**Technical Efficiency and Its Determinants among Micro and Small Dairy Enterprises in Hadiya Zone, Central Ethiopia**

**Abstract**

*This study investigates the technical efficiency of micro and small-scale dairy production enterprises and examines the key factors influencing their performance in the Hadiya Zone of Southern Ethiopia. A total of 212 dairy enterprises were selected using a multi-stage sampling method. In addition, data were collected through focus group discussions and interviews with key informants to enhance the qualitative insights. The study applied both descriptive statistics and the stochastic frontier model to estimate efficiency levels. The findings revealed that the average technical efficiency was 60.18%, with micro-level enterprises scoring 60.09% and small-scale enterprises 58.79%. Technical efficiency was significantly affected by variables such as education level, managerial experience, access to training, markets, gender, and credit availability. The results suggest that targeted and differentiated strategies are necessary to address the unique efficiency challenges faced by micro and small dairy enterprises.*

**Keywords:** Dairy enterprises, technical efficiency, stochastic frontier model, Micro and Small Dairy Enterprises

**1. Introduction**

The Ethiopian government has long acknowledged the critical role of enterprises in driving socio-economic progress and has prioritized support for this sector. In an effort to enhance industrial development, the government introduced its first enterprise development strategy in 1997. This policy aimed to establish a broad-based, competitive, and enabling environment for enterprise growth. Enterprises were categorized based on their paid-up capital into micro, small, medium, and large enterprises, and classified by sector: manufacturing, trade, construction, services, and agriculture (Setiawan et al., 2019).

Since the adoption of this strategy, enterprise activities have expanded significantly in various regions, including the Hadiya Zone. Government and development partners have contributed to improving the performance of these enterprises by facilitating credit, providing management and technical training, offering consultancy services, establishing market linkages, and supporting infrastructure such as business premises (Gelan & Muriithi, 2012).

Micro and small enterprises (MSEs) are recognized as engines of economic transformation, serving as key drivers of job creation, poverty reduction, innovation, and structural change from agriculture to industry (Leza et al., 2016). Despite growing interest from academics and policymakers, studies on the technical efficiency and influencing factors of these enterprises particularly within the dairy sub-sector remain limited (Ajibefun & Daramola, 2003). This research addresses that gap by evaluating technical efficiency and identifying the factors that influence it among dairy enterprises in Hadiya Zone, where such analysis has been relatively scarce.

**2. Objectives of the Study**

**General Objective**

The primary aim of this study is to assess the technical efficiency of micro and small-scale dairy production enterprises in the Hadiya Zone of Central Ethiopia and to examine the key factors influencing variations in their efficiency.

**Specific Objectives**

Specifically, the study seeks to:

Evaluate the level of technical efficiency among micro and small dairy enterprises in the study area.

Identify and analyze the major factors contributing to efficiency differences across these enterprises.

**3. Research Methodology**

**3.1 Description of the Study Area**

The research was conducted in the Hadiya Zone, located in Central Ethiopia. The zone lies approximately 232 kilometers south of Addis. Covering an estimated area of 346,958.5 hectares, Hadiya Zone is situated at an average elevation of 1,900 meters above sea level. It experiences a temperate climate, with daily temperatures ranging between 18°C and 27°C. Rainfall is seasonal, with a wet period extending from February to August and drier months from September to January.

As of the 2017 population projection of Ethiopia, Hadiya Zone had a total population of approximately 1,710,812, composed of male 846,852 (49.5%) and female 863,960 (50.5%). The population is known for its cultural diversity and peaceful coexistence across various ethnic and religious groups. Administratively, the zone consists of 13 rural Woredas and 7 urban centers, with Hosanna serving as the administrative capital.

The local economy is largely based on mixed farming systems that include both crop cultivation and livestock rearing. Farmers produce a range of cereals (such as wheat, teff, maize, barley, and beans), vegetables, fruits, and cash crops like coffee and khat. The zone is particularly known for its high wheat productivity, with yields reaching approximately 65 quintals per hectare earning it the nickname “the wheat basket” of Ethiopia. Livestock, especially dairy production, is also a significant component of household income and food security in the region.

**3.2 Description of Population and Sampling Methods**

This study focused on micro and small-scale dairy production enterprises operating in the Hadiya Zone. The target population comprised formally registered dairy enterprises actively engaged in milk production within the zone. To achieve a representative sample and ensure reliable estimation of technical efficiency, a multi-stage sampling approach was adopted.

