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Daily milk yield and its predictors in dairy cows in Jinka city of Ari Zone, Southern Ethiopia

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Abstract

A cross-sectional study was conducted in Jinka City, Ari Zone, Southern Ethiopia, from May 2024 to January 2025 to determine the daily milk yield and assess its predictors. The study revealed that the average milk yield was 18.13, 14.5, and 14.47 litres in Arkisha, Mehal Ketema, and Tenadam respectively. There was a significant difference in daily milk yield among the three sub-cities of Jinka City (Mehal Ketema, Arkisha, and Tenadam). Body condition and parity were among the predictors that caused an increase in daily milk yield with a unit increase of predictors. As milk yield is influenced by numerous factors in the study area, appropriate management practices during production are crucial to enhance milk production and the profitability of production. Regular follow-up for the output change, provision of production-specific nutrients, and using an appropriate breeding program were recommended.

Keywords: *Dairy cows, Jinka city, milk yield, predictors*

Cow's milk is one of the most consumed foods in the world because of its high nutritional value. Besides, due to its composition, it is considered ~~the most~~ as nutritious food source for mammals, including humans. For cows to produce milk, many physiological components are needed **(**Sorensen and Knight, 2002; Sáenz, 2021). During lactation, milk production starts increasing until the animal reaches peak yield and thereafter starts declining. So, better production can be achieved if the animal has lactation persistency, *i.e*., the ability to produce milk at a relatively constant level throughout the lactation. It depends upon the mammary cell population and their secretory activity. Breeding management along with proper nutrition and increased milking frequencies can help in achieving lactation persistency as well as higher milk yield for an extended period (Pal *et al*., 2019). Numerous factors affect milk yield and milk composition of dairy cows. Among these factors, the diet of the dairy cow influences the production and proportion of milk compositions. Non-nutritional aspects such as inheritance, days in milk, number of lactations, diseases, and number of secretory cells, including environmental conditions like temperature and humidity, affect milk production. Furthermore, the year, season of calving and age of the cow, affect its productivity. Also, lactation length is one of the main factors affecting milk yield (Bajwa *et al*., 2004). In recent years, a shift has happened in milk marketing towards a standardized price structure based on lipid and protein concentrations and this requires a better understanding of the anatomical and physiological processes occurring in the mammary gland (Favio *et al*., 2023). Average milk production in dairy cows will most likely continue to increase. Currently, known limitations originate from the physiology and effects of adverse environmental factors that restrict

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the maximal exploitation of genetic capacity (Geiger and Hovey, 2023). It is evident that livestock products in the form of meat, milk, cheese, butter, eggs, honey, etc. provide the needed animal protein that contributes to the improvement of the nutritional status of the people (CSA, 2020). However, challenges have arisen from an increase in the demand for food because of population growth and difficulties in increasing production through the costs and adversities of climate change. These challenges are quite evident and have required the use of extensive technical, human and financial resources in an attempt to overcome them. It is necessary to produce greater amounts of food with quality, at low cost, and under increasingly diverse environmental conditions (Cosme *et al*., 2021). However, the milk yields from dairy cows are always affected by different factors. Thus, there is a need to assess the daily milk yield and the factors that affect milk production in the study area. As there was a lack of research on this phenomenon in the study area, the current study was aimed to assess the daily milk yield and its predictors in cows in selected cities of Ari Zone, Southern Ethiopia.

Materials and methods

Study Area

The study was conducted from May 2024 to January 2025 in Jinka city, which is the capital city of the Ari Zone. It is located in the hills north of the Tama Plains. Currently, Jinka is the center of Jinka town administration. It has a latitude and Longitude of 5°47′N and 36°34′E coordinates, respectively, and an elevation of 1490 meters above sea level. The average annual temperature and precipitation are 21.1°C and 1274 mm, respectively. It is 750 km south of the main capital city of the country, Addis Ababa, and 550 km away from the regional capital, Hawassa. The climatic condition ranges from Dega (cold temperature) to Kola (warm temperature) which constituted 34.4% of the zonal climatic condition (Godana and Atta, 2013; Fesseha and Abebe, 2020). The town has 40,311 cattle, 11,411 Goats, 2868 Sheep, 95,718 poultry, and 1402 equine population (Jinka City Administration Agriculture office, 2023).

Study Population

A cross-sectional study was conducted in the study area in the population selected with the following criteria. The study population included recently calved dairy cows and their owners residing in the three sub-cities of Jinka City: Mehal Ketema, Arkisha, and Tenadam. Based on exclusion criteria, nulliparous cows and those cows that are sterile for their life and their owners who are unable to give their consent were excluded from the study

Sample Size Determination and Sampling Procedure

The sample size for this study was determined based on Thrustfield (2005), considering a single population proportion formula as follows: $\frac{n= z^2xP_{\exp}(1-P_{\exp})}{e^2}$; Where n=sample size, z=critical value (1.96 at 95% confidence level), P_{exp}=expected prevalence, e=margin of error at 95% confidence level, and the sample size was estimated by taking an expected prevalence of 50% since there is no previous study in the same setting. Therefore, the sample size becomes n=384. However, the sampling frame is too small (listed 175 dairy cows obtained by simple random sampling technique), it is better to use the adjustment method in the single population proportion: $nadj = \frac{NXn}{N+n}$ Where, N=number of study population, n=sample size, n_{adj}=adjusted sample size=120. 120= $\frac{N \times 384}{N+384}$ By solving for N, we got N=175, which can be proved as $n_{adj} = \frac{175 \times 384}{175+384}$= 120.

