

## Research Article

# Economic Efficiency of Peri-Urban and Urban Dairy Farmers in East Shewa, Oromia Region, Ethiopia

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## Abstract

Enhancing dairy productivity contributes to food security by enhancing production efficiency. This study investigated technical, allocative and economic efficiencies in urban and peri-urban dairy producers in East Shewa Zone of Oromia Region, Ethiopia. To conduct the study, Primary data were gathered from 120 randomly chosen dairy producers in Adama and Modjo Towns. Stochastic Frontier approach analysis indicated that 0.975 gamma value. This value implied 97.5% of the variation in output is due to the variation in technical inefficiency among the farmers where as 2.5% due to random shocks in production. The result indicated that the mean technical, allocative and economic efficiency of urban dairy producers were 30.7%, 71.7% and 23% whereas peri-urban dairy producer was 26.2%, 69.9% and 19.2% respectively. The result of truncated model revealed that experience of dairy production, Extension frequency and access to market information affect technical and economic efficiency of urban and peri-urban dairy producers positively and significantly while distance to animal health center affect technical and economic efficiency negatively. Number of dairy cows affects economic efficiency positively and significantly to urban and peri-urban dairy producers. Town office of Agriculture, stockholders and concerned bodies should focus on farmers' experience sharing, providing technical support and farmers increase productivity cross breed and local cows by improving management could jointly contribute to the improvement in technical and economic efficiency of dairy producers in the study area.

**Keywords:** Per-urban; Urban; Efficiency; Frontier and truncated model

## Introduction

### Background of the Study

"Ethiopia is believed to have the largest livestock population in Africa. The livestock sector contributes about 12-16% of national GDP, 30-35% of agricultural GDP, 15% of export earnings and 30% of agricultural employment. The total cattle population for the country is estimated to be about 65.35 million out of this the female cattle constitute about 55.90 percent and the remaining 44.10 percent are male cattle, Oromia contributes about 38.3% of cattle populations when West Arsi and East Shewa contributes about 11.75% and 3.82% of Oromia cattle population" [1].

"Urban dairy production system includes from smallholder to highly specialized, state or businessmen owned farms, which are mainly concentrated in major cities of the country. These dairy farmers have no access to grazing land. Currently, a number of smallholder and commercial dairy farms are emerging mainly in the urban and peri-urban areas of the capital and most regional towns and districts" [2].

"Farm efficiency is the ability of a farm to produce its output without wasting resources. An economically efficient farm is one that operates at the point of tangency between the production isoquant and the isocost line for a given output. Therefore, it is very important to understand differences in household efficiency in utilizing the resources (land, feed and labour) to achieve household objectives" [3]. According to Farrell [4], "the efficiency of a farm is its ability to produce the maximum amount possible of an output using the given

inputs. He further went ahead to define economic efficiency as a product of technical efficiency and allocative efficiency". According to economic principles, only producers who achieve low-cost production by pursuing economies of scale and management efficiency through the appropriate use of production technologies can survive over time in a competitive industry such as the dairy sector [5].

### Statement of the Problem

"Livestock sector has been contributing considerable portion to the economy of the country, and still promising to rally round the economic development of the country. Livestock as well confer a certain degree of security in times of crop failure, as they are a "near-cash" capital stock. Furthermore, livestock provides farmyard manure that is commonly applied to improve soil fertility and also used as a source of energy" [6]. "The better use of inputs is relevant and could contribute to improvements in dairy productivity and efficiency. Intensive dairy farming could contribute to the needed dairy productivity and efficiency gains in Africa, with important positive effects for poverty reduction and rural development" (World Bank, 2008). "The main aim of this study is, therefore, to provide detail information on economic efficiency of production peri-urban and urban dairy farms. Even though Ethiopia has large dairy cattle population and favorable climatic conditions Productivity is relatively low; Quality feeds are difficult to obtain and Support services are inadequate" [1].

Adami Tulu Agricultural Research Center undertakes composite breeding of Arsi Cows to increase the productivity and genetic improvement. The center also distributed the cross-breed bulls to farmers as intermediate results of composite breeding, but it takes time to reach target population. So, it is important to improve the efficiency of dairy producers with existing technology and breeds by identifying the factors contributing to dairy production efficiency. Technical efficiency is the ability of a company or system to produce the maximum output with a given set of inputs, or alternatively, to produce a given output with the minimum number of inputs. Economic efficiency is the optimal allocation and utilization of resources to produce goods and services in a way that maximizes output and minimizes costs. There is huge gap of milk production in peri-urban and urban of East Shewa Zone that ranges from 3 to 6 litres per local cow per day and 12 to 26 litres per cross breed cow per day [7]. Therefore, it is important to identify factors affecting technical and economic efficiency of dairy production in peri-urban and urban of East Shewa Zone for better future interventions.