In the first stage, three Woreda Lemmo, Analemmo, and Misha were randomly selected from the thirteen rural woredas’ in the zone. These woredas were chosen to reflect the diversity of dairy enterprise operations within the area. In the second stage, six kebeles where micro and small dairy enterprises operate were identified across the selected woredas. Finally, individual dairy enterprises were randomly sampled from these kebeles based on their classification into two groups: micro and small enterprises.

The sample size was determined using Watson’s (2001) simplified formula, which accounts for a 95% confidence level, a 5% margin of error, a 50% estimated population variance, and a 96% expected response rate. With a total population of 528 dairy enterprises, the resulting sample size was 212 enterprises 114 classified as micro-level and 98 as small-scale.

Stratified random sampling ensured that each group was proportionally represented. This method was chosen for its ability to capture variability within the population and to avoid underrepresentation of smaller groups.

**3.3 Types of Data and Data Collection Methods**

This study utilized both primary and secondary data sources to provide a comprehensive understanding of technical efficiency among dairy enterprises.

Primary data were collected directly from the selected dairy enterprises using structured questionnaires, face-to-face interviews, and field observations. The questionnaire was designed to capture detailed information on production inputs, outputs, enterprise characteristics, and managerial practices. Prior to full deployment, the instrument was pre-tested in a non-sampled area to ensure clarity and consistency.

Additionally, qualitative insights were gathered through focus group discussions involving 18 participants and interviews with five key informants, including local officials and cooperative leaders. These discussions helped contextualize the quantitative data and identify practical challenges facing the enterprises.

Secondary data were obtained from various published and unpublished materials, including government reports, research articles, development agency records, and documents from the Hadiya Zone enterprise development office.

**3.4 Methods of Data Analysis**

To analyze the collected data, the study employed a combination of descriptive and econometric methods.

Descriptive statistics were used to summarize key characteristics of the sampled dairy enterprises, including demographic profiles, resource allocation, and production outputs. These analyses were conducted using SPSS software and provided insights into patterns and variations across enterprise types.

For the estimation of technical efficiency and the identification of its determinants, the study adopted the stochastic frontier analysis (SFA) approach, which was executed using STATA software. The stochastic frontier model (SFM) allows for the separation of random errors from inefficiency effects, making it well-suited for cross-sectional data in agricultural production studies.

A Cobb-Douglas functional form was selected for its simplicity and effectiveness in representing production relationships. The model included inefficiency effects to capture the influence of factors such as education, experience, training access, and market linkage. The parameters of the production frontier and the inefficiency model were estimated simultaneously using the maximum likelihood estimation (MLE) method.

**4. Results and Discussion**

**4.1 Descriptive Statistics**

**Technical Efficiency:** Understanding the technical efficiency of dairy enterprises requires a closer examination of the production inputs and outputs across the sampled units. The efficiency levels largely depend on how effectively inputs such as land, labor, livestock, and feed are utilized in relation to milk output.

The average milk yield across all sampled enterprises was approximately 492.06 liters per cow. When disaggregated by enterprise size, micro-level enterprises reported an average yield of 526.11 liters per cow, while small-scale enterprises achieved a slightly higher yield of 543.18 liters per cow.

Enterprise characteristics such as age, employee count, and startup capital also varied significantly. Most enterprises had been in operation for less than three years, with many micro-level enterprises operating with fewer than four employees and limited initial capital often below the recommended thresholds. In terms of management, the majority of enterprises were male-led, with managers having relatively low levels of formal education and limited entrepreneurial experience.

Despite these challenges, around 69% of the enterprises reported having some level of entrepreneurial skill, with small-scale enterprises more likely to report such capabilities.

