**Technical Efficiency of Micro and Small Dairy Production Enterprises and Their Determinant Factors in Hadiya Zone, Central Ethiopia**

**Abstract**

*This study employed to get findings on technical efficiency of micro and small dairy production enterprises and their determinant factors in Hadiya zone, Southern Ethiopia. The study was performed the technical efficiency estimation of micro and small dairy production enterprises and analyzing their determinant factors of 212 dairy enterprises selected by multi-stage sampling techniques. In addition to these 18 member participants in three focus group and 5 key informant stakeholders were used to sharpen and summarized the data collected from sample to fill the identified research gaps and to address the research objectives of the study. The data were analyzed using descriptive statistics and econometric model called stochastic frontier model. The overall average micro and small dairy production enterprises technical efficiency (TE), score of total sampled micro and small dairy production enterprises obtained from stochastic frontier model result was 60.18%, (it were 60.09%, for micro level enterprises and 58.79%, for small level enterprises) respectively. Inefficiency factors estimated result of the model showed that TE of total sample enterprises was found to be statistically and significantly influenced by education level, experience of manager, access to training, access to market, gender of manger and access to credit at different significant levels. In the same manner education level, access to training, access to market and access to credit were important factors influencing TE of micro level enterprises in the study area found to be statistically significant at different levels of significance. The small level enterprises TE were also statistically and significantly influenced by education level, experience of manager, access to training, access to market and access to credit were the sources of efficiency deferential in different levels of significance.* *Generally, there is no single policy and strategy that can be recommended to improve the TE as well as their determinant factors. Hence, the findings of this study unveil the need for implementing different policies and strategies that separately target and address the micro and small dairy production enterprises TE and their determinant factors.*

**Keywords***:* Dairy enterprises, technical efficiency, stochastic frontier

# 1. Introduction

The government of Ethiopia recognizes the role of enterprises in the socio-economic development of the country and giving special attention to the sector. To achieve these golden goals of growth, the government of Ethiopia introduced the first enterprise development strategy in 1997 to create broad base, competitive and convenient sector for industry development and classified enterprises based on paid up capital in to three levels of development stages (micro, small, medium and large) and five sectors (manufacturing, trade, construction, service and agriculture) in which enterprises engaged to achieve their intended goals of establishment (FeMSEDA, 2014). Following the national enterprise development strategy of 1997, enterprises are flourished in the zone in three levels of development stages (micro, small, medium and large) and in five sectors (manufacturing, trade, construction, service and agriculture) to achieve their intended goals of establishment. According to the enterprise development office of the zone, their technical efficiency is improved time to time due to closer support of stockholders through credit facilitation, management and technical training for managers and operators, consultancy service, market linkage for inputs and products and by providing working premises and sheds to ensure the profitability of their business.

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 technical efficiency and their determinant factors were not much of the views about the links. Because of this, the study gives high emphasis on the relationship to establish statistical nexus between technical efficiency and their determinant factors on the basis of annual cross sectional data of sample enterprises. Hence, this study is deemed to estimate the technical efficiency and analyze their determinant factors of the dairy 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 TE and their determinant factors of dairy enterprises in the study area.

## 2. Objectives of the Study

The general objective of this study was to estimate technical efficiency and to identify the determinant factors of micro and small dairy production enterprises in Hadiya Zone, Southern Ethiopia.

The specific objectives of the study were:

1. To estimate technical efficiency of micro and small dairy production enterprises;
2. To identify the determinant factors of technical efficiency differentials among micro and small dairy production enterprises in the study area.

**3. Research 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 national census of 2007 was estimated to be male 769,584 (49.7%) and female 778,262 (50.3%) the total of 1,547,846 hard-working, peace-full, multi-ethnic and religious people are found. It is divided into 13 *Woreda* administrations and 7 town administrations. Hosanna town is a capital of the zone Administration.

Mixed farming, business activities public and private sectors employments are the dominant economic activities in the zone. It is suitable for living and highly productive in nature. Farmers in the study area practice mixed farming system, which is mainly concerned on the rearing of different types of livestock like cattle, sheep, and goat and production of multiple dairy 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. The area is known as “*the* *basket of wheat /smaller Canada”* Great Leader Late Prime Minister Meles Zenawi speech (Hadiya Zone Administration). In addition some cash crops like *khat* and coffee are also produced.

