**Assessing Economic Efficiency and Key Determinants of Dairy Enterprises in Hadiya Zone, Central Ethiopia**

**Abstract**

*This study examines economic efficiency and its determinant factors in dairy enterprises in the Hadiya Zone, Central Ethiopia. A total of 212 enterprises were selected using multi-stage sampling techniques. Economic efficiency was estimated, and the data were analyzed using descriptive statistics and econometric model called stochastic frontier model. The findings indicate that the overall average enterprises economic efficiency (EE), score of total sampled enterprises obtained from stochastic frontier model result was 36.16% (it were 36.88% for micro level enterprises and 37.34%, for small level enterprises) respectively. The result of the study confirms that the EE of total sampled enterprises were statistically and significantly determined by number of employee, amount of initial capital, access to market, access to infrastructure and access to credit at different levels of significance. Moreover, EE of micro level enterprises were also found to be statistically and significantly influenced by number of employee, amount of initial capital, access to consultancy service, sex of manager and access to premises in the study area at different levels of significance. Furthermore, the EE of small level enterprises were statistically and significantly affected by education level, number of employee, experience of manager, access to training, access to infrastructure and access to credit at different levels of significance in the study area. These results carry important implications for enhancing the performance of dairy enterprises and guiding policy decisions in the area of enterprises.*

**Keywords:** Dairy enterprises, economic efficiency, maximum likelihood, stochastic frontier.

# 1. Introduction

“The Ethiopian government recognizes the significance of this sector and shows its dedication to promote the enterprises development by the Issuance of National Micro and Small Enterprises Strategy in 1997 and 2014 and the Establishment of the Federal Micro and Small Enterprises Development Agency. In Ethiopia, years have elapsed since enterprises were recognized as an important area of intervention by the private sector so that they would contribute their part to curb the socio-economic problems of the vast society. However, it is hardly possible to think that all enterprises are successful in serving the purpose they are intended for. This is largely true that their performance is dependent on a number of factors like, age of enterprise, experience of manager, educational level of manager, number of employs, amount of initial capital, type of sector, entrepreneurial skill, managerial skill, access to training, access to market, gender of manager, consultancy service, access to premises, access to infrastructures, customer networks, access to credit, lack of security, lack of promotion, motivation, commitment, corruption, insufficient technology and high cost of input” (Hailay *et al.,* 2014; Fikire; 2015).

“Enterprises are the main source of rapid economic growth and the basic transformer of the structure of economic system from agriculture to industrialization. These makes enterprises a major area of concern for government and NGOs with the objectives of investing in human capital, employment creation, saving promotion, asset building, income generation and income inequality reduction, import substitution, innovation etc. However, the intense studies in both academic and policy making circles about the economic efficiency (EE) and their determinant factors were not much of the views about the links”. (Ababiya; 2018)

The EE and determinant factors of the micro and small agricultural enterprises in Hadiya zone in current status of enterprisesare therefore very essential. In this regard, any studies are not available in the study area. This paper was explored the EE and determinant factors of enterprisesin Hadiya zone, Ethiopia. Because of this, the study gives high emphasis on the relationship to establish statistical nexus between EE and their determinant factors on the basis of annual cross sectional data of sample enterprises. Hence, this study is deemed to estimate the EE and analyze their determinant factors of the enterprises in the study area, which have not been adequately studied. Recognizing this fact the effort was made to fill the gap by conducting research on EE and their determinant factors of enterprises in the study area.

## 2. Objectives of the Study

The general objective of this study was to estimate the economic efficiency and to identify the determinant factors of micro and small dairy production enterprises in Hadiya Zone, Ethiopia. The specific objectives of the study were:

1. To estimate economic efficiency of micro and small level dairy production enterprises;
2. To identify the determinant factors affecting the economic efficiency of dairy enterprises.

**3. Methodology**

**Description of the study area:** This study was undertaken in Hadiya zone. It is located at a distance of 232 km away from the Addis Ababa, capital city of the country, to south and 180 km away from regional capital city, Hawassa to North West. The estimated total area of the zone is 346,958.5 hectares. It is characterized by temperate type of climate with daily temperature ranging from 180c to 270c, and is located 1900 meters above sea level. It have low to high rainy season for 7 months from February to August and for the remaining 5 months from September to January have bright and conducive air condition throughout the year. The total population of the zone as per the population projection of Ethiopia for 2017 was estimated to be male 846,852 (49.5%) and female 863,960 (50.5%) the total of 1,710,812. It has a population density of 342.64. It is divided into 13 *Woreda* administrations and 7 town administrations. Hosanna town is a capital of the zone Administration.

In Hadiya zone mixed farming, business activities, public and private sectors employments are the dominant economic activities in the zone. Farmers in the study area practice mixed farming system, which is mainly characterized by the rearing of different types of livestock like cattle, sheep, and goat and production of multiple agricultural products such as cereals (wheat, *teff*, maize, barley and bean), fruits and vegetables. The area is specialized in wheat production and its productivity is about 65 quintals per hectare. In addition, some cash crops like *khat* and coffee are also produced (Hadiya zone agriculture and natural resource development).

**Description of population and sampling methods:** The study was used stratified and simple random sampling techniques in order to select the required sample. Accordingly, to select the representative sample from the population, this study was employed multi-stage and combination of different sampling procedures. In the first step, three *woredas* was selected by simple random sampling method from the study area. The three sample *woredas* were *Lemmo, Analemmo and Misha* from ten *woredas* in the zone. The three sample *woredas* was representative of the ten *woredas* of Hadiya zone. In the second stage, identification of *kebeles* where enterprises exist with two stages (micro and small) and which are engaged in dairy production business activity within the respective *woredas*. Following this, six *kebeles* was selected by simple random sampling method. In the third step, the existing Enterprises which are found in the six *kebeles* of the study area were classified into major development stages. In the study area, there are two establishment stages in which enterprises are engaged as shown below in Table 1. To select representative sample enterprises from each stratum simple random sampling method was used.

