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# Adoption and Impacts of Dairy Production Technologies in Southwest Ethiopia: The Cases of Jimma and Ilu- Ababora Zones

Samuel Diro Chelkeba Misganaw Anteneh Tegegne Efrem Asfaw Gutema Beza Erko Erge
Addisu Bezabeh Ali
Economist and Assistant Researcher ,Ethiopian Institute of Agricultural Research, Jimma Agricultural Research Center

**Abstract**
The study was aimed to assess access, use and impacts of dairy production technologies on the livelihood of smallholder farmers. A structured and pretested questionnaire was used to collect the data from randomly selected 240 respondents in Jimma and Ilu- Ababora zones of southwest Ethiopia. The result of the study witnessed that there was a significant difference between milk yield of cross and local breed in all lactation periods. A significant difference between adopters and non-adopters was also seen on number of local bulls, number of chickens, income from sale of cattle, availability of farm assets, and nutrition diversity and availability. The logistic regression result revealed that distance to artificial insemination center affected the adoption decision negatively and significantly. Economic factors such as land, labor and income or cash was also seen as positive and significant relation on the adoption decision. On other hands, frequency of extension visits and training on dairy management affects the adoption decision positively. The result from Tobit model also shows extension and credit services affect extent of adoption positively and distance to market, distance to veterinary services and family size affects negatively. Therefore, huge emphasis should be provided in building infrastructural facilities that enhance dairy technology adoption and in improving farmers' awareness, understanding and perception through training, demonstration, field visits and experience sharing at different levels.
**Keywords:** Adopter, Artificial insemination, Lactation, logistic regression, Non adopter

## Introduction

### Background and justification of the study

With more than 52 million cattle, 35 million sheep, 34 million goats, and 4 million camels, 6 million donkeys, nearly 2 million horses, 0.63 million mules and more than 32 million poultry, Ethiopia is the largest livestock producer in Africa (Behnke, 2010). The sub-sector contributes an estimated 12% to total GDP and over 45% to agricultural GDP (MOA, 2010). However, the contribution and the productivity of livestock is very poor in Ethiopia due to poor genetic potential for productive traits, poor feeding practices and poor health care and management practices (Zegeye, 2003). Ethiopia's milk production remains among the lowest in Africa and in the world (CSA, 2008) even though the milk sector can contribute significantly to poverty alleviation and improved nutrition in the country through income diversification and employment generation. Studies witnessed that there is a mismatch in the demand and supply of dairy products such as milk and other bi-products (Mohamed *et al.*, 2004) because of rapid increase in individual's income on demand side and low animal productivity, inappropriate technologies, inadequate research and extension support and poor infrastructure on supply side.

The country has set-up the second five year growth and transformation plan (GTP) with a vision of building an economy which has a modern and productive agricultural sector with enhanced technology. One of the strategic pillars of the plan is maintaining agriculture as a major source of economic growth. The key strategy designed to achieve this is scaling-up of the best technologies and practices of the model farmers for use by all other farmers. Governmental, non-governmental, private and international organizations have been engaged in promoting and disseminating dairy production technologies to smallholder farmers through various channels of extension such as technology verification and demonstrations, knowledge and skill enhancing training, experience sharing visits, farmer-to-farmer information exchange mechanisms and others. Improved dairy breed technologies, improved feeds and feeding practices, dairy processing technologies and improved health management practices are technologies diffused. Despite dissemination of those improved dairy technologies to beneficiaries, there is no adequate information on the rates and extent of adoption of dairy production technologies among smallholder farmers. Moreover, the impacts of the technologies on the farmers' livelihoods is not adequately addressed and documented for different agro-ecologies of the country. Therefore, this study is envisaged to bridge-up this gap as the aim of the study is to assess the rate and extent of adoption and impacts of dairy production technologies on smallholder farmers and the study addresses the following specific objectives:

I. To investigate the rate and extent of adoption of dairy production technologies
II. To assess factors influencing adoption of dairy production technologies
III. To document the impacts of dairy production technologies on livelihoods of smallholder farmers
IV. To suggest research, extension, policy and development intervention options that enhance utilization of

dairy production technologies

The rest of this paper is organized under four sections. Section two presents key concepts like adoption and determinants of adoption of dairy technologies, impact of improved technologies, and theoretical and empirical literature. Section three discussed issues related to data such as data types and sources, data collection and data analysis methods used. Section four focuses on interpretation and discussion of results and section five summarizes the study and presents conclusions and recommendations as well as future directions.