Method of Data Collection

Questionnaire Survey

A prior communication was done with the local administration and agriculture office for the objective of having affinity in the study area. There was a brief discussion on the objective of the survey and respondents were asked for their consent before the interview commenced. The data regarding daily milk yield and its predictors were obtained from randomly selected dairy cow owners. The interview was conducted with each selected owner in the common local language (Amharic and Ari). Based on the responses collected, observations and field-guided walks (Martin, 1995) were conducted.

Study Variables

Dependent Variables

The dependent variable in this study was the daily milk yield of dairy cows, measured in litres.

Independent Variables

The independent variables investigated included the sample site (Mehal Ketema, Arkisha, or Tenadam), body condition score (poor, medium, or good), the season of birth (autumn, summer, winter, or spring), parity number (1st, 2nd, 3rd, 4th, 5th, or 6th and above), age of the cow in months, and calving interval in months.

Operational Definitions

Poor body condition score: A very thin dairy cow with no fat reserves.

Medium body condition: Dairy cows with ideal musculature.

Good body condition: A severely over-conditioned dairy cow with some fat reserves

Data Quality Control

A pretest for the questionnaire was conducted in 10 respondents (5% of the sample size) out of the study area and feedbacks were incorporated in the final tool to improve its quality. The collected data was reviewed and checked daily for completeness and consistency at the spot during data collection time.

Data Management and Statistical Analysis

Collected data was managed by MS Excel spreadsheet version 2010 and then exported to STATA software version 14. The descriptive results are presented in tables and figures. Multi-variable linear regression test was employed to assess the association between milk production and its predictors.

Results and discussion

Descriptive statistics

The average age in months, daily milk in litres and calving interval of cattle in months were 60.16, 15.07 and 15.13, respectively. Therefore, each cow in the study area yields an average of 15.07 litres per day with an average calving interval of 15.13 months. Each cow in the study area gave birth after average age of 60 months (5 years) (Table1).

Regarding the sample frequencies and percentages, 50 (41.67%), 34 (28.33%), and 36 (30%) samples were collected from Mehal Ketema, Arkisha, and Tenadam, respectively. Among these, 61 (50.83%) animals were with medium body condition and 25.83% of the animals were in 4th parity (Table 2).

Association between milk yield and its predictors

The average milk yields were 18.13, 14.5, and 14.17 litres in Arkisha, Mehal Ketema, and Tenadam respectively. Body condition, season of birth, number of parity, age of animal in months and calving interval in months were observed to be the most important risk factors of milk yield in Jinka city. Most of the predictors were not significantly associated with daily milk yield (Table 3).

This study revealed that the average change in milk yield was 10.42 liters (as indicated by α; constant=10.42 in Table 3) when changes in the predictors remained zero (if no changes). However, 46.69% of the variability in the daily milk yield was explained by the predictor variables (the

Table 1. Means of age, daily milk yield, and calving interval observed during the study in Jinka city from May 2024 to January 2025

	Mean	SE	[95% Conf. Interval]
Age in month	60.158	1.810	56.57-63.7
Daily milk yield in liter	15.069	0.304	14.46-15.67
Calving interval in month	15.125	0.191	14.746-15.50

Season wise daily milk yield recorded is shown in Fig. 1.