Table 1: Sampling distribution of enterprises

|  |  |  |  |
| --- | --- | --- | --- |
| Enterprises level | Number of Enterprises | Proportion (percentage) | Sample size |
| Micro | 285 | 54 | 114 |
| Small | 243 | 46 | 98 |
| Total | 528 | 100 | 212 |

Source: Own design based on Hadiya zone enterprises development office (2024)

To determine the sample size of enterprises for EE estimation and to identify their determinant factors, this study was used simplified formula provided by Watson (2001) to determine the required sample size at 95% confidence level, estimated variance in the population 50% and margin of error 5%.

(1)

Where *n* is the sample size required (212), *N* is the population size (528), *P* is estimated variance (50%), *A* is margin of error (5%), *Z* is confidence level (95%) and *R* is estimated response rate (96%). So according to the above formula the sample size *n* was 212 enterprises and this study was carried out on 212 enterprises for EE estimation and to identify their determinant factors. A total of 212 enterprises (114 from micro level and 98 from small level) was randomly selected based on probability proportional to size of the enterprises. To capture the representative sample of enterprises from each stratum, simple random sampling method was used. The qualitative data was collected by using key informant interviews and focus group discussions. Such an approach was helpful to build a comprehensive understanding as well as identification and ranking of some of the proxy indicators as well as to quantify and analyze the relationships among significant variables.

**Types of Data and Data Collection Methods**: The study was used both primary and secondary data collected from various sources.The primary data was collected from the sample enterprises through observationandstructured questions and interview which are the main instruments of data collection, supported by key informants interview and focus groups discussion and observation checklists which are pre-tested prior to its use to answer the research questions and to attain the research objectives of the study in the field. Moreover, key informants’ interview was carried out using checklists prepared for the purpose of obtaining the qualitative information in order to supplement the primary data.

## Methods of Data Analysis: The study was employed both descriptive statistics and econometric model. Descriptive statistics was used to describe sample demographic and socio-economic characteristic in the study area. Since descriptive statistics was important tools to present research results clearly and concisely. In case of that to compare and contrast different categories of sampled units with respect to the desired characteristics, so as to draw some important conclusions. The econometric models was employed to estimate EE and to identify the determinant factors of their efficiency differential was carried out using econometric method called, stochastic frontier model was used. The Cobb-Douglas stochastic frontier production function was used to estimate the economic efficiency of smallholder milk production. Following Coelli (2008) the model is expressed as:

Y*iVi-Ui*  ,i=1,…,N (2)

Where

Yi = logarithm of the milk production of the i-th farm;

Xi = a kx1 vector of the logarithm of the input quantities of the i-th farm;

β = a vector of unknown parameters;

Vi = random variables which are assumed to be N(0, 2), and independent of the Ui;

Ui = non-negative random variables which are assumed to account for technical inefficiency in production, and are assumed to be 

The computer program FRONTIER version was used to estimate the model and obtain maximum likelihood estimates of the stochastic frontier production function. The production function has farm effects which are assumed to be distributed as truncated normal random variables. Calculation of the maximum likelihood estimates (Coelli, 2008) requires that:

Where

is variance of noise

is variance of inefficiency effects

If the value of *δ2* is equal to zero, then *ui* is also zero which means the Enterprises are fully efficient. *γ* has a value between zero to one. If the value of *γ* is one, the deviations from the frontier are attributed to random error. If it has the value of one, the deviations are due to technical inefficiency.

To estimate economic efficiency, the dual cost frontier was derived from the primal Cobb-Douglas production function in equation (1) utilizing the assumption of duality. The dual cost frontier is given as:

Where

Ci = minimum cost of the i-th farm due to Yi\*,

pi = input price vector.

Yi\* = output adjusted for stochastic disturbances.

Φ = vector of parameters estimated.

The economically efficient input vector for the *i-*th farm was derived by applying Shephard’s Lemma, then substituting the firm’s input price and the adjusted output levels into the derived system of input demand equations given by (Xu, *et al.,* 1998):

Given that the observed costs of production of the i-th firm are calculated by ∑*xipi*, and the economically efficient costs as ∑*xiepi*, the economic efficiency indices (EE) are thus computed by determining the ratio of the two, thus:

**4. Results and Discussion**

**4.1. Descriptive Statistics**

Economic Efficiency Indicators of **Enterprises:** There are many factors that determine EE of enterprises. Hence, to understand these factors it is important to know the descriptive statistics of the milk obtained from individual Enterprises and inputs used. Generally, the intensity of EE depends greatly on the allocation of production inputs such as land, labor, number of cows, amount of concentrated and unconcentrated feed and amount of veterinary services. As shown in Table 2 below, the mean milk amount obtained by sampled Enterprises was 41.13 liter/cow for total sampled enterprise (40.34 liter/cow for micro enterprise and 40.31 liter/cow for small enterprise).

Table 2: Descriptive statistics of output and production inputs

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | Variables | | | | | | |
| Enterprises | descriptive statistics | output of milk (liter/cow) | number of cows (number) | number of labor (man day) | quantity concentrated feed (kg/cow) | quantity concentrated feed (kg/cow) | land size (ha) | veterinary medicine (dose/cow) |
| Total sample | Mean | 41.13 | 4.29 | 8.7 | 16.7 | 41.5 | 0.39 | 0.18 |
| Std. dev. | 31.84 | 1.81 | 4.52 | 23.34 | 60.39 | 0.44 | 0.09 |
| Micro level | Mean | 40.34 | 4.26 | 8.85 | 18.09 | 37.99 | 0.11 | 0.19 |
| Std. dev. | 32.27 | 1.84 | 4.92 | 26.25 | 19.81 | 0.64 | 0.92 |
| Small level | Mean | 40.31 | 4.24 | 8.66 | 17.27 | 37.63 | 0.13 | 0.19 |
| Std. dev. | 33.05 | 1.86 | 4.65 | 23.94 | 19.57 | 0.41 | 0.09 |

Source: Author’s survey data (2024)

**Characteristics of sample enterprises:** The age of enterprises imply that duration of time the enterprises stay in the business. In the study area, Enterprises were established and started operating following national enterprise development strategy of 1997. About 4% of total sampled Enterprises and 8.2% of small level enterprises were established before ten years ago; 21% of total sampled enterprises (it was 11.4% of micro level enterprises and 32.7% of small level enterprises) were organized since 7-9 years, 26% of total sampled Enterprises (it was 35.1% of micro level and 15.3% of small level enterprises) were joined the sector before 4-6 years and 49% of total sampled Enterprises (it was 53.5% of micro level enterprises and 43.8% of small level enterprises) were organized during the past 1-3 years (Table 3). Thus almost half of the enterprises had age one to three years were passed since their establishment.

