Traditional Region				Commercial Dairy Region			
	1st lact.	2nd lact.	3rd lact	4th and higher lact.	1st lact.	2nd lact.	3rd lact.	4th and higher lact.
0< To 1	1298	1345	1390	1397	1906	1953	1998	2005
1< To 3	1017	1064	1109	1119	1625	1672	1717	1724
3< To 5	989	1036	1081	1088	1597	1644	1689	1696
>5	942	989	1034	1041	1550	1597	1642	1649

Source: Calculated from Estimated Milk Response Model Table (2).

ملخص دراسة : تحليل نموذج استجابة انتاج اللبن من الجاموس في المزرعة المصرية

باستخدام بيانات ميدانية من ثماني قرى من أربع محافظات لأحجام مختلفة من المزارع أمكن تقدير دالة استجابة لانتاج اللبن للرأس من الجاموس المصرى شملت ٢٤٠ شاهدة ، وتضمن النموذج خمسة متغيرات كمية وسبعة متغيرات وصفية ، بعضها ذات طبيعة اقتصادية ، وبعضها ذات طبيعة تكنولوجية . وقد أمكن استنتاج مجموعة من النتائج ذات العلاقة بتنمية انتاج اللبن فى المزرعة المصرية التقليدية الصغيرة . بالرغم من زيادة عدد الحيوانات الحلابة بزيادة حجم المزرعة فان انتاجية الرأس تقل بزيادة حجم المزرعة ، وباعتبار أن حجم المزرعة يعبر هنا عن كفاءة الادارة أكثر من تعبيره عن وفورات السعة ، فان صغر حجم الحيازة يجعل المزارع يهتم باقتناء جاموس ذات كفاءة وراثية أفضل ويقدم لها رعاية أكبر خاصة وأنه غير قادر على التوسع العددى فى حيوانات اللبن ، وقد تبين تأكيدا لذلك أن المزارع الصغير يقدّم علف مصنوع للرأس بكمية أكبر من المزارع الكبير رغم أنه يشترى معظمه من السوق الحرة (السوداء) . ونسبة عدد المزارعين الذين يقدّمون رعاية بيطرية لحيواناتهم تزيد فى المزارع الصغيرة عن الكبيرة ، كما أن المزارع الصغير يستخدم الجاموسة الحلابة فى العمل بمعدّل أقل من المزارع الكبير .

واذا كانت المنطقة (القرية) متمتعة بميزات وحوافز المكان التسويقية أدى ذلك لحيازة حيوانات أعلى انتاجا وأكثر عددا من المناطق التقليدية المعزولة نسبيا عن حوافز السوق . وفى المناطق الانتاجية التجارية فان المزارع يخصص معظم حيازته الأرضية لانتاج البرسيم ولا يعتمد على العلف المركز ولا يكاد يستخدم الحيوان فى العمل .

وتبين أن أكثر من ٥٧ ٪ من التغير فى انتاج اللبن للرأس يرجع لعوامل اقتصادية (المنطقة) ، ٣٣ ٪ من التغير يرجع لكفاءة الادارة ، ٩ ٪ فقط يرجع لترتيب موسم الحليب . وأكدت هذه الدراسة أن زيادة العمل المجهد فقط فى المزرعة (جرّ المحراث أو الدراس) هى التى تقلل من انتاج اللبن ، بينما ادارة الساقية بواسطة الحيوان ذات أثر موجب ومعنوى نسبيا . وهذا يرجع الى أن عمل الحيوان لادارة الساقية يعتبر عملا خفيفا مرادفا لضرورة ترييض الحيوانات المنتجة للبن فى المزارع المتخصصة ، علما بأن ادارة الساقية هى أغلب أنواع العمل التى تقوم بها الماشية حاليا فى المزرعة ..