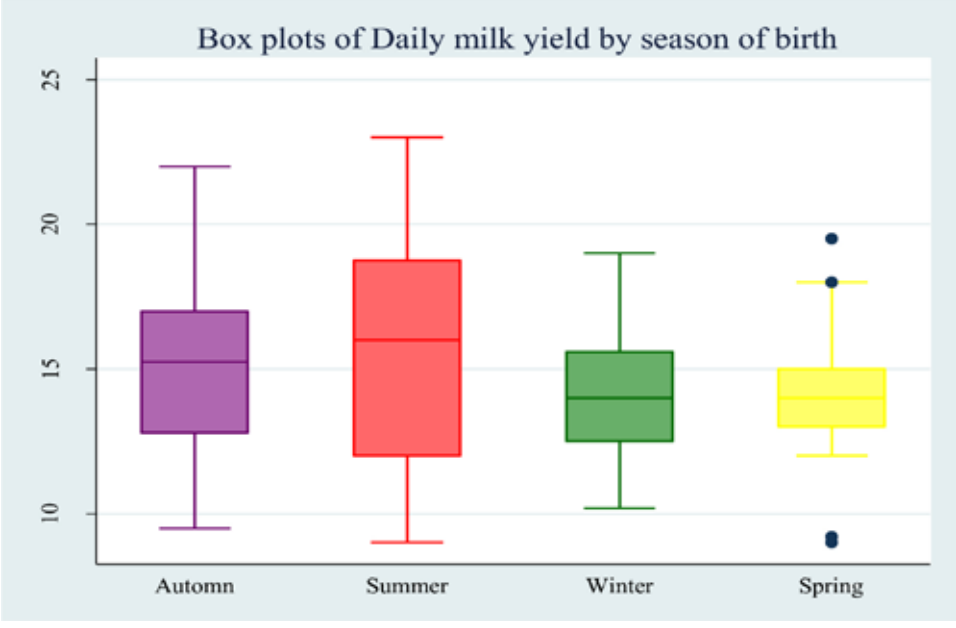

Fig. 1. Daily milk yield by season in Jinka city

Table 2. Frequencies, percentages, and cumulative percentages of sampled data per its predictors in Jinka City from May 2024 to January 2025

Sample Site (code)	Frequency	Percentage (%)	Cumulative (%)
Mehal Ketema	50	41.67	**41.67**
Arkisha	34	28.33	**70.00**
Tenadam	36	30.00	**100.00**
Body condition score	Poor	14	**11.67**
	Medium	61	**50.83**
	Good	45	**37.50**
Season	Autumn	54	**45.00**
	Summer	44	**36.67**
	Winter	9	**7.50**
	Spring	13	**10.83**
Parity	1st	15	**12.50**
	2nd	25	**20.83**
	3rd	27	**22.50**
	4th	31	**25.83**
	5th	20	**16.67**
	6th&above	2	**1.67**
Total		**120**	**100.00**

Table 3. Multivariate linear regression for daily milk yield in Jinka city

(Stata output) (sample code for study sites (Mehal ketema=1[a], Arkisha=2, Tenadam=3); bcs (good=3, medium=2, poor=1[a]); season (autumn=1[a], summer=2, winter=3, spring=4)

Predictors	Coef	Std. Err	t	P>|t|	[95% Conf. Interval]
site 2*	3.51	0.64	5.46	**0.000**	2.238-4.788
Site 3*	-2.51	0.65	-3.83	**0.000**	-3.8-1.2
bcs 2	0.63	1.068	-0.59	0.554	-1.48-2.75
Bcs 3	-0.337	1.111	-0.30	0.762	-2.54-1.86
Season 2	-0.195	0.542	-0.36	0.720	-1.27-0 .88
Season 3	0.206	1.174	0.18	0.861	-2.12-2.5
Season 4	0.354	0.944	0.37	0.708	-1.5-2.2
Parity 2	0.6502365	0.89	0.73	0.469	-1.12-2.42
Parity 3	1.75	0.897	1.95	0.053	-0.026-3.533
Parity 4	1.775335	0.99	1.79	0.077	-0.195-3.74
Parity 5	0.536	1.177	0.46	0.650	-1.798-2.87
Parity 6	2.448	2.189	1.12	0.266	-1.89-6.79
Age in months	-0.023	.0193	-1.20	0.233	-0.061-0.015
Calving interval in months	0.298	0.137	2.18	0.032	.0266-0.569
_cons l	10.42	2.65	3.92	0.000	5.15-15.68

1[a] the predictors which were not considered due to collinearity

*Statistically significant predictor

coefficient of determination; adjusted R-squared=0.4649). It was observed that study sites influenced milk yield in the study area.

Regarding the predictors, there was a significant difference in daily milk yield among the three sub-cities of Jinka City. Dairy cows from the Arkisha sub-city had

a higher average daily milk yield (18.13 liters) when compared to Mehal Ketema (14.5 liters). This difference might be attributed to environmental differences, including management, nutrition, and housing (Bajwa *et al*., 2004). In this study, cows with good body condition tend to produce more milk compared with the others. This might be related to nutritional supplements and the size of the mammary gland. It might also be possibly due to a difference in parity and age among the cows.

Higher mean daily milk yield was observed during the summer season and was statistically non-significant. This might be attributed to the availability of suitable pasture for milk production. This is because the coincidence of parturition with suitable pasture availability increased milk production.

A unit increase in parity increased daily milk yield by 1.775 liters, 0.536 liters, and 2.448 liters in the 4th, 5^{th,} and 6th parities, respectively. As stated by Wondossen *et al*. (2018) and Kashoma *et al*. (2015), parity significantly influenced the daily milk yield during lactation. Fahim *et al.* (2017) also revealed that animals during early stage of lactation, in their fourth parity performed best in the milking parlor.

Conclusion

In conclusion, milk yield is influenced by numerous factors, including the study site, body condition score, season of birth, calving interval, and parity number. The study site was the only statistically significant predictor of daily milk yield. Appropriate management practices during production are crucial to enhance milk production and the profitability of the due production. As a recommendation, to increase the daily milk yield of dairy cows in the study area, producers should regularly follow up on the output change (daily milk yield), provide production-specific nutrients, and share experiences with others.

Conflict of interest

We declare that there is no conflict of interest.

Acknowledgment

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