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Analysis of Resource Use Efficiency Among Urban Sudano-Sahelian Dairy Farmers in Maiduguri Metropolis, Borno State, Nigeria

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ABSTRACT

The study analyzes Resource Use Efficiency among Urban Sudano-sahelian Dairy Farmers in Maiduguri metropolis area of Borno State, Nigeria. Data were collected using structured questionnaire. Two stage random sampling techniquewas used for the study. Ten herds were randomly selected from 1122 registered herds as primary sampling unit for the study. The second stage consisted of proportionate random sampling of 120 dairy farmers in the primary sampling unit. Descriptive and inferential statistics were used to analyzethe socioeconomic characteristics and quantities of inputs and outputs of the dairy farmers. Stochastic frontier production function was employed to analyze the determinants of dairy production. The study concluded that production resources in small scale dairy farm such as feed and veterinary drugs/vaccines were inefficiently utilized, while labour and landwere over-utilized. The optimal use of resources in dairy production suggests quantities of inputs level under-utilized should be reduced to optimal level for increased dairy production

INTRODUCTION

Nigeria is one of the leading countries in cattle and diary production in Sub-Saharan Africa (Kubkumawa 2017). The country had over 14.73 million cattle consisting 1.43milking cows and contributing about 12.7% of the agricultural sector in terms of gross domestic products (CBN, 2019). Resource use Efficiency in dairy industry measures dairy quantity of milk output that allows the production of a litre of milk with a fewer nutrients and less consumed waste. This means improving productive efficiency of milk yield per resource input used. This is the mechanism by which a dairy herd produces more milk from the same quantity of resource or same amount of milk with fewer resources and reduces the demand for energy intensive input

The industry provides a means of livelihood for significant population of pastoral households and participants in the dairy value chain of the sub-humid and semi-arid ecological zone of the countries (Adam et.al. 2021). Dairy or milk from cattle is a fresh whitish solution providing an important source of energy, protein, and micronutrients including many essential minerals and vitamins. Therefore, dairy and its products contribute significant amount of 4 of 7 nutrients of concern identified by the recent dietary guidelines for America has been deficient in adult diets and 3 of 5 nutrients of concern in children diets (Kumaet. al; 2015).

Despite the enormous importance of dairy products in Nigeria, dairy producers in Maiduguri metropolis continue to bridge the milk demand gap of 1.45billion liters consumption in Nigeria that is less than 10 liters per head per week. Whereas the global average was about 40litres per head per week. In other parts of Africa it is 28litres per head per week (World Bank, 2019). This resultsinto the current challenges confronting the dairy industry in terms of low rate of improvement in investment, operating capital, low productive traits of the dairy livestock and other facilities that could improve dairy farmers efficiency to meet the dairy needs of consumers (world Bank, 2017).Moreover, Ali et.al (2013) revealed that milk or dairy farmers couldn't break even due mainly to low milk production using the traditional breed and could only make a profit of 6% on their average cost of production per liter respectively.

The dairy farmer to be helped to increase productivity, the focus should not only be on whether they have adopted productivity enhancing technologies, but rather to carefully examine whether they are making maximum use of technologies available to them. The efficiency or inefficiency of available resource utilization for urban dairy production enterprise has remained an important question in the quest for increase productivity in Maiduguri Metropolis, Borno State, Nigeria. Therefore, this study analyses resource use efficiency of dairy producers.

METHODOLOGY

The study was conducted in urban sudano-sahelian area of Maiduguri metropolis that comprisesMaiduguri metropolitan area and the peripheral wards of Jere, Konduga and Mafa local government areas of Borno State. It lies between latitudes $10^0$9"N and$13^0$44"N of the equator and longitudes $12^0$26"E and $14^0$38"E of Green Which Meridian. The area is characterized by short rainy season of 3-4 month (June-September) followed by a prolonged dry season of more than 8 months which support the growth of shrubs and other short trees. The population of Maiduguri metropolis is 3601124 in 2021 as projected (NPC, 2006).The major stakeholders of the dairy enterprise in the area are Kanuri, Shuwa-Arabs, and

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Fulani. Different local breeds were used for the dairy production. The cattle were grazed along the shores of River Ngada and Yatzaram which were supplemented by different types of concentrates (acacia and cotton seeds, groundnut and cowpea leaves) and supplements used (millet and sorghum brans, millet and sorghum stalks refreshed with salt and potash leaks).