Table 3: Age of enterprises stay in the business

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Total Sample | | Micro level | | Small level | |
| Age of Enterprises | Frequency | Percentage | Frequency | Percentage | Frequency | Percentage |
| 1-3 years | 104 | 49 | 61 | 53.5 | 43 | 43.8 |
| 4-6 years | 55 | 26 | 40 | 35.1 | 15 | 15.3 |
| 7-9 years | 45 | 21 | 13 | 11.4 | 32 | 32.7 |
| 10 years and above | 8 | 4 | 0 | 0 | 8 | 8.2 |
| Total | 212 | 100 | 114 | 100 | 98 | 100 |

Source: Author’s survey data (2024)

**Number of employees in the enterprises: “**According to national enterprise development strategy of 1997 micro level of enterprise set the number of employee up to 10 employees in the enterprise but in the study area 62% of micro level enterprises accommodate less than 4 employees in each enterprise to run their business. This indicates that 62% of micro level enterprises were less than the necessary number of employees and do not practically occupy and create job opportunity in line with the standard of the strategy. On the other hand 53% of small level enterprises actually handle not more than 9 employees even if the strategy put the number of employee could be from 10-50 in small level enterprises. It is clear that in small level 53% enterprises do not fit the minimum requirement to accommodate and create job opportunity as stated in the strategy as shown in Table 4 below”. (Ababiya; 2018)

Table 4: Number of employees in the enterprises

|  |  |  |  |
| --- | --- | --- | --- |
| Enterprises level | Number of Employees | Frequency | Percentage |
| Micro level | 1-4 | 71 | 62 |
| 5-8 | 43 | 38 |
| Total |  | 114 | 100 |
| Small level | 1-9 | 52 | 53 |
| 10-14 | 46 | 47 |
| Total |  | 98 | 100 |
| Grand total |  | 212 | 100 |

Source: Author’s survey data (2024)

**Amount of initial capital: “**As stated in 1997 national enterprise development strategy the amount of initial capital for micro level enterprises is up to Birr 20,000, but the amount of initialcapital of 67% of the enterprises in the study area was started their business not more than half of the stated amount of initial capital that is Birr 10,000 and even if the strategy clearly showed that the amount of initial capital for small level of enterprises from Birr 20,000-50,000, by fact 56% of small level of enterprises in the study included in the study started their business below the given range of initial capital. This indicates that the majority of enterprises in the study area started their business with insufficient amount of initial capital as summarized in Table 5 below”. (Ababiya; 2018)

Table 5: Amount of initial capital

|  |  |  |  |
| --- | --- | --- | --- |
| Enterprises level | Amount of initial capital | Frequency | Percentage |
| Micro level | Less than 10,000 Birr | 76 | 67 |
| 10,000-20,000 Birr | 38 | 33 |
| Total |  | 114 | 100 |
| Small level | Less than 20,000 Birr | 48 | 56 |
| 20,000-50,000 Birr | 50 | 44 |
| Total |  | 98 | 100 |
| Grand total |  | 212 | 100 |

Source: Author’s survey data (2024)

**Characteristics of sample managers/operators of Enterprises :** About 71% and 29% of total sampled Enterprises (it was 66.6% and 33.3% of micro level enterprises and 76.5% and 23.5% of small level enterprises) managers were male and female respectively as indicated in Table 6 below. This indicates that there was not proportional participation of men and women in managing position of Enterprises in the study area. This may be encountered due to various reasons, which could be the problem of economic position of female managed enterprises, including shortage of labor, limited access to information and required inputs due to social attitude.

Table 6: Gender of Enterprises managers

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Total sample | | Micro level | | Small level | |
| Gender of managers | Frequency | Percentage | Frequency | Percentage | Frequency | Percentage |
| Male | 151 | 71 | 76 | 66.7 | 75 | 116.5 |
| Female | 61 | 29 | 38 | 33.3 | 23 | 23.5 |
| Total | 212 | 100 | 114 | 100 | 98 | 100 |

Source: Author’s survey data (2024)

Regarding the experience of the managers of enterprises included in the sample most of them (52% of total sample enterprises, it was 60.5% of micro level and 41.8% of small level enterprises) were under the year group of 1-3, 24% of total sample enterprises (it was 21% of micro level and 27.6% of small level enterprises) were in between 4-6, 19% of total sample enterprises (it was 15% of micro level and 23.5% of small level enterprises) were in between 7-9 age group and 5% of total sample enterprises (it was 3.5% of micro level and 7.1% of small level enterprises) were in age group 10 years and above. This shows that almost half of the enterprises in the study area were managed by managers who do not have Table sufficient experience to lead, inspire and champion the followers to be successful in the sector (7).

Table 7: Experience of managers

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Total sample | | Micro level | | Small level | |
| Experience of managers | Frequency | Percentage | Frequency | Percentage | Frequency | Percentage |
| 1-3 years | 110 | 52 | 69 | 60.5 | 41 | 41.8 |
| 4-6 years | 51 | 24 | 24 | 21 | 27 | 27.6 |
| 7-9 years | 40 | 19 | 17 | 15 | 23 | 23.5 |
| 10 years and above | 11 | 5 | 4 | 3.5 | 7 | 7.1 |
| Total | 212 | 100 | 114 | 100 | 98 | 100 |

Source: Author’s survey data (2024)

About 43% of the total sample enterprises managers (it was 48.2% of micro level and 36.7% of small level enterprises managers) attained from grade 1-8 (elementary level of education), 32% of the sample enterprises managers (it was 32.5% of micro level and 31.6% of small level enterprises managers) attained from grade 9-12 (high school level), 18% of total sample enterprises managers (it was 16.7% of micro level and 19. % small level enterprises managers) had preparatory level of educational background and 7% of the total sample enterprises managers (it was 2.6% of micro level and 12.3% small level enterprises managers) have upgraded their academic status up to TVT and above level of education (Table 8). This indicates that the majority of Enterprises managers have attained elementary and high school level of education.