## Objectives of the Study

The objectives of the study were:

1. To identify the technical, allocative and economic efficiencies of Peri-Urban and Urban dairy farmers.
2. To identify factors affecting the Technical and economic efficiency of Peri-Urban and Urban dairy farmers.

## Research Methodology

### Description of the Study Area

This study was conducted in East Shewa zone of Oromia region, Ethiopia. East Shewa Zone lies between 60 00' N to 70 35'N and 380 00'E to 400 00'E. This zone is bordered on the South by the West Arsi Zone, on the Southwest by the Southern Nations, Nationalities and Peoples Region, on the West by South west Shewa Zone, on the Northwest by North Shewa, and on the Southeast by Arsi Zone. Adama city is the capital city of East Shewa Zone and located at 100 km from Addis Ababa/Finfinnee towards South-East direction [8].

### Data Sources and Methods of Data Collection

The primary and secondary sources of data were used for this study. The household survey data that was collected from East Shewa zone was used as primary source. Secondary data relevant for this study was gathered from East Shewa office of Agriculture, Sample urban Agriculture office, CSA, and from published and unpublished sources.

### Sampling Procedure and Sample Size

A three-stage sampling procedure was employed to select the sample urban and peri-urban dairy farms. In 1<sup>st</sup> stage, two towns

Name of sampled Urban	Dairy producers	Total Dairy producers' households (number)	Proportion sampled Households (%)	Number of samples household heads (number)
Adama	Urban	1473	23.34	28
	Peri-urban	684	10.84	13
Modjo	Urban	1841	29.16	35
	Peri-urban	2314	36.66	44
<b>Total</b>		<b>6312</b>	<b>100</b>	<b>120</b>

Source: UOA and Own computation, 2023 [13].

selected from each zone based on dairy cattle population and milk supply. 2<sup>nd</sup> stage two kebeles from each urban and peri-urban were selected based on potential of dairy cattle.

3<sup>rd</sup> Stage: A peri-urban and urban dairy farmer determined by formula by Kothari [9] sample size determination.

### Method of Data Analysis

The data was analyses using the descriptive statistics, Cobb-Douglas regression analysis in the form of a profit function, and truncated regression factors affecting technical and economic efficiency of peri-urban and urban dairy producers.

**Descriptive Statistics:** Descriptive statistics was applied to the basic characteristics of the sample households to assess differences or similarities among the households. The descriptive statistics such as mean, standard deviations, minimum and maximum values, frequencies, and percentages were used to describe the households.

**Econometric Model Specification:** Econometrics model: Economic efficiency was estimated using a Cobb Douglas Stochastic Profit Function. Factors affecting technical and economic efficiency analysed by truncated regression model.

## Results And Discussion

### Descriptive Statistical Results

**Sex of Household Head:** Majority of respondents 58.73% were male respondents in urban and female 52.63% in peri-urban dairy producers. There is no significance difference between urban and peri-urban dairy farmers in terms of sex of respondents.

The average age of the sample respondents was found to be 44.19 years. This result implied that the sample respondents were work age group and experienced that can increase production if they get technology and training. The average family size of the sample households was 5.37 persons per household. The dependency ratio was about 0.61. The farming experience of Dairy production was about 8.08 years. The average livestock holdings measured in terms of tropical livestock unit (TLU) were found to be 5.81. The average distance from animal health centre was 2.74 kilometres and frequency of extension contact was on average 4.22 per year. An independent sample t-test result shows significant mean difference between urban and peri-urban farmers in terms of age of respondents, family size, experience dairy production, livestock holding and distance to animal health centre. Those variables improve efficiency as experience and technical information in production increase productivity and minimize the cost of production (Table 1,2,3).

Urban and peri-urban access to market information was 50.79% and 50.88% respectively. An independent sample  $\chi^2$ -test result shows significant difference between urban and peri-urban farmers in terms of access to market information. This market information

**Table 2:** Sex of sample respondents.

Variable		Urban		Peri-Urban		$\chi^2$ -value
		Freq	%	Freq	%	
Sex of household head	Male	37	58.73	27	47.37	1.5521
	Female	26	41.27	30	52.63	
	Total	63	100	57	100	

Source: Survey result, 2023.