**Description of population and sampling methods:** To estimate technical efficiency (TE) andtoidentify the determinant factors of the micro and small dairy production enterprises,the study was performed at dairy enterprises level.For the technical efficiency estimation andidentification of determinant factors of micro and small dairy production enterprises, the sampling frame was described as follows. The study was used stratified and simple random sampling techniques in order to select the required sample. Stratified random sampling is used when the population is divided into two or more relevant strata based on one or more attributes. The advantage of stratified sampling is said to be its ability to ensure inclusion of subgroups, which would otherwise be omitted entirely by other sampling methods because of their small number in the population. It is appropriate for any social science research when a sample size of more than 30 and less than 500 (Ruth, 2015). In general the size of the sample in each stratum is taken in proportion to the size of the stratum i.e. proportional allocation among levels of dairy enterprises.

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 13 *woredas* in the zone. The three sample *woredas* was representative of the 13 *woredas* of Hadiya zone. In the second stage, identification of *kebeles* where dairy 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 dairy 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 dairy enterprises are engaged as shown below in Table 1. To select representative sample Dairy enterprises from each stratum simple random sampling method was used.

Table 1: Sampling distribution of micro and small dairy production enterprises

|  |  |  |  |
| --- | --- | --- | --- |
| Enterprises level  | Number of dairy enterprises | Proportion (%) | 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)

There are several ways to determine the sample size. These include using a census for small populations, imitating a sample size of similar studies, using published tables and applying formulas to calculate a sample size. To determine the sample size of dairy enterprises for TE 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 dairy enterprises and this study was carried out on 212 dairy enterprises for TE estimation and to identify their determinant factors. A total of 212 dairy enterprises (114 from micro level and 98 from small level) were randomly selected based on probability proportional to size of the micro and small dairy production enterprises. To capture the representative sample of dairy 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 dairy 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. Finally, the respondents were asked whether in their opinion their dairy enterprises are successful or not, their recommendations to government and NGOs to help in the development of micro and small dairy production enterprises. The secondary data was obtained from published books and journal articles, as well as unpublished annual reports and records from government offices and other relevant organizations. All data collection process was completed under close supervision of the researcher.

## Methods of Data Analysis: The study was employed both descriptive statistics and econometric model. The descriptive statistics was run in SPSS while the empirical models were run in STATA computer soft-wares. Specifically, 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 TE and to identify the determinant factors of their efficiency differential was carried out using econometric method called, stochastic frontier model was used.

A number of techniques have been developed to estimate technical efficiency indicators index. Several authors broadly classified them into two main groups: parametric and non-parametric. Generally, the parametric method uses a stochastic frontier technique by specifying a stochastic production function. It is composed of technical efficiency and statistical noise. The non-parametric approach is often associated with data envelopment analysis which is based on a mathematical programming model to estimate the optimal level of output and does not distinguish between technical efficiency and statistical noise (Coelli *et al.,* 2008).

As recommended by different scholars, the stochastic frontier approach is most relevant for this study. Stochastic frontier model (SFM) was first introduced by (Coelli, 2008). In this model there is a composed error term which captures the effects of exogenous shocks beyond the control of the analyzed units in addition to incorporating technical inefficiency. Errors in measurement of outputs and observations are also taken into consideration. For cross-sectional data their model specification was expressed as follows:

Y*iVi-Ui*  (2)

Where

𝑌𝑖 is output of the  MSAEs, i = (1, 2, 3 …n) are sample dairy enterprises,

 is the input used by the  dairy enterprises

 is a vector of unknown parameters

 is a random error which represents random variations or random shocks in the milk of the  MSAEs, outside the control of the dairy enterprises assumed independently and identically distributed as.

 is non-negative random variable which estimate technical inefficiency in production and are assumed to be independently distributed as truncations at zero of the distribution with the assumption of a linear functional relationship, the mean distribution of is a function of the explanatory variables and can be specified as:

 (3)

Where

is a vector of variables that explain inefficiency of dairy enterprise.

 is a vector of unknown parameters to be estimated.

The individual dairy enterprises technical efficiencies from estimated stochastic frontiers were estimated as:

 (4)

Where

is technical efficiency, *y* is the observed output, the inefficiency term is always between 0 and 1, When is equal to 0, then production is on the frontier  is the frontiers output and, therefore dairy enterprises is technically efficient. When is greater than 0 (> 0) the dairy enterprises is technically inefficient (< 1), since production was below the frontier.