Table 8: Educational level of mangers

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Total sample | | Micro level | | Small level | |
| Educational level | Frequency | Percentage | Frequency | Percentage | Frequency | Percentage |
| Elementary | 91 | 43 | 55 | 48.2 | 36 | 36.7 |
| High school | 68 | 32 | 37 | 32.5 | 31 | 31.6 |
| Preparatory | 38 | 18 | 19 | 16.7 | 19 | 19.4 |
| TVT and above | 15 | 7 | 3 | 2.6 | 12 | 12.3 |
| Total | 212 | 100 | 114 | 100 | 98 | 100 |

Source: Author’s survey data (2024)

**Entrepreneurial skill of the operators in the Enterprises:** In the study area about 69% of the total sample enterprises (it was 61.4% of micro and 77.6% small enterprises) included in the study had organized by operators who had entrepreneurial skill or had ability to do something well which leads the enterprises to achieve their intended goals of establishment. On the other hand, the study ensures that 31% of the total sample enterprises (it was 38.6% of micro level and 22.4% small level enterprises) did not have operators who have adequate entrepreneurial skill in doing their tax in the enterprises. Many of the managers of enterprises indicated that most of the problems they faced could be solved if they have entrepreneurial skill to run their obligations in the enterprises as indicated in the following Table 9.

Table 9: Entrepreneurial skill of the operators’

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Total sample | | Micro level | | Small level | |
| Entrepreneurial skill | Frequency | Percentage | Frequency | Percentage | Frequency | Percentage |
| Yes | 146 | 69 | 70 | 61.4 | 76 | 77.6 |
| No | 66 | 31 | 44 | 38.6 | 22 | 22.4 |
| Total | 212 | 100 | 114 | 100 | 98 | 100 |

Source: Author’s survey data (2024)

**4.2. Econometric Model** **Analysis**

**Test of hypothesis:** “In this section we tried to estimate the extent of enterprises’ EE of milk production in the study area. SFM was opted for executing multiple inputs and single output and it is possible to test various hypotheses using maximum likelihood ratio test. In order to choose an appropriate model for further analysis, hypotheses tests are critical before discussing about parameter estimates of production frontier function and the inefficiency effects. Because of this, three hypotheses were tested, to select the correct functional form for the given data set, for the existence of inefficiency and for variables that explain the difference in efficiency”. (Beyene et al. 2020)

Table 10: Generalized likelihood ratio tests of hypothesis for the parameters of the SFM

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| For total sampled Enterprises | | | | | | | | | |
| Null hypothesis | LH0 | LH1 | | Calculated χ2 (LR) value | | | Critical χ2 value | | Decision |
| Production function is CD,  (i.e. H0: = βij = 0) | -170.74 | -161.03 | | 19.42 | | | 32.67 | | Not reject |
| Absence of inefficiency,  (i.e. H0: γ= 0) | -187.4 | -170.74 | | 33.32 | | | 2.71 | | Reject H0 |
| Joint efficiency effects are insignificant,  (i.e. H0: = δ1=…. δ 14 = 0) | -188.3 | -170.74 | | 36.6 | | | 32.67 | | Reject H0 |
| For Micro Level Enterprises |  |  | |  | | |  | |  |
| Production function is CD,  (i.e. H0: = βij = 0) | -95.4 | -88.6 | | 13.6 | | | 32.67 | | Not reject |
| Absence of inefficiency,  (i.e. H0: γ= 0) | -101.6 | -95.4 | | 12.4 | | | 2.71 | | Reject H0 |
| Joint efficiency effects are insignificant, (i.e. H0: = δ1=…. δ 14 = 0) | -115.12 | -95.4 | | 39.4 | | | 32.67 | | Reject H0 |
| For Small Level Enterprises | | | | | | | | | |
| Production function is CD,  (i.e. H0: = βij = 0) | -85.9 | | -78.4 | | 15 | 32.67 | | Not reject | |
| (Absence of inefficiency),  H0: γ= 0 | -90.5 | | -85.9 | | 9.2 | 2.71 | | Reject H0 | |
| Joint efficiency effects are insignificant,  (i.e. H0: = δ1=…. δ 14 = 0) | -107.7 | | -85.9 | | 43.6 | 32.67 | | Reject H0 | |

Source: Author’s survey data (2024)

“The first test identifies an appropriate functional form between restrictive Cobb Douglas and the more flexible Translog production function which specifies that square and cross terms are equivalent to zero. The Translog frontier function turns into Cobb-Douglas when all the square and interaction terms in the translog are zero. The test is made based on the value of likelihood ratio (LR) statistics, which can be computed from the log likelihood value obtained from estimation of Cobb-Douglas and Translog functional specifications. Then, this computed value is compared with the upper 5% critical value of the chi-square at the degree of freedom equals to the difference between the numbers of explanatory variables used in the two functional forms (in this case df = 14). For the sample enterprises, the estimated log likelihood values of the Cobb-Douglas and Translog production functions for total sample enterprises were -170.74 and -161.03, (It is -95.4 and -88.6 for micro level enterprises and -85.9 and -78.4 for small level enterprises) respectively. The computed value of likelihood ratio (LR) = 19.42 for total enterprises (13.6 for micro level enterprises and 15 for small level enterprises) is lower than the upper 5% critical value of the chi-square with its respective degree of freedom as shown in Table 10. Thus, the null hypothesis that all coefficients of the square and interaction terms in Translog specification are equal to zero was not rejected. This implies that the Cobb-Douglas functional form adequately represents the data.The second null hypothesis was H0: γ = 0, which specifies that the inefficiency effects in the SPF were not stochastic, i.e., milk producing enterprises are efficient and have no room for efficiency improvement. After the appropriate production function is selected, the next step is a test for adequacy of representing the data using SPF over the traditional mean response function, OLS. The null hypothesis, H0: γ = 0, which specifies that the inefficiency effects are absent from the model (that is all milk producers are fully efficient). Whereas, the alternative hypothesis, H1: γ > 0, states that there is inefficiency in production of milk in the study area. Since this study is using the STATA version computer programs, after fitting the function with the required defined variables the computer output displays results which include the test of null hypothesis about inefficiency component. From this computer program output it is found that, log likelihood value = -187.4, (χ2 (01)-value = 33.32 and p = 0.001) for total sample Enterprises (but it is log likelihood value = -101.6, (χ2 (01)-value = 12.4 and p = 0.025 for micro level enterprises and log likelihood value = -90.5, (χ2 (01)-value = 9.2 and p = 0.04 for small level enterprises). Therefore, the decision of null hypotheses H0: γ = 0, which specifies that the inefficiency effects are absent from the model is rejected at 1% level of significance for the total sampled enterprises (but it is 5% level for both micro and small level enterprises)”. (Beyene et al. 2020)