**Table 3:** Summary of descriptive continuous variables.

Variables	Urban		Peri-urban		Over all		t-value
	Mean	St.Dev	Mean	St.Dev	Mean	St. Dev.	
Age of household head in years	47.08	11.65	41	7.99	44.19	10.49	3.2997***
Family size in numbers	5.08	1.67	5.68	1.68	5.37	1.70	-1.9640*
Dependency ratio	0.53	0.56	0.70	0.59	0.61	0.58	-1.6627*
Experience of dairy production in years	9.33	5.42	6.93	4.82	8.08	5.24	2.3357**
Livestock holding (TLU)	5.13	3.42	6.57	4.49	5.81	4.01	-1.9822**
Distance to Animal health center	3.23	3.17	2.21	1.98	2.74	2.71	2.0970**
Frequency of extension contact	5.04	4.02	3.43	4.13	4.22	3.65	1.5012

Source: Survey result, 2023.

was specifically on dairy products. The participation of non-farm activities and participation of dairy cooperatives was very low in both urban and peri-urban areas. The results indicated that only 7.94% and 529.82% participated in nonfarm activities of urban and peri-urban dairy producers respectively. Urban and peri-urban dairy producers participated in dairy cooperatives was 14.29 % and 0.02% respectively. There was insignificance difference between urban and peri-urban dairy producers in terms of Access to market information, nonfarm activities and participation in dairy cooperatives (Table 4).

**Table 4:** Summary of categorical variables.

Dairy producers	Percent	Access to market information			Non-farm activities			Participation in Dairy cooperatives		
		Yes	No	Total	Yes	No	Total	Yes	No	Total
Urban	Freq	32	31	63	5	58	63	9	57	63
	%	50.79	49.21	100	7.94	92.06	100	14.29	85.71	100
Peri-urban	Freq	29	28	57	17	40	57	1	56	57
	%	50.88	49.12	100	29.82	70.18	100	0.02	0.98	100
Total sample size	Freq	61	59	120	22	98	120	10	110	120
	%	50.83	49.17	100	18.33	81.67	100	8.33	91.67	100
$\chi^2$ -value		0.0001			9.5755			6.1517		
Pr		0.993			0.002			0.013		

Source: Survey result, 2023.

**Table 5:** Dairy cow, number of cattle, milking cow and lactation period.

Dairy producers	Statistics	Variables			
		Dairy Cow (Number)	Cattle (number)	Number of milking cow	Lactation period of dairy cow (Months)
Urban (n=63)	Mean	2.81	5.24	1.40	7.91
	St.dev.	2.24	3.76	0.91	1.32
Peri-urban (n=57)	Mean	2.32	5.86	1.12	8.11
	St.dev.	1.44	3.92	0.33	1.40
Total (n=120)	Mean	2.58	5.53	1.27	8.01
	St.dev.	1.91	3.83	0.71	1.36
t-Value		1.4214	-0.8868	2.1526**	-0.8098

Source: Survey result, 2023.

## Dairy Production in Urban and Peri-urban of Sample Respondents

The average dairy cow was 2.81 and 2.32 in urban and peri-urban sample dairy producers respectively. This result implies small scale of dairy farming practiced in the study area. The average number of cattle was 5.24 and 5.86 urban and peri-urban sample dairy producers respectively.

The average number of milking cow was 1.40 and 1.12 n urban and peri-urban sample dairy producers respectively. There are significant difference in between urban and peri-urban dairy producers at 5% significance level in terms of number of milking cow. The average number of milking cows in urban was more than peri-urban dairy producers. The average lactation period was 7.91 and 8.11 months in urban and peri-urban sample dairy producers respectively. An independent t- test indicted that there is insignificant difference between urban and peri-urban dairy producers in terms of number of dairy cows, number of cattle and lactating period of dairy cow (Table 5).

## Milk Production in Sample Urban and Peri-Urban Dairy Producer

The average milk yield from local breed cow was 6.55 and 7.74 litre per cow per day in urban and peri-urban respectively while for cross breed cow was 13.21 and 11.96 litre per day in urban and peri-urban dairy producers respectively. There is insignificant difference in terms of milk from local breed and cross breed cow between urban and peri-urban dairy producers (Table 6).

The results of the estimated parameters revealed that all the coefficients of the physical variables conform to a priori expectation of a positive signs.

The positive coefficient of herd size, concentrate and labor implies that as each of these variables is increased, ceteris paribus, milk output increased.

The coefficients of the variables; herd size, concentrate and labor are significant even at 1% level of significance. Therefore, these are factors explaining milk production in study the area (Table 7).