Source of Data

Data on dairy production for the 2021 production season were collected using structured questionnaire. The study used Yamane's (1967) sample size estimator for the proportionate sample size estimate as adopted by Ali (2019) with (e=95%) level of precision. The Yamane estimator is given by the formula

$n = N/1+N(e)^2$ ……1

Where:

n = number of dairy farmers selected as sample within each herd

N = sum of dairy farmers in all sampled grouped dairy farms

e = level of precision used (0.05)

i = (1, 2, 3…….....n) number of herds in the community

Sampling Technique

Reconnaissance survey in the study area indicated fifteen grouped herds each comprising of different numbers of dairy farmers having different number of dairy cattle within the herd were enumerated.Two stage random sampling was used for the study; ten herds were randomly selected as primary sampling unit for the study. The second stage consisted of proportionate random sampling of 120 dairy farmers in the primary sampling unit. This considered 67% of the dairy farmers in each herd.

Analytical Technique

Descriptive statistics were used to summarize the socioeconomic characteristics and quantities of inputs and outputs of the dairy farmers. Also, stochastic frontier production function was employed to analyze the determinants of dairy production. Aigneret al (1977) independently proposed the stochastic frontier function. In their view, the stochastic frontier production function is defined by:

$y_i=f(x_i; \beta)+e(i)$…….2

Where:

i = 1, 2, 3……N

$e_i = v_i-u_i$……3

y_1 Represent the level of milk output of the ith dairy farmer, therefore, $f(x_i;\beta)$is an appropriate production function of vector xi of inputs for the i^{th} dairy farmer and a vector β of parameters to be estimated; e_i is an error term that decomposes into two components: v_i and u_i; v_i is a random error with zero mean; $N(0;\sigma^2v)$, and is specifically associated with random factors like measurement errors in production as well as those factors that the dairy farmer has no control over them and assumed symmetric and independently distributed as $N(0;\sigma^2v)$ and is independent of u_i. Conversely, u_i is a non-negative truncated half normal $N(0;\sigma^2v)$, random variable which is linked to dairy farmers specific characteristics that leads dairy farm not attaining maximum production efficiency. u_i Which ranges from zero to one is linked to the technical inefficiency of the dairy farm. N is the number of dairy farmers that were considered for the survey.

Technical efficiency of a dairy farmer is the ratio of observed output to the frontier milk output; given the quantity of resources employed by the dairy farmer. Technical inefficiency, therefore, refers to the margin with which the level of output for the dairy farmer falls short of the frontier milk output.

$$\text{Technical efficiency} = TE_i = \frac{y_i}{y_i^*} \quad \ldots\ldots\ldots 4$$

Where yi = f (X_i; β), highest predicted value for the i^{th} farm

TEi = Exp(U_i)…… ……..……..……5

Technical inefficiency = 1 − TE_i…..……..6

The stochastic frontier production function can be estimated by the maximum likelihood estimation (MLE) technique. This technique use specific distribution of the disturbance term which is more efficient than the corrected ordinary least squares (Dadson; et. al, 2016). The functional form of the stochastic frontier production function was determined by testing the adequacy of the transcendental logarithmic (trans-log) model which is adequately fitted and adopted for the study. Therefore, the stochastic frontier production function is given as follows:

$$lny_i = \beta_0 + \sum_{k=1}^{m} \beta_k \ln x_{ki} + \frac{1}{2}\sum_{k=1}^{m}\sum_{j=1}^{m} \beta_k \, In\, x_{ki} \ln x_{ji} + v_i - u_i \ldots\ldots 7$$

Where in natural logarithm, y_i is total milk output, x_i is vector of dairy input and ij are positive integers $i \neq j$, β is a vector of parameters in dairy production to be estimated, and v_i and u_i have been defined above. The inefficiency model is also specified below:

$$u_i = \delta_0 + \sum_{m=1}^{N} \delta_m z_i \ldots\ldots\ldots\ldots\ldots 8$$

Where z_i is a vector of dairy farmer characteristics and δ_i is a vector of parameters to be estimated. STATA package give a joint estimation of the parameters of the stochastic frontier production and those of variables in the inefficiency model as well as variance parameters. Empirically, the following stochastic frontier production function was estimated.