The coefficient for the discrepancy ratio (γ) could be interpreted in such a way that for the total sampled enterprises was about 85.41% (it was 83.63% for micro level enterprises and 84.00% for small level enterprises) of the variability in milk output in the study area was attributable to inefficiency scores effect, while the remaining 14.59% variation in output for total sampled enterprises was due to the effect of random noise (it was 16.37% for micro level enterprises and 16.00% small level enterprises in the study area). “This implies presence of scope for improving output of milk by first identifying those institutional, socioeconomic and farm attribute factors causing this variation. Therefore, this data can be better represented by the stochastic production frontier than the average response function. The null hypothesis was rejected (Table 10). This implies the traditional average production function does not adequately represent the data. Therefore, the inclusion of the technical inefficiency term is an important issue to the model. The third null hypothesis that the explanatory variables associated with inefficiency effects are all zero (H0: δ1= δ2…= δ14 = 0) was also tested. To test this hypothesis likewise, LR (the inefficiency effect) was calculated using the value of the Log-Likelihood function under the stochastic production function model (a model without explanatory variables of inefficiency effects: H0) and the full frontier model (a model with explanatory variables that are supposed to determine inefficiency of each: H1)”. (Ababiya; 2018)

For the total sample Enterprises , the calculated value LR = -2(170.74 – 188.3) = 36.6 (for micro level enterprises LR = -2(95.4 – 115.12) = 39.4 and for micro level enterprises LR = -2(85.9 – 107.7) = 43.6) is greater than the critical value of 32.67 at 14 degree of freedom (Table 10) the value of LR implying that, the null hypothesis (H0) that explanatory variables are simultaneously equal to zero was rejected at 5% significance level. Hence, these variables simultaneously explain the sources of efficiency differences among sample farmers in the study area. Thus the observed inefficiency among the milk producing enterprises in Hadiya zone could be attributed to the variables specified in the model and the variables exercised a significant role in explaining the observed inefficiency. Therefore, the result confirms as the null hypothesis was rejected, implying that there is at least one variable that explain the difference in efficiency.

**Estimation of parameters of production function model:** The output variable was milk production defined as quantity of milk produced in liters whereas the inputs were cow, unconcentrated feed, concentrated feed, labor, veterinary medicine and land. The result of the Cobb-Douglas stochastic production frontier for the total sampled enterprises showed that inputs like cow (at 10% significance level), concentrated feed (at 1% significance level), labor (at 1% significance level) and land (at 5% significance level) allocated for milk were found to positively and significantly explained the level of efficiency of milk production (Table 11), which are important variables in shifting the frontier output to the right. This indicated that at each and every unit of these variables there is a possibility to increase the level of output. But the increase of unconcentrated feed and veterinary medicine was insignificant. In the case of micro level enterprises the result showed that inputs such as cow at 10% significance level, concentrated feed at 5% significance level, labor at 5% significance level and land at 5% significance level explained the level of efficiency of milk production positively (Table 12), the remaining inputs like unconcentrated feed and veterinary medicine affect the production system insignificantly. On the other hand the number of cow allocated for milk production at 10% significant level, concentrated feed used at 5% significance level, labor used at 1% significance level and land at 5% significance level explained the level of efficiency of milk production positively for small level enterprises. In similar way the unconcentrated feed and veterinary medicine allocation has insignificant effect on small level enterprises of milk producers (Table 13).

Table 11: Maximum likelihood estimate of SPF model (total sample enterprises)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Types | Variables | Parameters | Coefficients | Std. Err. | Z-value |
| For total sampled Enterprises | Constant | β0 | 1.3099\* | 2.1908 | 0.55 |
| Ln(cow) | β1 | 0.3454\* | 0.1798 | 1.92 |
| Ln(unconce) | Β2 | 0.1814 | 0.2530 | -0.72 |
| Ln(conce) | Β3 | 0.1325\*\*\* | 0.0189 | 6.98 |
| Ln(labor) | Β4 | 0.4749\*\*\* | 0.1729 | 2.75 |
| Ln(vet) | Β5 | 0.3399 | 0.7269 | 0.47 |
| Ln(land) | Β6 | 0.1528\*\* | 0.0707 | 2.16 |
| Sigma- square | δ 2 | 0.6795\*\*\* |  | |
| Gamma |  | 0.8541 |
| Lambda |  | 2.4208\*\*\* |
| Log likelihood function | | -170.74 |
| Returns to scale |  | 1.6269 |

Source: Author’s survey data (2024)

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

Table 12: Maximum likelihood estimate of SPF model (micro level enterprises)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Types | Variables | Parameters | Coefficients | Std. Err. | Z-value |
| For micro level | Constant | β0 | 2.2890\* | 3.1123 | 0.74 |
| Ln(cow) | β1 | 0.4598\* | 0.2499 | 1.84 |
| Ln(unconce) | Β2 | 0.3602 | 0.3980 | 0.91 |
| Ln(conce) | Β3 | 0.0845\*\* | 0.0384 | 2.20 |
| Ln(labor) | Β4 | 0.0993\*\* | 0.4782 | 0.21 |
| Ln(vet) | Β5 | 0.2559 | 1.0994 | 0.23 |
| Ln(land) | Β6 | 0.1566\*\* | 0.1017 | 1.54 |
| Sigma- square | δ 2 | 0.7011 | 0.1378 |  |
| Gamma |  | 83.63 |  |  |
| Lambda |  | 2.26 |  |  |
| Log likelihood function | | -95.41 |  |  |
| Returns to scale |  | 1.4163 |  |  |