**Table 6:** Milk from local and cross breed cow per day in urban and peri-urban areas.

Dairy producers	Statistics	Variables	
		Milk from local breed cow litre per day	Milk from cross breed cow litre per day
Urban (n=43)	Mean	6.55	13.21
	St.dev.	1.85	5.53
Peri-urban (n=38)	Mean	7.74	11.96
	St.dev.	4.07	4.98
Total (n=81)	Mean	7.14	12.62
	St.dev.	3.17	5.29
t-Value		-1.1556	1.0617

Source: Survey result, 2023.

**Table 7:** Estimated Dairy stochastic production and cost frontier function.

Table 7. Estimated Daily stochastic production and cost frontier function.					
Variables	Production frontier		Variables	Cost frontier	
	ML estimate			ML estimate	
	Coefficient	Std.Err		Coefficient	Std.Err
Intercept	4.113 ***	0.4520876	Intercept	4.908***	0.9960532
LnHerd size	0.299***	0.1128464	LnConcetratcost	0.213 **	0.093847
LnConcentrate	0.269***	0.0586241	LnRoughagecost	-0.044	0.0900086
LnRoughage	-0.062	0.0840831	Lnlabourcost	0.309***	0.1040188
LnLabor	0.261 *	0.1027717	LnVeterinary & other operational costs	0.043	0.0545135
	$\Sigma\beta = 0.767$				
$\sigma^2 = \sigma^2_u + \sigma^2_v$	0.674			0.679	
$\lambda = \sigma_u / \sigma_v$	6.289	0.2402992		0.656	0.7356983
$\gamma$ (gamma)	0.975 ***			0.6992	
Log likelihood	-260.092			-268.493	
LR test	5.68			0.080	

\*\*\*, \*\*, &amp; \* Significant at 1%, 5% and 10% respectively. Source: Own computation, 2023.

**Table 8:** Efficiency estimation by stochastic production frontier model.

Types of commodities	Efficiency	Dairy producers	Mean	St.dev.	Minimum	Maximum	t-value
Dairy Production	TE	Urban (n=63)	0.307	0.206			1.2566
		Peri-urban(n=57)	0.262	0.183			
		Total(n=120)	0.286	0.196	0.051	0.933	
	AE	Urban (n=63)	0.717	0.057			1.6389
		Peri-urban(n=57)	0.699	0.065			
		Total(n=120)	0.708	0.061	0.568	0.841	
	EE	Urban (n=63)	0.230	0.171			1.2649
		Peri-urban(n=57)	0.192	0.149			
		Total(n=120)	0.212	0.162	0.029	0.782	

Source: Survey result, 2023.

## Estimation of Technical, Allocative and Economic Efficiencies

The study indicated that 28.6%, 70.8% and 21.2% were the mean levels of technical, allocative and economic efficiency of respectively. This in turn implies that farmers can increase their dairy production on average by 71.42% at the existing level of inputs and current technology by operating at full technical efficient level. The mean technical, allocative and economic efficiency of urban dairy producers were about 30.7%, 71.7% and 23% whereas peri-urban dairy producers were 26.2%, 69.9% and 19.2% respectively. This result implies that urban dairy producers more efficient than peri-urban dairy producers (Table 8).

## Determinants of Technical Efficiency in Dairy Production

The model chi-square test indicates that the overall goodness-of-fit of the truncated model was statistically significant at 1% probability level which in turn indicates the usefulness of the model to explain the relationship between the dependent and at least one independent variable.

The result of truncated model estimation indicated that the technical and economic efficiency of dairy production in urban and peri-urban was significantly influenced by the variables Breed type, education level, total family size, number of dairy cows, distance to animal health centre, Extension frequency and access to market information while dairy farming experience only affect technical efficiency (Table 9).

**Experience of Dairy Farming:** “Experience of the household head in dairy farming had positive relationship with technical efficiency as prior expectation significantly at 5% significance level. Dairy farming experience increase by one year the dairy technical and economic efficiency increase by 1.4% and 1.3% respectively keeping all other factors constant. This result is in conformity with the finding of” [10,11].