$LnOUTPUT=\beta_o+\beta_1 lnFED+\beta_2 lnLAB+\beta_3 lnDRV+ \beta_4 lnALU$.....9

Where,

OUTPUT- output of dairy production measured in liters per individual farm within the herd and it is the dependent variable;

FED-the quantity of feed used measured in Kg per

individual farm;
LAB-labour employed in dairy production measured in man-day;
DRV-the quantity of drugs and vaccines administered per individual dairy farm measured in Kg and liters respectively; and
ALU-the area of land used by individual dairy farmer within the herd measured in meter square.

RESULTS AND DISCUSSION

Table1: Socio-characteristics, Quantities of Inputs Used, and Dairy Output Produced in the StudyArea.

Table 1: Socio-economic Characteristics of Dairy Farmers

Variable	Frequency	%	Mean	Std. dev.
Sex				
Male	140	70.00		
Female	60	30.00		
Age				
25-33	81	40.5		
34-42	57	28.5		
43-51	62	31	36.74	7.58
Education (years)				
Non-formal (0)	137	68.60		
Primary (6yrs)	25	12.40		
Secondary (12yrs)	38	19.00		
Tertiary (18yrs)	00	0.00	5.17	6.028
Membership of Association				
Present of membership	28	14.80		
Absence of membership	172	85.20		
Access to formal credit facilities				
Easily accessible	21	10.60		
Difficult to access	44	22.10		
Not accessible	135	87.30		
Extension visit within current production program				
No visited	152	76.00		
Once	18	9.00		
Twice	15	7.50		
Thrice	10	5.00		
More than three times	5	2.50		
Experience (years)				
0-5	7	3.50		
6-11	15	7.50		
12-17	47	23.50		
18-23	131	65.50	17.56	
Size of the household				
1-5	59	29.50		
6-11	82	41.00		
12-17	43	21.50		
17 and above	16	8.00	8.695	4.95
No of dairy cattle owned				
1-3	60			
4-6	120			
7-9	20		4.4	1.80
Labor (in man-day 1 dairy cattle)				
1-1.075	25			

1.076-1.151	47			
1.152-1.227	71			
1.228-1.303	57		1.1743	0.0754
Drugs/vaccine (in Naira N)				
1150-1612.50	21			
1612.51-2075.01	49			
2075.02-2537.52	60			
2537.53-3000.03	70		2257.71	471.036
Feed (in KG)				
7.5-9.5	19			
9.6-11.6	53			
11.7-13.7	58			
13.8-15.8	70		12.48	2.088
Output of milk in liter per dairy cattle per program class				
2.25-3.00	22			`
3.01-3.76	50			
3.77-4.52	74			
4.53-5.28	54	5.251	3.993	0.590

Source: Field Survey, 2022

Table 1: Present descriptive statistics of dairy farmers characteristics and qualities of inputs used and dairy outputs produced. The result revealed that 66.66% constituting 133 dairy farmers were male while 67(33.34%) of the sample in the study area were females. The age of the respondents ranged from 25-50 years with an average age of 36.24 years. From the same table, majority (40%) were within the age bracket of 25-33 years. The study also indicated educational level expressed in number of years in education of the sampled dairy farmers. The age ranged from 0-18 years with a mean age of 5.17; and 0-6 years constituting 75% of the sample representing those without formal education to those that attended primary education respectively; while those that had 14 -20 years in education comprised only 6%.

This categorized those that received tertiary education. The result for dairy farmers' years of experience from table one ranged from 0 to 26 years and a mean of 17.56 years. This indicated that 3.5% of the dairy farmers had 0-5 years of experience, however the largest percentage was 65.59% with 18 -23 years of experience. The size of the household as shown in the table revealed that an average family size (8.695) of dairy farmers in Maiduguri metropolis, had members with minimum of one member per household and maximum of 21 members. Majority (41%) of the dairy farmers had 6-10 members in their households, while the minimum (8%) of the dairy farmers' household size were between the ranges of 16-20 members.