Source: Author’s survey data (2024)

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

Table 13: Maximum likelihood estimate of SPF model (small level enterprises)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Types | Variables | Parameters | Coefficients | Std. Err. | Z-value |
| For small level | Constant | β0 | 3.8546\*\*\* | 3.7466 | 1.03 |
| Ln(cow) | β1 | 0.3621\* | 0.2722 | 1.33 |
| Ln(unconce) | Β2 | 0.4323 | 0.4383 | 0.99 |
| Ln(conce) | Β3 | 0.0889\*\* | 0.0419 | 2.12 |
| Ln(labor) | Β4 | 0.0743\*\*\* | 0.5276 | 0.14 |
| Ln(vet) | Β5 | 0.3232 | 1.2869 | 0.25 |
| Ln(land) | Β6 | 0.1766\*\* | 0.1198 | 1.03 |
| Sigma- square | δ 2 | 0.7639 | 0.1638 | |
| Gamma |  | 0. 84 |
| Lambda |  | 2.2933\*\*\* |
| Log likelihood function |  | -85.92 |
| Returns to scale |  | 1.4574 |

Source: Author’s survey data (2024)

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

As shown on the table 11, 12 and 13 above, the parameter estimate for unconcentrated feed and veterinary medicine turned out to be insignificant. Given unconcentrated feed and veterinary medicine are the important production input in the study area, the insignificance of the estimated coefficients for unconcentrated feed and veterinary medicine which implies that use of this input has no significant effect on productivity was contrary to the expectation.

Out of total inputs allocated for milk production, the elasticity of cow is very high implying that these have more effect in determining the output level at the best practice (the maximum technical efficiency score). The positive coefficients of inputs indicate a 1% increase in cow, concentrated labor and land yields 34.54%, 13.25%, 47.49%, 15.28%, increase in milk output improvement, respectively for the sampled Enterprises ; in the case of micro level enterprises 1% increase in cow, concentrated feed, labor and land yields 45.98%, 8.45%, 9.93% and 15.66% increments on milk yield. In the same manner for the small level enterprises 1% increase in cow, concentrated feed, labor and land yields 36.21%, 8.89%, 7.43% and 17.66% increments on milk output respectively.

The estimated stochastic production frontier model indicates that labor for total sampled enterprises (cow for micro enterprises and cow for small enterprises) was a key input in improving milk productivity since its response is one of the moderate perhaps, due to the low application level of the input. This implies that there is a need to increase the current level of these inputs usage along with good farm management. In other words, as indicated on the above tables if all the inputs are improved by 1%, milk output would increase by 1.63% for total sampled Enterprises (1.42% for micro level enterprises and 1.45% for small level enterprises). The results showed that micro level enterprises are operating in the stage one of production process (increasing return to scale) and have ample opportunities to increase output by improving their efficiencies.

Another essential outcome in the analysis is the variance ratio parameter γ which found to be significant at 1% level expressing that about 85.41% of milk output for the total enterprises (83.63% for micro level enterprises and 84.00% for small level enterprises) deviations are caused by differences in farm level technical efficiency as opposed to the random variability that are outside their control of the producers. In order to decrease inefficiency (technical as well as noise) specifically for small level enterprises it is advisable to internalize external technologies like improved breed to boost productivities.

Table 14: Summary statistics of estimated EE of sampled Enterprises

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Types of sample | EE estimates of Enterprises | | | |
| Maximum | Minimum | Mean | Standard deviation |
| Total sampled Enterprises | 0.7382 | 0.0647 | 0.3616 | 0.1628 |
| Micro level | 0.6654 | 0.0723 | 0.3688 | 0.1557 |
| Small level | 0.7179 | 0.0720 | 0.3734 | 0.1611 |

Source: Author’s survey data (2024)

“As indicated in Table 14 above, the combined effect of TE and AE shows that the mean EE of total sample Enterprises AE was 36.1% (it was 36.8% for micro level enterprises and 37.3% for small level enterprises). This result indicated that if the mean total sample Enterprises in the were to reach the EE level of the most efficient counterpart, then the mean total sample Enterprises could experience a 73.8% increase (that means 66.5% for micro level enterprises and 71.7% for small level enterprises) in output by improving both EE and AE, with the existing technology. Therefore, this result shows the existence of significant technical, allocative and economic inefficiency in milk production among Enterprises in the study area. The result of this study mean levels of efficiencies were comparable to those other similar studies like” (Alemdar *et al.,* 2010; Karoi *et al.,* 2010; Sajjad *et al.,* 2010; Dlamini, 2012; Michalickova, 2013; Masuku *et al.,* 2014; Mawa *et al.,* 2014).

**Estimation results of sources of inefficiency:** After measuring levels of enterprises’ efficiency and determining the presence of efficiency differences among enterprises, finding out factors causing inefficiency disparity among enterprises was the next most important step of this study. To see this, inefficiency levels of sample enterprises were regressed on factors that were expected to affect inefficiency levels using a MLE estimation procedure. The marginal effects of changes in explanatory variables from regression were computed for the purpose of interpretation. That is, the derived values for the significant explanatory variables indicated that the effects of a unit change in those variables on the unconditional expected value of efficiency scores and expected value of efficiency scores conditional upon being between 0 and 1, and probability of being between 0 and 1.