**Review of literature**

**Determinants of adoption of dairy technologies**

Adoption is a mental process through which an individual passes from hearing about an innovation to its adoption that follows awareness, interest, evaluation, trial, and adoption stages (Bahadur and Siegfried, 2004). Adoption of any agricultural innovation can be measured in two ways: In terms of the number of farmers who adopt the innovation and in terms of the total area on which the innovation is adopted. Neither of measures is inherently better and the choice depends on the issue being addressed. If the goal is to determine how many people have been affected by an innovation, it makes sense to ask what proportions of farmers have adopted the innovation. However, if the goal is to calculate the economic benefits attributable to adoption, it makes sense to ask how much area is affected (Morris et al., 2001).

Different studies conducted in different countries revealed that demographic, social and economic factors affect adoption of improved agricultural technologies more specifically dairy technologies and few of those studies will be discussed below. Kaaya et al., (2005) used tobit model to reveal factors influences the extent of adoption artificial insemination (AI) services and found age of the farmer, years of awareness of the AI technology, total farm milk production and sales, extension visits per year and quality of AI services provided to the farmers were positively associated with adoption and use of AI technology. Besides farm level cost of AI services, farming experience, herd size, breed of animals were negatively associated with adoption and use of AI technology.

Abayomi (2013) used Probit model to analyze factors influencing ownership of exotic dairy cattle and witnessed that marital status (being married) and number of boys in the household have positive and significant impact on adopting exotic cows and off farm income the household head collected, number of local breed cattle and feed problem negatively and significantly influenced the adoption of exotic dairy cows.

Howley et al., (2012) also found that farmers with high off-farm job were much less likely to adopt artificial insemination (AI) and household with large family size could have a high probability of dairy technology adoption and farmers with children were much more likely to use AI services.

Lemma et al., (2012) revealed that mass media exposure, training on dairy farming and knowledge of the dairy farmers on dairy husbandry practices had positive and highly significant relationship with the adoption of improved dairy husbandry practices. Education status and experiences of the dairy farmers on dairy farming and participation of the dairy farmers in various dairy farming related organizations also had positive and significant relationship with the adoption of the improved dairy husbandry practices.

Farmers in the areas of training availability could adopt AI than non-training areas` farmers (Quddus, 2013). On other hands, the study stated that the probability of adoption decreased with the increase in age of household heads and increases with level of farmer’s education, farming experience and household income.

Dehinenet et al., (2014) also reported that both age of the household and off-farm activities negatively and significantly related to adoption of improved dairy technologies. Family size, farming experience, availability of extension services, availability of training and accessibility of credit and saving institution affects adoption of the technologies positively and significantly.

**Impact of improved technologies**

There are four indicators of impact assessment of technologies: agricultural productivity, farmer incomes, nutritional status and gender equality (Morris et al., 2001). The first criterion is the improvement in productivity. It is believed that any technology that succeeds in increasing the productivity of resources devoted to dairy cows will bring about real income gains for the vast majority of the rural population by freeing up resources for use in other activities. This can be measured simply by asking farmers if their milk yields have changed during adoption of new and improved dairy technologies. Income is also the second criterion which is widely used as a welfare measure because it is strongly correlated with the capacity to acquire many things that are associated with an improved standard of living such as food, clothing, shelter, health care, education, and recreation. Income gains are a valid indicator of impacts because the productivity gains attributable to the adoption of improved maize technologies logically should be reflected in income gains either through increased sales of cows or milk and other byproducts directly, or decreasing the expense on buying of other cows, milk, butter and other byproducts indirectly. The focus on nutrition, the third criterion, was understandable because improvements in nutrition are associated with numerous measures of well-being, including improved health, increased life expectancy, enhanced intellectual capacity, and increased ability to perform physical work. The nutritional status of improved dairy technology adopters is thus a valid indicator of adoption impacts, because milk production is expected to improve food consumption levels in these households.