For both the SFM and the inefficiency effects model, the maximum likelihood method can be used to estimate the coefficients of the two functions simultaneously. This was given consistent estimates of the parameters of the production frontier and the inefficiency effects model. For technical efficiency, Cobb Douglas stochastic frontier model was also used through maximum likelihood estimate approach to determine the technical efficiency of the enterprises. The likelihood function is expressed in terms of the variance parameters of the frontier function:

 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 dairy 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.

Based on the suggestions of different scholars like, Sibylle (2011) and Melaku (2013), the inputs and outputs were arranged for the study by taking into account the particularities of dairy enterprises which were defined in the following way: The dependent variable in the production function (y) is milk, the vector of inputs includes cow (number), labor (number), quantity of concentrated feed (kilogram), unconcentrated feed (kilogram), land (hector) and veterinary medicine (dose).

**4. Results and Discussion**

**4.1. Descriptive Statistics**

Technical Efficiency Indicators of **dairy enterprises:** There are many factors that determine technical efficiency of dairy enterprises. Hence, to understand these factors it is important to know the descriptive statistics of the milk obtained from individual dairy enterprises and inputs used. Generally, the intensity of technical efficiency depends greatly on the allocation of production inputs such as land, labor, cow, concentrated feed, unconcentrated feed and veterinary medicine. As shown in Table 2 below, the mean milk amount obtained by sample dairy enterprises was 492.06 liter/cow for total sampled enterprise (it were 526.11 liter/cow for micro enterprise and 543.18 liter/cow for small enterprise).

|  |  |  |
| --- | --- | --- |
|  |  | Variables |
| Enterprises | Descriptive statistics | Milk (liter/cow) | Cow (number) | Labor (man day) | Concentrated feed (kg/cow) | Unconcentrated feed (kg/cow) | Land size (ha) | Veterinary medicine (dose/cow) |
| Total sample | Mean | 492.06 | 4.29 | 8.70 | 199.42 | 497.55 | 0.39 | 1.83 |
| Std. dev. | 382.04 | 1.81 | 4.52 | 280.03 | 724.65 | 0.06 | 0.87 |
| Micro level  | Mean | 526.11 | 4.26 | 8.85 | 220.53 | 571.37 | 0.41 | 1.96 |
| Std. dev. | 413.09 | 1.80 | 4.92 | 295.92 | 966.94 | 0.06 | 0.94 |
| Small level | Mean  | 543.18 | 4.24 | 8.66 | 228.86 | 588.86 | 0.41 | 2.02 |
| Std. dev. | 422.81 | 1.86 | 4.65 | 309.41 | 1038.42 | 0.06 | 0.96 |

Table 2: Descriptive statistics of output and production inputs

Source: Author’s survey data (2024)

**Characteristics of sample dairy enterprises:** The age of dairy enterprises imply that duration of time the enterprises stay in the business. In the study area, dairy enterprises were established and started operating following national enterprise development strategy of 1997. About 4% of total sampled dairy enterprises and 8.2% of small level enterprises were established before ten years ago; 21% of total sampled dairy 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 dairy 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 dairy 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 dairy enterprises had age one to three years were passed since their establishment.

Table 3: Age of dairy 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 dairy 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.

Table 4: Number of employees in the dairy 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 of dairy enterprises:** 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 dairy enterprises in the study area started their business with insufficient amount of initial capital as summarized in Table 5 below.

Table 5: Amount of initial capital of dairy enterprises

|  |  |  |  |
| --- | --- | --- | --- |
| 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 dairy enterprises:** About 71% and 29% of total sampled dairy 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 dairy 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 dairy 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 dairy 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 dairy enterprises (it was 21% of micro level and 27.6% of small level enterprises) were in between 4-6, 19% of total sample dairy 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 dairy 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 dairy enterprises in the study area were managed by managers who do not have sufficient experience to lead, inspire and champion the followers to be successful in the sector (Table 7).

Table 7: Experience of dairy enterprises 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 dairy 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 dairy 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 dairy 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 dairy 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 dairy enterprises managers have attained elementary and high school level of education.