**Table 1:** Summary of Milk Output and Input Use by Enterprise Size

| Variable | Total Sample (Mean) | Micro Level (Mean) | Small Level (Mean) |
| --- | --- | --- | --- |
| Milk (liters/cow) | 492.06 | 526.11 | 543.18 |
| Number of Cows | 4.29 | 4.26 | 4.24 |
| Labor (man days) | 8.70 | 8.85 | 8.66 |
| Concentrated Feed (kg/cow) | 199.42 | 220.53 | 228.86 |
| Unconcentrated Feed (kg) | 497.55 | 571.37 | 588.86 |
| Land (ha) | 0.39 | 0.41s | 0.41 |
| Veterinary Medicine (dose) | 1.83 | 1.96 | 2.02 |

*Source: Author’s field survey (2024)*

**Age Distribution:** The duration that dairy enterprises have been in operation varies across the sample. As illustrated in Table 3, nearly half of the sampled enterprises (49%) have been established within the last three years. This trend is more prominent among micro enterprises, where 53.5% fall within this age category. In contrast, only 4% of all enterprises (entirely small-scale) have been in operation for over ten years. This suggests that a significant portion of the enterprises are relatively new entrants to the dairy sector, which may affect their efficiency due to limited experience and resource constraints.

**Table 2:** Age of Dairy Enterprises

| Age Group | Total Sample | Micro Level | Small Level |
| --- | --- | --- | --- |
| 1–3 years | 49% | 53.5% | 43.8% |
| 4–6 years | 26% | 35.1% | 15.3% |
| 7–9 years | 21% | 11.4% | 32.7% |
| 10+ years | 4% | 0% | 8.2% |

*Source: Author’s field survey (2024)*

**Employment Size:** In terms of workforce, most micro enterprises operate with limited human resources. Approximately 62% of micro-level units employ fewer than four individuals, which is significantly below the national strategy guideline that allows up to ten employees for micro enterprises. Similarly, 53% of small enterprises employ fewer than ten people despite the standard classification allowing up to fifty employees. These figures point to limited job creation capacity, possibly due to financial or managerial limitations.

**Table 3:** Number of Employees

| Enterprise Level | Employee Range | Percentage |
| --- | --- | --- |
| Micro | 1–4 employees | 62% |
|  | 5–8 employees | 38% |
| Small | 1–9 employees | 53% |
|  | 10–14 employees | 47% |

*Source: Author’s field survey (2024)*

**Initial Capital Investment:** Many dairy enterprises in the study area began operations with limited startup capital. According to the national enterprise development guidelines, the expected capital for micro enterprises is up to Birr 20,000, and for small enterprises, between Birr 20,000 and Birr 50,000. However, 67% of micro enterprises reported starting with less than Birr 10,000, and 56% of small enterprises began with less than Birr 20,000. This shortfall in initial investment could be a limiting factor in enterprise growth and efficiency.

**Table 4:** Initial Capital by Enterprise Type

| Enterprise Level | Capital Range | Percentage |
| --- | --- | --- |
| Micro | Less than 10,000 Birr | 67% |
|  | 10,000–20,000 Birr | 33% |
| Small | Less than 20,000 Birr | 56% |
|  | 20,000–50,000 Birr | 44% |

*Source: Author’s field survey (2024)*

**Gender of Enterprise Managers:** The majority of dairy enterprises in the study area are managed by men. Out of the total sample, 71% of the managers were male, while 29% were female. Gender distribution varied slightly by enterprise type: 66.7% of micro-level enterprises were managed by men compared to 76.5% among small enterprises. This gender imbalance suggests that female participation in dairy enterprise leadership remains limited, potentially due to structural challenges such as limited access to finance, information, and support services.

**Table 5:** Gender of Managers

| Gender | Total Sample | Micro Level | Small Level |
| --- | --- | --- | --- |
| Male | 71% | 66.7% | 76.5% |
| Female | 29% | 33.3% | 23.5% |

*Source: Author’s field survey (2024)*

**Experience of Managers:** Managerial experience is another key factor influencing enterprise performance. More than half of the respondents (52%) had less than three years of experience managing a dairy business. This figure was higher among micro enterprises (60.5%) compared to small enterprises (41.8%). Only a small portion of managers (5%) had ten or more years of experience, indicating that a majority of enterprises are still in the early learning phase of operation.

**Table 6:** Experience of Managers

| Experience Level | Total Sample | Micro Level | Small Level |
| --- | --- | --- | --- |
| 1–3 years | 52% | 60.5% | 41.8% |
| 4–6 years | 24% | 21% | 27.6% |
| 7–9 years | 19% | 15% | 23.5% |
| 10+ years | 5% | 3.5% | 7.1% |

*Source: Author’s field survey (2024)*

**Educational Background:** The education level of managers varied widely, but a large share had only basic schooling. About 43% had completed elementary education (grades 1–8), while 32% had a high school background (grades 9–12). Only 7% of respondents had attained a vocational or college-level education. The relatively low academic qualifications among managers could present challenges in areas such as financial literacy, record-keeping, and technology adoption.