Size of the dairy cattle owned indicated a mean herd size of 4.4 dairy cattle per individual farmer with a range of 1-9 cattle. The highest percentage of sampled dairy farmers interviewed (60%) had herd size 4-6 cattle while the least (10%) with 7-9 cattle. Furthermore, the number of veterinary extension visits to the dairy farms in the study area revealed a minimum of no visit(0) and a maximum of (15) visits and a mean visit of 2 per herd per production program witha standard deviation of 1.7. Similarly, the minimum amount of feed offered per dairy cattle was 7.5kg while 15kg was the maximum quantity, with mean of 12.48 kg and standard deviation of 2.088. The least number of respondent (9.50%) offered 7.5kg to 9.5 kg, however the highest number of respondent (35%) fed 13.8-15.8kg. In the same vein, labor in Man-day ranged from 1-11 hour per day with an average period of 1.17 hours and a standard deviation of 0.075 for milking and other dairy operations while the highest (57%) used 1.228-1.303 hours.

Table 1 also presents drugs/vaccines administered to dairy cattle computed in naira value where highest percentage of dairy farmers in the sample (70%) administered N2537 worth of drugs/vaccines per production program, while the least (21%) administered N1150 to N1612.50 worth of drugs/ vaccines. The minimum drugs/vaccines used were valued at N1150 while the maximum was N3000 with mean and standard deviation of 2257.71 and 471.03 respectively.

Also from the sampled dairy farmers, the average dairy output in liters per dairy cattle per day was 3.99litres with a maximum of 5.25litrs per dairy cattle per day and a minimum of 2.25litres and a standard deviation of 0.590. The least number of sampled respondent (11%) produced 2.25litres – 3.00litres per day, while the majority (27%) produced 4.53-5.28 liters per day.

Table 3: Maximum Likelihood Estimates Dairy Stochastic Frontiers Production Function

Variable	**Coefficient**	**Standard error**	**Constant**
In feed	0.575	0.0076***	2.134
In DRC/VCN0.335	0.0876***		
In FLND	- 0.0355	0.0232**	
In LB	-0.009	0.006*	
Variables		**Parameter**	**Standard error**
Sigma squared σ2 = σ2u+σ2v		0.86	0.5300*
Gamma γ = σ2u/σ2v		0.923	0.1359***
Lambda λ = σu/σv		0.0002	0.0001***
Log-likelihood		-34.871	
Number		0.3123	
Wald		3.1x1010	0.0000***
Mean VIF		1.23	
Breuseh – pagan stat		0.53	

Source: Field Survey, 2022

The result of the stochastic frontier trans-log production function analysis for dairy herds showed that feed and veterinary drugs/ vaccine had significant positive effect on the dairy output of herd whereas labour and land had significant but negative effects (Table 3). Similarly, the production elasticity of inputs were 0.575, 0.335, 0.0355, and 0.009 for feed, veterinary drugs/vaccines, land, and labour respectively.Considering the technologies available to herds, resource use efficiency was determined at the level where the return to scale was less than one (RTS was less than one).That is the stage of positive decreasing returns to scale. This is the stage where every dairy farmer thrives to maximize output with least use of inputs.

DISCUSSION

It could be deduced from the results on sex distribution of the dairy farmers in Maiduguri metropolis was dominated by the male folk. This could be as a result of crucial roles played by men in the economic activities of the community as most of the heads of households, saddled with the responsibility of caring for the needs of their members. This finding corroborated those from earlier studies (Njaruiet.al. 2014) which implied that dairy production is mostly dominated by males. The mean age distribution of sampled dairy farmers was 36.74 which indicated that most of the farmers were young. This implied a positive impact on resource use efficiency of dairy farmers in the study area. The result is in line with the belief that young dairy farmers accept changes in technologies especially those connected to appropriate use of feed mix that improve dairy production which concurred with finding of Hassenet.al.(2012) that showed majority of the dairy farming population are youth. The study observed that young dairy farming population may have positive implication on dairy productivity as a result of the fact that the younger the farming population, the more productive its labour: consequently the higher dairy output obtained. The finding on education among dairy producers was comparable to that reported byOkoruwaet. al.(2021) on lack of formal education inducingsome levels of inefficiencies in input use among dairy farmers as education is expected to have positive effect on efficiency. The result further indicated higher level of experience among dairy farmers. The implication is that the higher the level of dairy farming experiences the more the productivities and efficiencies of dairy farmers. This was expected since experienced dairy farmers could predict appropriate dairy husbandry practices for efficient dairy production.The result on access to dairy extension visit was an indication of inadequate extension service to dairy farmers. This may have negative effect on resource utilization for efficient dairy production