The fourth and the last criterion is gender effect of the technology. In assessing the achievements of the adoption, it is important to examine the distribution of technologies among different groups within the population. Particularly important is whether the improved dairy technologies have been accessible to women as well as to men. Accessibility for women is important because women often represent a relatively disadvantaged group within society and also because women tend to make household-level resource allocation decisions that directly influence the welfare of children (Morris et al., 2001).

**Theoretical and conceptual framework**

Innovation diffusion model (Feder et al, 1985), economic constraint model (Smale et al, 1994; Shampine, 1998) and adopter perception paradigm (Norris and Batie, 1987) are three most commonly mentioned models in agricultural technologies adoption studies. The innovation diffusion model stated that access to information which is directly related to extension services, visits, farm trials and other means of information dissemination mechanisms are very essential for the adoption and diffusion of technologies and the economic constraint model also suggests that adoption is constrained by economic factors in short run but not in the long run since adoption decision becomes feasible in the long run. Adopter perception paradigm also noted that farmers evaluated the technology differently from the scientist and calls for periodic studies on technology adoption to address the gaps.

Generally, it is assumed that firms make a profit-maximizing cost-benefit assessment of different alternatives when deciding whether to adopt new technology. A firm decides to adopt a particular new technology if the corresponding expected net payoffs are larger than those of the alternatives, including the alternative of not adopting it. Besides the cost of the technology itself, different factors may affect the expected net payoffs from the adoption of modern technology.

**Methodology**

**Study area description**

Jimma Zone is one of the 17 Zones of the Oromia regional state of Ethiopia. The capital of the Zone, Jimma Town, is located at 346kms Southwest of Addis Ababa. Based on the 2014 national population census conducted by the Central Statistics Agency (CSA) of Ethiopia, the Zone has a total population of 2.9 million, of whom 93.5% are rural inhabitants (CSA, 2015). There are 2.2 million and 1.8 million cattle and poultry in the zone respectively and 824208 sheep, 422180 goat, 92093 horse, 71880 donkey, 20011 mule and 570241 bee hives (CSA, 2015). Based on the general characteristics of traditional ecology, Jimma zone consists of three major climates **78**%, **12**% &**10**% respectively belongs to subtropical, temperate and tropical or thermal zones. Ilu-Ababora is another Zone of the Oromia regional state. Its capital is Metu Town which is located 660kms from Addis Ababa. The Zone has a total population of 1.5 million, of whom 88.7% are rural inhabitants (CSA, 2013). There are 1.2 million and 1.3 million cattle and poultry in the zone respectively and 410295 sheep, 237811 goat, 50401 horse, 50505 donkey, 15810 mule and 598361 bee hives (CSA, 2015).

**Data type, sources and collection techniques**

Primary data was collected from a random of 240 farmers from the two agro ecological zones of Ethiopia: Jimma and Illubabor zones. Five districts namely Chora, Mettu, Manna, Kersa and Shebe Sombo districts was selected on basis of information that the districts have high supply of dairy and dairy products like cheese and butter. Finally, 14 peasant associations of the two zones were also randomly selected. A structured and pretested questionnaire was used to collect both qualitative and quantitative data set from randomly selected sample respondents using trained enumerators. Based on the data obtained on the survey, concrete and quantifiable information on selected parameters such as the rate and extents of adoption, impact of adoption and factors affecting rate and extent of adoption of dairy production technologies has been generated.