Table 8: Educational level of dairy enterprises 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 dairy enterprises** **operators:** In the study area about 69% of the total sample dairy 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 dairy enterprises to achieve their intended goals of establishment. On the other hand, the study ensures that 31% of the total sample dairy 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 dairy enterprises indicated that most of the problems they faced could be solved if they have entrepreneurial skill to run their obligations in the dairy enterprises as indicated in the following Table 9.

Table 9: Entrepreneurial skill of dairy enterprises of 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 TE 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.

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 dairy 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 dairy 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 dairy 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 dairy 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).

The coefficient for the discrepancy ratio (γ) could be interpreted in such a way that for the total sampled dairy 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 dairy 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).

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 dairy 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 dairy 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 MSAEs | 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\*\* | .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 MSAEs; 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 Dairy enterprises (1.42% for micro level enterprises and 1.45% for small level enterprises). The results showed that dairy enterprises were 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 dairy 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.

**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 14: 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 survey data (2024)

The SFA model results indicated that the mean value total sampled Dairy enterprises TE was 60.1% (it was 60% for micro level enterprises and 58.7% for small level enterprises), indicating farm enterprises were producing 39.9% less (that means 40% for micro level enterprises and 41.3% for small level enterprises) of potential output given their prevailing level of technology and input use. Alternatively, the Dairy enterprises could still produce their current output of milk with fewer inputs if they were more efficient. Under the assumption of constant returns to scale, the efficiency scores remain the same in both input orientation (input minimization) and output orientation (output maximization). Thus, if we had chosen to keep inputs constant and measure efficiency in output increasing direction the efficiency score is also indicating that outputs should be increased by 39.9% to become efficient (it became 40% for micro level enterprises and 41.3% small level enterprises). The wide variation in TE was an indication that most of the Dairy enterprises in the study area were still using their resources inefficiently in the production process and there still exists opportunities for rising their milk production by improving their current level of technical efficiency. Therefore, the result of this study mean levels of technical efficiencies were comparable to those other similar studies like (Alemdar, 2010; Dlamini, 2012; Michalickova, 2013).

**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 Dairy enterprises was the next most important step of this study. To see this, inefficiency levels of sample Dairy 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 |
| 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\*\* |
| Gender 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 survey data (2024)

The result of the model showed that TE of total sampled enterprises was found to be statistically and significantly influenced by education level, experience of manager, access to training, access to market, access to consultancy service, access to infrastructure and access to credit at different significant levels. In the same manner education level, access to training, access to market, access to access to infrastructure, access to customer network and access to credit were important factors influencing TE of micro level enterprises in the study area found to be statistically significant at different levels of significance. The small level enterprises TE were also statistically and significantly influenced by education level, experience of manager, access to training, access to market, access to infrastructure and access to credit as indicated in Table 15 in different levels of significance.

**Education level of manager (Edu):** The variable education level of manager coefficient was found to be negative and statistically significant at 1% probability level for total sampled dairy enterprises TE. Similarly, it is found to be negative and statistically significant at 1% probability level for micro level enterprises TE. It is also found to be negative and statistically significant at 1% probability level for small level enterprises TE of the enterprises respectively. This implies that there is decrease the level of inefficiencies as level of education of the manager was increases by one level. This finding might be due to the fact that higher education opens up higher opportunities for dairy enterprises manager and hence that creates higher incentives to pay much attention to improve the efficiency scores of the enterprises. The finding of this study was confirmed with the finding of King *et al.,* 2002 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.

**Experience of manager (Exp):** Thevariable experience of manager may be defined as knowledge and skill gained by contact with facts and events with staying in the business for long period of time. By its nature, it is a product of the past and therefore limited to and controlled by previous exposures. Number of years a manager has spent in the dairy enterprises business may give an indication of practical knowledge he/she has acquired on how to cope with the inherent dairy farm production, processing and marketing problems leading to higher levels of efficiency scores. The coefficient of the variable experience of manager was found to be negative and statistically significant at 5% probability level for total sampled dairy enterprises TE respectively. Similarly, it is found to be negative and statistically significant at 5%, probability level for small level enterprises TE of the enterprises respectively. This indicates that there is decrease in the level of inefficiencies as the manager has experienced in the field of dairy enterprises business in the study area.