Table 7: Educational Level of Managers

| Education Level | Total Sample | Micro Level | Small Level |
| --- | --- | --- | --- |
| Elementary (Grades 1–8) | 43% | 48.2% | 36.7% |
| High School (9–12) | 32% | 32.5% | 31.6% |
| Preparatory | 18% | 16.7% | 19.4% |
| TVT & Above | 7% | 2.6% | 12.3% |

*Source: Author’s field survey (2024)*

**Entrepreneurial Skills:** Roughly 69% of enterprise operators were reported to possess basic entrepreneurial skills that is, the ability to identify business opportunities, manage resources efficiently, and solve operational challenges. This percentage was higher among small enterprises (77.6%) compared to micro enterprises (61.4%). The remaining 31% of operators lacked such skills, which could limit their ability to grow and sustain their businesses.

**Table 8:** Entrepreneurial Skills among Operators

| Skill Possession | Total Sample | Micro Level | Small Level |
| --- | --- | --- | --- |
| Yes | 69% | 61.4% | 77.6% |
| No | 31% | 38.6% | 22.4% |

*Source: Author’s field survey (2024)*

**4.2 Econometric Model Analysis**

The stochastic frontier model was applied to estimate technical efficiency and examine the determinants of inefficiency among the sampled enterprises. Three hypotheses were tested: the suitability of the Cobb-Douglas function, the presence of inefficiency effects, and the joint significance of inefficiency determinants.

These tests justify the use of a Cobb-Douglas stochastic frontier framework and confirm that inefficiency effects were found to be statistically significant, indicating that enterprises were not operating on the production frontier and had room for efficiency improvement. The gamma coefficient (γ) was estimated at 0.8541 for the total sample, suggesting that over 85% of the output variation was due to inefficiency rather than random shocks. Key inputs like the number of cows, feed, and labor were found to positively influence output.

All input coefficients were positive, indicating that increases in these inputs are associated with higher milk output. Notably, the number of cows and feed (both concentrated and roughage) had a statistically significant and substantial impact on milk production, highlighting their central role in enterprise performance.

**Efficiencies scores of enterprises:** According to the SFA model results, there exists a difference in efficiency scores among the milk producing Dairy enterprises in the study area. TE scores range from 13.78% to 91.06% with the mean 60.18% (from 14.80% to 90.15% with the mean 60.08% for micro level enterprises and from 14.48% to 89.48% with the mean 58.79% for small level enterprises). Such low efficiencies in production indicated potential for improvements in milk production given the current levels of productivity among the level of enterprises.

Table 9: Summary statistics of estimated TE of sampled enterprises

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Types of sample | TE estimates of enterprises | | | |
| Maximum | Minimum | Mean | Standard deviation |
| Total sampled MSAEs | 0.9106 | 0.1378 | 0.6018 | 0.1816 |
| Micro level | 0.9015 | 0.1480 | 0.6009 | 0.1778 |
| Small level | 0.8945 | 0.1448 | 0.5879 | 0.1822 |

*Source: Author’s field survey (2024)*

**Sources of inefficiency estimation:** After measuring levels of enterprises efficiency and determining the presence of efficiency differences among enterprises. Several factors significantly influenced efficiency: education level, access to training, experience of the manager, market access, credit availability, and gender of the manager. These findings underscore the importance of human capital and institutional support in improving enterprise performance.