Table 15: Determinants of efficiencies score differentials among Enterprises

|  |  |  |  |
| --- | --- | --- | --- |
| Variables | Total sampled Enterprises | Micro level enterprises | Small level enterprises |
| EE | EE | EE |
| Coefficient | Coefficient | Coefficient |
| Age | -0.463 | -0.477 | -0.418 |
| Education | -0.289 | -0.466 | -0.383\*\* |
| No- of employee | -0.468\*\* | -0.525 | -0.097\* |
| Initial capital | -0.064\* | -0.005\*\* | -0.842 |
| Entrepreneur skill | -0.462 | -0.131 | -0.582 |
| Experience | -0.095 | -0.463 | -0.454\*\* |
| Access to training | -0.321\* | -0.268\*\* | -0.410\* |
| Access to market | -.833\*\*\* | -0.570\* | -0.643 |
| Gender of manager | -0.189 | -0.265 | -0.718 |
| Consultancy service | -0.354 | -0.603 | -0.866 |
| Access to premises | -0.005\*\* | -0.162 | -.340\*\* |
| Access to infrastructure | -0.042 | -0.149\*\* | -0.531 |
| Customer networks | -0.014 | -0.008\*\*\* | -0.783 |
| Access to credit | -0.720 | -0.034\* | -0.238\* |

Source: Author’s survey data (2024)

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

The result of the study confirms that the EE of total sampled dairy enterprises as significantly and positively determined by number of employee, access to training and access to market at 1%, 5% and 10% significance levels. Moreover, EE of micro level enterprises were also found to be significantly and positively influenced by access to training, access to market and access to credit at 1%, 5% and 10% significance levels. Furthermore, the EE of small level enterprises were significantly and positively affected by education level of manager, number of employee, experience of manager, access to training and access to credit at 5% and 10% significance levels (Table 15). The discussion about each of the significant variable is provided below.

**Education level of manager (Edu):** It is found to be positive and statistically significant at 5% probability level for small level dairy enterprises EE of the dairy enterprises. From this an increase in the level of education of manager could bring an overall increase in the level of EE of small level dairy enterprises increase in the level of EE by 3.8%. This finding might be due to the fact that higher education opens up higher opportunities for dairy enterprises managers and hence that creates higher incentives to pay much attention to improve the efficiency scores of the dairy enterprises. The finding of this study was confirmed with the finding of Masuku *et al.* (2014) obtained similar results and concluded that enterprises manager with higher education level are more likely to be rich in such opportunities and hence depend more on better methods for their enterprises to be efficient in their business that have acquired relatively more technical and managerial expertise on the job than lower level educated ones.

**Number of employee (Emp):** The coefficient of number of employee was observed positive and statistically significant at 5% probability level for total sampled dairy enterprises EE. This implies that an increment by one employee, then the EE of total sampled dairy enterprises increase in the level of EE by 3.6% percent. It is also found to be positive and statistically significant at 10% probability level for small level dairy enterprises EE of the enterprises. This implies that an increment by one employee, then the EE of small level dairy enterprises increase in the level of EE by 1.7 percent. The positive sign of this inefficiency parameter establish the fact that efficiency of dairy enterprises increase with increase in number of employee with in the appropriate work load of the dairy enterprises. This may be due to the fact that increased number of employee means increasing available labor force for dairy production activities.

**Experience of manager (Exp):** It is found to be positive and statistically significant at 5% probability level for small level enterprises EE of the enterprises. This indicates that experienced manager performs better in in managing enterprise than non-experienced manager. Thus, experience of manager increases the levels of EE of small level dairy enterprises by 1.4 percent. This indicates that there is increase in the level of efficiencies as the manager has experienced in the field of dairy enterprises business in the study area.

**Access to training (Train):** The coefficient of access to training was observed positive and statistically significant at 10% probability level for total sampled dairy enterprises EE. That implies enterprise operator who participated in training performs better in operational technical skills than non-participant. Thus, participation in training increases the levels of EE of total sampled enterprises by 3.2 percent. Similarly, it is found to be positive and statistically significant at 5% probability level for micro level enterprises EE. This indicates that operator who participated in training performs better in operational technical skills than non-participant. Thus, participation in training increases the levels of EE of micro level enterprises by 2.6 percent. It is also found to be positive and statistically significant at 10% probability level for small level enterprises EE of the enterprises in the study area. That means operator who participated in training performs better in operational technical skills than non-participant. Thus, participation in training increases the levels of EE of small level enterprises by 2.1 percent. That is the availability of access to training on different issues of the dairy enterprises increases the chance of dairy enterprises to have good EE in their business. Similarly, Taciana *et al.* (2019) and Mawa *et al.*, 2014 found that the existence of sufficient training access in building the capacity of dairy enterprises provides them with high opportunity to have good EE of enterprises.

**Access to market (Mkt):** The coefficient of access to market was observed positive and statistically significant at 1% probability level for total sampled dairy enterprises EE. Hence, access to alternative market access increases the levels of EE of total sampled enterprises by 1.3 percent. Similarly, it is found to be positive and statistically significant at 5% and 10% probability level for micro level dairy enterprises EE. From this, access to alternative market access increases the levels of EE of micro level dairy enterprises by 2.6 percent. The dairy enterprises which have sufficient market access for their product have better chance to increase the profitability opportunities of dairy enterprises with higher returns than dairy enterprises with limited access to market. Similar result was found in the work of (Mawa *et al.*, 2014), that dairy enterprises which have different market access were expected to have higher EE than those without alternative market accesses.

**Access to credit (Credit):** It is also found to be positive and statistically significant at 10% probability level for micro level dairy enterprises EE. This implies that access to credit is engine to motivate enterprise to produce more efficiently than non-accessed. Therefore, access to credit increases the level of micro level dairy enterprises EE 1.4 percent. Similarly, it is found to be positive and statistically significant at 10% probability level for small level dairy enterprises EE of the enterprises. This means that access to credit is the monetary power to push enterprise to produce more effectively than non-accessed. Therefore, access to credit increases the level of small level enterprises EE 2.3 percent. The results indicate that dairy enterprises which have more access to credit had more efficient than those which had not sufficient access to credit in the study area.

**5. Conclusions and Recommendations**

Based on the finding of this study, high inefficiency and weak optimal use of dairy farm inputs were the most important problems to the study area which needs appropriate policy intervention to address these problems. Therefore, the results of this study give information to policy makers on how to improve the technical efficiency of dairy enterprises, their optimal use of resources to become efficient in their business which helps them to achieve good financial performance beyond their cost incur conditions which ensures the positive impact of dairy enterprises in employment creation and income generation in the study area.