**Access to training (Train):** The enterprises which had sufficient access to training is expected to provide dairy enterprises with new information, technologies and demonstration of best practices on managerial, operational and financial issues to dairy enterprises build their capacity and encourage them very well to succeed in the business. It also improves both enterprises ability of choosing appropriate combination of inputs and ability of getting the maximum output from the inputs. The coefficient of access to training was observed negative and statistically significant at 5% probability level for total sampled dairy enterprises TE. Similarly, it is found to be negative and statistically significant at 10% probability level for micro level enterprises TE. It is also found to be negative and statistically significant at 10% probability level for small level enterprises TE of the enterprises in the study area. That is the availability of access to training on different issues of the dairy enterprises increases the chance of dairy enterprises to have good TE in their business. Similarly, Henry (2006) found that the existence of sufficient training access in building the capacity of dairy enterprises provides them with high opportunity to have good TE.

**Access to market (Mkt):** Another factor worth considering, as a variable affecting TE was access to markets. The hypothesis in this study is that dairy enterprises create different market accesses for their products insure the higher level of market access results the greater level of production efficiency. This might be due to the fact that as dairy enterprises which did not have sufficient market access, there would be limited access to input and output markets linkages and market information. The coefficient of access to market was observed negative and statistically significant at 1%, 10% and 1% probability level for total sampled dairy enterprises TE. Similarly, it is found to be negative and statistically significant at 5% probability level for micro level enterprises TE. It is also found to be negative and statistically significant at 5% probability level for small level enterprises TE of the enterprises. 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 (Michalickova, 2013), that dairy enterprises which had different market access were expected to have higher TE than those without alternative market accesses.

**Gender of manager (Sex):** The gender of manager coefficient measured as dummy variable with value of one for male and zero for female was found to be negative and statistically significant at 10% probability level for total sampled dairy enterprises TE. 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. This suggests that dairy enterprises which are managed by females were less efficient than dairy enterprises managed by men which are fund in the study area. The result of this study have similar conclusion with the finding of Admasu, 2012. They concluded that in many cases, as decision makers females were disproportionately imply their responsibility due to different attitudinal and home based activities made them busy even if they are loyal in their responsibility. They may therefore have acquired relatively more inefficient managerial expertise on the position than men.

**Access to credit (Credit):** The coefficient of the dummy variable for access to credit was found to be negative and statistically significant at 1% and probability level for total sampled dairy enterprises TE. It is also found to be negative and statistically significant at 1% probability level for micro level enterprises TE. Similarly, it is found to be negative and statistically significant at 5% probability level for small level enterprises TE of the enterprises respectively. 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. Conclusions and Recommendations**

This study was undertaken to estimate the technical efficiency and to identify the determinant factors dairy enterprises in Hadiya Zone, Ethiopia. For this end, the study examined relevant literature, the national enterprise development strategy and programs and carried out the study to attain the intended objective. The study was mainly based on the primary data which were collected from sampled 212 dairy enterprises that were randomly drawn from Hadiya zone three *Weredas* and six *Kebeles* through multi-stage sampling technique. The secondary data were also obtained from published and unpublished annul reports and other relevant organization documents to support the primary data and describe the study area.

From the total inputs allocated for milk production, unconcentrated feed and veterinary medicine turned out to be insignificant. But cow, concentrated feed, labor and land were significant. 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 feed, 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.

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. This suggests that dairy enterprises were not operating at the possibility production frontier and there is a considerable potential to increase the productivity of milk with the present inputs available to milk producing enterprises.

The econometric analysis of TE of dairy enterprises computed by SFA model pointed out that for the total sampled dairy 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 sample dairy 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).

Inefficiency factors estimated result of the model showed that TE of total sample enterprises was found to be statistically and significantly influenced by education level, experience of manager, access to training, access to market, gender of manger and access to credit at different significant levels. In the same manner education level, access to training, access to market and access to credit were important factors influencing TE of micro level enterprises in the study area found to be statistically significant at different levels of significance. The small level enterprises TE were also statistically and significantly influenced by education level, experience of manager, access to training, access to market and access to credit were the sources of efficiency deferential in different levels of significance.

The overall results of the study implies that the major improvements related to enterprises technical efficiency as well as on their determinant factors would require attention on the identified significant factors. Generally, there is no single policy and strategy that can be recommended to improve the technical efficiency as well as their determinant factors. Hence, the findings of this study unveil the need for implementing different policies and strategies that separately target and address the enterprises technical efficiency and their determinant factors.

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