Table 10: Determinants of efficiencies score differentials among enterprises

|  |  |  |  |
| --- | --- | --- | --- |
| Variables | Total sampled enterprises | Micro level enterprises | Small level enterprises |
| TE | TE | TE |
| Coefficient | Coefficient | Coefficient |
| Age | -0.022 | -0.086 | -0.015 |
| Education | -0.914\*\*\* | -0.292\*\*\* | -0.234\*\*\* |
| No- of employee | -0.086 | -0.293 | -0.204 |
| Initial capital | -0.920 | -0.0410 | -0.501 |
| Entrepreneur skill | -0.090 | -0.281 | -0.424 |
| Experience | -8.337\*\* | -0.3936 | -0.481\*\* |
| Access to training | -0.926\*\* | -0.132\* | -0.108\* |
| Access to market | -0.502\*\*\* | -0.058\*\* | -0.260\*\* |
| Sex of manager | -0.854\* | -0.201 | -0.493 |
| Consultancy service | -0.177 | -0.062 | -0.113 |
| Access to premises | -0.345 | -0.418 | -0.336 |
| Access to infrastructure | -0.565 | -0.807 | -0.033 |
| Customer networks | -0.232 | -0.397 | -0.375 |
| Access to credit | -0.180\*\*\* | -0.957\*\*\* | -0.917\*\* |

\*, \*\*, \*\*\*, Significant at 10%, 5% and 1%, level of significance

*Source: Author’s field survey (2024)*

These variables were found to be statistically significant at different confidence levels (1%, 5%, and 10%), confirming their influence on efficiency outcomes. The analysis indicates that improving managerial capacity and institutional support can significantly enhance productivity in dairy enterprises. The inefficiency effects model revealed that several socio-economic and institutional variables significantly influenced the technical efficiency of dairy enterprises. Key findings include:

**Education level**: Negatively associated with inefficiency, suggesting that higher education leads to better management and resource use.

**Access to training**: Significantly improved efficiency, indicating the value of capacity-building programs.

**Managerial experience**: Positively influenced efficiency, particularly for small enterprises.

**Access to credit**: Both were associated with reduced inefficiency, highlighting their importance in operational effectiveness.

**Access to market:** It is found to be negative and statistically significant. The dairy enterprises which have sufficient market access for their product have better chance to increase the profitability opportunities.

**Sex of manager:** There were significant differences in efficiency scores among male-managed and female-managed enterprises. Male managed dairy enterprises were more likely to be efficient than female managed enterprises. This is due to the fact that female managed dairy enterprises have additional responsibilities within their household.

**Access to credit (Credit):** It is found to be negative and statistically significant. The results indicate that dairy enterprises which have more access to credit had less inefficient than those which had not sufficient access to credit.

**5. Conclusion and Recommendations**

**Conclusion**

This study assessed the technical efficiency of micro and small-scale dairy production enterprises in the Hadiya Zone and examined the key socio-economic and institutional factors influencing their performance. Using a stochastic frontier approach, the analysis revealed that the average technical efficiency across sampled enterprises was relatively low, with significant variations between micro and small operators.

The results indicated that a considerable proportion of output variation over 85% was due to inefficiency rather than random factors. Important determinants of efficiency included the education level and experience of managers, access to training programs, market linkages, gender of enterprise leaders, and access to credit. These findings suggest that both human capital and institutional support play a critical role in improving enterprise performance.

**Recommendations**

Based on the results of this study, the following policy recommendations are proposed:

* Tailored training programs: Develop and deliver regular capacity-building initiatives focusing on modern dairy management, financial literacy, and entrepreneurial skills tailored to the needs of micro and small enterprise owners.
* Enhance access to credit: Improve the accessibility and flexibility of financial services to enable small-scale dairy producers to invest in productivity-enhancing technologies and inputs.
* Promote market linkages: Facilitate stronger connections between producers and markets by supporting cooperative models and infrastructure that reduce transaction costs and increase bargaining power.
* Support female entrepreneurs: Address barriers limiting the participation of women in dairy enterprise leadership through targeted support programs and inclusive development initiatives.
* Diversified policy approaches: Recognize the differences in efficiency challenges between micro and small enterprises, and implement segmented strategies that reflect their Woreda characteristics and resource constraints.

**Disclaimer (Artificial intelligence):**

The author hereby declares that generative AI technologies such as Large Language Models have been used during the editing of the manuscript. The details of the AI usage are provided below:

1. Name and Source of Generative AI Technology: ChatGPT, developed by OpenAI
2. Version and Model: GPT-4-turbo, April 2025 release
3. Input Prompts Provided to the AI:
   * “Language editing of this manuscript.”
   * “Please improve grammar, coherence, and flow in the attached academic paper.”
   * “Polish the language while preserving the original structure and meaning.”

The AI was used solely for language enhancement, including grammar correction, clarity improvement, and academic tone refinement. No content generation or substantive academic contribution was performed by the AI.

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