There were few number of dairy farmers with membership of one form of agricultural based organization or the other which could have an adverse effect on technical efficiency of dairy production in the study area.Since extension agent disseminate information on good production practices through those organization. Difficulty in accessing credit by dairy farmers is a major source of technical inefficiencies in dairy production as credit allows dairy farmers to purchase efficiency enhancing inputs that include feed mix and veterinary drugs/vaccines. Given dairy production being labor demanding activity, the effect on dairy household size indicated that dairy farmers have some sources of labour that could enhance technical efficiencies. The result on dairy output implied average dairy output for the farmers is relatively low. The low level of dairy output recorded in the study area implied that most dairy production activities in Maiduguri metropolis were on a small scale.

The significance of likelihood ratio test on the trans-log dairy production function was appropriate for the data. The high γ value for dairy farmers in the study revealed the presence of technical inefficiencies among the sampled dairy farmers hence, making the stochastic frontier production function an appropriate model for

the study. The value of λ indicated that the one sided error term U dominated the symmetric error term V, therefore variation in actual dairy output was as a result of differences in dairy farmers specific characteristics rather than random variability, hence the need for the inclusion of an inefficiency term in the dairy production function and again the appropriateness of the stochastic frontier production function for the study. Also the significances for the value of ʎ and sigma squared means a fit and correctness of the specified distributional assumption.

The elasticity for the dairy farmers in the area indicated that a 1% rise in the level of feed and veterinary drugs/ vaccines increase the dairy output levels by 57.5% and 33.5% respectively. This findings concurred the result of Iorliamet.al(2017) that an increase in the two variable results to increase in dairy output level. However, the significant negative effect of labour and land might be as a result of excess land and labour supply by the dairy farm household. The return to scale (0.87) computed for the dairy farmers in the same area show increasing return to scale for the farmers which implied that dairy production in Maiduguri metropolis was in stage I.

The result also suggests that dairy farmers could enhance production scale by (0.87). On average in order to adequately increase productivity given disposable resources, dairy farmers can enhance production by employing more inputs (feed and veterinary drugs/ vaccines). This finding was in agreement with the result of (FAO, 2019). The result on the technical efficiency for dairy farmers in the study area suggests that dairy farmers produce below the efficient level, because of allocative inefficiency in resource use which particular suggest feed and veterinary drugs/vaccines underutilization while, labour and land were over- utilized. Dairy output in the study area could therefore be increased with increase, in feed and veterinary drugs/vaccine, while decrease in labour and land will also increase dairy output.

CONCLUSION

The study concluded that production resources in small scale dairy farm such as feed and veterinary drugs/ vaccines were inefficiently utilized because these inputs were underutilized, while labour and land were over-utilized while, the limitation in the study, is the dynamics that was not considered and could be useful to see how a given economic variable changes over time. This will be a future consideration for those with interest in such studies

RECOMMENDATIONS

The optimal use of resources in dairy production in Maiduguri metropolis Nigeria, suggests that the quantities of those inputs level that were under-utilized should be reduced to optimal level for increased dairy production, while those that were over-utilized be increased.

Dairy farmers should be mobilized through the use of incentives and strategies aimed at encouraging farmers to increase the use of those inputs that were under-utilized and decrease those that were over-utilized. The incentives and strategies should include: better management by government of the current veterinary services and livestock programs for improved drugs/vaccines and feed-mix distribution through dairy farmers based association to ensure easy access by the farmers. Livestock extension agents should motivate farmers to form dairy farmer based organization (DFO) in the study area by offering the dairy farmer the advantages of forming such association, the extension should help the dairy farmer to come together and form this association. This is because information on dairy production technologies and right input mix are disseminated through these associations. Therefore dairy farmers that belong to such are likely to acquire more knowledge on the suggested technologies and the appropriate input mix compared to those without membership of such association.

Micro finance institutions and agricultural banks should ensure easy financial access to dairy farmers and acquired loans must be used to purchase the intended inputs for dairy production. Farmers in dairy based associations should also be encouraged to form informal credit association that can assist one another when the need arises

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