**Table 9:** Truncated results of determinants of technical efficiency of dairy producer.

Variables	Technical efficiency			Economic Efficiency		
	Coefficient	Robust Std. err	p> z	Coefficient	Robust Std. err	p> z
Sex of HH	-0.031	0.043	0.475	-0.026	0.038	0.498
Age of HH	-0.001	0.002	0.809	-0.001	0.002	0.573
Breed type	-0.055	0.042	0.186	-0.063	0.039	0.111
Education level	0.006	0.004	0.161	0.005	0.004	0.182
Total family size	0.013	0.011	0.253	0.010	0.010	0.328
Experience of dairy production	0.014**	0.005	0.010	0.013***	0.005	0.007
Number of dairy cows	0.017	0.012	0.162	0.017*	0.009	0.070
Distance to animal health center	-0.033***	0.012	0.004	-0.033***	0.011	0.002
Extension frequency	0.026***	0.007	0.000	0.023***	0.006	0.000
Access to market information	0.198***	0.041	0.000	0.180***	0.037	0.000
Non/and off-farm activities	-0.006	0.040	0.888	-0.003	0.926	0.374
Distance to market center	0.004	0.015	0.801	0.002	0.013	0.900
Sigma	0.181***	0.014	0.000	0.154**	0.012	0.000
Log pseudo likelihood	76.900977			108.80749		
Wald chi <sup>2</sup> (12)	337.60			281.89		
Prob> chi <sup>2</sup> =	0.0000			0.0000		

\*\*\*, \*\*, implies statistical significance at 1%, 5% and 10% level respectively. n=120 Limit: lower = 0, upper = 1, Source: model result, 2023.



**Number of Dairy Cows:** “Number of the household head in dairy farming had positive relationship with economic efficiency as prior expectation significantly at 10% significance level. Additional increase Dairy cow increase the dairy economic efficiency increase by 1.7% than others keeping all other factors constant. This result is in conformity with the finding of” [12].

**Distance to Animal Health Center:** Distance to farmers residence from animal health centre of dairy producers had negative relationship with technical and economic efficiency as prior expectation significantly at 5% and 1% significance level respectively. Farm distance to animal health center increase by one kilometer the dairy technical and economic efficiency would decrease by 3.3% and 3.3% than others keeping all other factors constant.

**Frequency of Extension Contact:** “Frequency of extension contact was found to have a positive and significant influenced on technical and economic efficiency of sample dairy producers at 1% level of significance. The result implies that an additional unit of extension contact would increase farmers’ technical and economic efficiency by 2.6% and 2.3% respectively than others, keeping all other factors constant. This implies that it improves the technical knowhow and skill of the farmers thereby exchange of experience that improve the efficiency. This is in line with the findings of” [11].

**Access to Market Information:** “Access to market information was found to have a positive and significant influenced on technical and economic efficiency of sample dairy producers at 1% level of significance. Farmer who had participate in social organization were 19.8% and 18% respectively more of technical and economic efficiency than others respectively, keeping all other factors constant. A farmer who is member of farmer cooperative is more likely to adopt improved agricultural technologies and hence efficient in dairy production than others. This is in line with the findings of” [12].

## Conclusions And Recommendations

### Conclusions

The result of mean technical, allocative and economic efficiencies was 28.6%, 70.8% and 21.2% respectively. This in turn implies that farmers can increase their dairy production on average by 71.4% at the existing level of inputs and current technology by operating at full technical efficient level. The mean technical, allocative and economic efficiency of urban dairy producers were about 30.7%, 71.7% and 23% whereas peri-urban dairy producers were 26.2%, 69.9% and 19.2% respectively. An independent sample t-test result shows insignificant mean difference between urban and peri-urban farmers in terms of technical, allocative and economic efficiency at 1% significance level.

Technical and economic efficiency were affected by experience in dairy production, extension frequency and access to market information while distance to animal health center affect technical and economic efficiency negatively. Additionally dairy number of dairy cows affect economic efficiency of urban and peri-urban dairy producers positively and significantly.

### Recommendations

Based on the findings of this study, the following recommendations are made.

Frequency of extension contact positively influenced households’ technical efficiency of urban and peri-urban dairy producers. Agricultural experts should be continuous follow up the dairy producers by providing technical support and extension advisors to improve technical efficiency of dairy producers.

Experiences in dairy production positively affect technical and economic efficiency urban and peri-urban dairy producers. Therefore, Agricultural office should be organized field days to conduct farmers experience sharing and disseminate best practices among dairy producers.

Number of dairy cows was positively affected economic efficiency of urban and peri-urban dairy producers. Therefore, farmers should increase productivity of cross breed and local cows in order to increase both technical and economic efficiency. Finally concentrates and forages important for improve milk yield. Therefore, concerned government bodies should practice establishment of improved forage initiatives in urban and peri-urban in order to improve efficiency of dairy production in the study area.

## Disclaimer (Artificial Intelligence)

Authors declare no any use of AI technologies during manuscript writing and editing.

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