The SPF result revealed that from the inputs allocated for the production of milk, number of cow, quantity of concentrated feed, labor and land were appeared to be positively and significantly influencing milk production. But, unconcentrated feed and veterinary medicine was statistically insignificant in the production process of milk. Given unconcentrated feed and veterinary medicine were important production input in the study area, the insignificance of the estimated coefficients for unconcentrated feed and veterinary medicine which imply that use of these inputs has no significant effect on productivity was contrary to the expectation. The results showed that dairy enterprises were operating in the stage one of production function that is one percent increase in the level of input use; increases the output by more than one percent (increasing returns to scale) and dairy enterprises have opportunities to increase output by improving their efficiencies. Therefore dairy enterprises should increase the level of inputs used up to the point where the constant return to scale (optimization) was achieved. So dairy enterprises should have to maximize their efficiency scores level because, they should have to be successful to transform their enterprises from the micro and small level to medium and large enterprises in the long run.

The result of the study confirms that the EE of dairy enterprises were statistically and significantly determined by number of employees, access to training and access to market at different levels of significance. This indicates that there was the existence of technical, allocative and economic inefficiencies between dairy enterprises that indicates there is a room for improvement inefficiency even at the existing level of inputs by using right proportion of inputs given their prices if policy measures are taken. The overall results imply that the major improvements related to dairy enterprises’ production efficiency as well as require attention on the identified significant factors. Generally, there is no single policy and strategy that can be recommended to improve the production efficiency of dairy enterprises. Hence, the findings of this study recommend the need for implementing different policies and strategies that separately target and address the dairy enterprises’ production efficiency.

The results of this study confirmed that, if dairy enterprises are efficient in their production they have also positive impact on efficient use of scarce resources to produce optimum outputs. Thus, further researches are required on the impact of membership in dairy enterprises on some common economic variables like, saving promotion, asset building, income inequality reduction, import substitution and innovation etc. to provide strong policy recommendations.

Disclaimer (Artificial intelligence)

Author(s) hereby declare that generative AI technologies such as Large Language Models, etc. have been used during the writing or editing of manuscripts. This explanation will include the name, version, model, and source of the generative AI technology and as well as all input prompts provided to the generative AI technology

Details of the AI usage are given below:

1. Name and Version of the AI Tool: ChatGPT (GPT-4), developed by Open AI.  
2. Source of the AI Tool: Accessed via ChatGPT (https://chat.openai.com), a product of Open AI.  
3. Purpose and Scope of Usage:  
- The AI tool was used to assist in language editing, grammar correction, improvement of academic tone, and formatting of the manuscript titled 'Assessing Economic Efficiency and Key Determinants of Dairy Enterprises in Hadiya Zone, Central Ethiopia'.  
- The core research content, methodology, analysis, and interpretations were developed independently by the author. The AI did not generate or influence the scientific content, data, or conclusions.  
4. Input Prompts Provided to the AI:  
- “Can you help me with language editing and formatting of this manuscript?”  
- “Return the full revised manuscript in a downloadable format following specific formatting guidelines from Asian Journal of Advances in Research.”  
- Other follow-up instructions regarding formatting and language clarity.

**6. References**

Alemdar, T., Bahadir, B. and Oren, M. N. 2010. Cost and return analysis and technical efficiency of small scale milk production: A case study for Cukurova Region, Turkey. *Journal of Animal and Veterinary Advances,* 9(4): 844-847*.*

Coelli, T.J., Rao, D.S.P. and Battese, G.E. 2008. *An introduction to efficiency and productivity analysis* *2nd edition*. Springer, New York. NY.

Dlamini, Z. 2013. Technical efficiency for smallholder dairy farmers in Swaziland. M.Sc. thesis, University of Swaziland, Luyengo.

FeMSEDA (Federal Micro and Small Enterprises Development Agency). 1997. Micro and small enterprises development strategy, Addis Ababa, Ethiopia.

FeMSEDA (Federal Micro and Small Enterprises Development Agency). 2014. Micro and small enterprise development strategy, provision framework and methods of implementation framework. Addis Ababa, Ethiopia.

Fikirte Wolde and Endrias Geta. 2015. Determinants of growth and diversification of micro and small enterprises. The case of Dire Dawa, Ethiopia. *Journal of Developing Country Studies,* 5(1): 61-75*.*

Hailay Aregawi, Aregawi Gebremichael and Assmamaw Getie. 2014. Determinants of micro and small enterprises growth in rural area. *Journal of Economics and Sustainable Development*, 5(19): 2222-2855.

Karoi, M., Dana, L., and Pritchett, J. 2010. Measurement of economic efficiency for small holder dairy cattle in marginal zones of Kenya. *Journal of Development and Agricultural Economics,* 2(4): 122-137.

Masuku, B.B. and Masuku, M.B. 2014. Economic efficiency of smallholder dairy farmers in Swaziland. *Journal of Economics and Sustainable Development,* 5(15): 2222-2855.

Mawa, L.I., Kavoi, M.M., Baltenweck, I. and Poole, J. 2014. Profit efficiency of dairy farmers in Kenya: An application to smallholder farmers in Rift Valley and central province. *Journal of Development Agricultural Economics,* 6: 455-465.

Michalickova, M., Krupova, Z. and Krupa, E. 2013. Technical efficiency and its determinants in dairy cattle. *Journal of Acta Oeconomica Informatica,* 10(6): 2-12.

Sajjad M. and Khan, M. 2010. Economic efficiency of milk production in district Peshawar, Stochastic frontier approach. *Journal of Sarhad Journal of Agriculture,* 26(4): 655-663.

Taciana M., Luiz, F., Antonio, M., Fernando, L. and Tiago, W. 2019. Analyzing the determinants of efficiency of dairy farms in Brazil. *International Journal of Productivity and Performance Management,* 66(3): 380-404*.*

Watson, J. 2001. How to determine a sample size, Penn state cooperative extension. University of Park.

Ababiya, A. (2018). Financial performance of agricultural enterprises and their determinant factors in Hadiya Zone, Ethiopia. Small (weinheim an Der Bergstrasse, Germany), 243(46), 98.

Beyene, T., Mulugeta, W., & Merra, T. (2020). Technical efficiency and impact of improved farm inputs adoption on the yield of haricot bean producer in Hadiya zone, SNNP region, Ethiopia. Cogent Economics & Finance, 8(1), 1833503.