**Data analysis techniques**

SPSS-20 and Stata 12.1 version was statistical soft-wares used to analyze the data and descriptive and inferential statistics; and econometric model was implemented. Binary logistic regression model was an econometric model applied and best fitted to identify factors affect adoption of improved diary technologies. It is a linear probability model for binary response where the response probability is evaluated as a linear function of the explanatory variables (Maddala, 1983; Wooldridge, 2003). According to Pindyck and Rubinfeld, (1981) logit model is specified as:

$$\ln\{\frac{P_i}{1-P_i}\} = \beta_0 + \beta_1 X_1 + .......\beta_7 X_7$$ ------------------------------------------------------------ (1)

Where $\mathbf{P_i}$ is the probability of adopting the technology for $\mathbf{i^{th}}$ respondent which ranges from 0 to 1 (the qualitative variable adopt is 1 if adopt and 0 if not adopt), $\boldsymbol{\beta_0}$ is the intercept and $\boldsymbol{\beta_1}$ are the slope parameter in the model and $\mathbf{X_i}$ are explanatory/independent variables affecting the adoption of the technology.

Factors affecting the extent of adoption of livestock technology were analyzed using Tobit model. Tobit, hybrid of the Probit and multiple regressions analysis, model or also called limited dependent variable regression model is censored normal regression model. This model was used by Ojiako et al., (2007) and Kaaya et al., (2005) in extent or intensity of adoption studies. The functional form of the conceptual random utility model, *G(.)*, is specified with a tobit model as:

$y_i = X_i'b$, if $y^* = X_i'b + t_i > T$ ------------------------------------------------------------------- (2)

$y_i = 0$, if $y^* = X_i'b + t_i \leq T$ ---------------------------------------------------------------------- (3)

where *yi* is the probability of adoption and extent of adoption of the improved dairy technology, $y^*$ is a non-observable latent variable, T is a non-observed threshold value which can either be a constant or a variable (Wu, 1992), *Xi* is an (n x k) matrix of the explanatory variables, which in this study consists of farmer and farm-specific characteristics, technology-specific attributes, and institutional and market-related variables, $\beta_i$ is a (k x 1) vector of parameters to be estimated, and $\tau_I$ is an independent normally distributed error term with zero mean and constant variance, that is, $\tau_i \sim N(0, \sigma^2 I)$. The conceptual model of Equations 2 and 3 is both a simultaneous and stochastic decision model (Adesina and Zinnah, 1993). If the non-observed latent variable ($y^*$) exceeds the threshold value ($T$), that is, if $y^*>T$, the $y_i$ (observed qualitative variable that indexes adoption) becomes a continuous function of the independent variables. If, on the other hand, $y^*\leq T$, the observed qualitative variable ($y_i$) will take zero value. In the first case adoption is observed while in the second adoption is not observed. If the unobserved $y_i^*$ is assumed to be normally distributed, the Tobit model estimation could be performed using the maximum likelihood estimation (MLE) function expressed as:

$$L = \prod_{y^*>T}(1-G_t)\prod_{y^*\leq T}\frac{1}{2\prod\delta^2}e[-\frac{1}{2\delta^2}(y_t-\beta X_t)^2]$$ --------------------------------------------- (4)

Where, $G_i$ is the distribution function of $\tau_i$. The resultant coefficients of the likelihood function are consistent, asymptotically efficient, unbiased and normally distributed. Accordingly adoption of improved dairy cattle (1=adopter and 2=Non adopter) and extent of adoption (number of improved dairy cattle adopted) was our two dependent variables analyzed by binary logistic regression and tobit models respectively. Independent variables used on our models was Zones ( a dummy of 1=Jimma ,2=Illubabor ), gender ( a dummy of 1=Male, 2=Female ), education ( a dummy of 1=Not able to read and write, 2=Read and write, 3=Formal school), participation on training, experience share, artificial insemination services and credit access (a dummy of 1=yes; 2=no) and continuous variables such as respondents age, family size, active labor force (age 15-64), frequency of extension visits, distance to market and service providers, land holding, annual income and total number of local cows were used. Here under summarized on **table 1** below is the lists of independent variables used on one of the models mentioned above with their own expected or hypothesized sign.

**Table 1:** Definition of independent variables used in logit and Tobit models

| **Variables** | **Description** | **Expected sign** |
|---|---|---|
| Zone | Dummy: 1=Jimma ,2=Illubabor | +/- |
| Sex of the head | Dummy: 1=Male, 2=Female | +/- |
| Age of the head | Continuous | +/- |
| Education | Dummy: 1=Not able to read and write, 2=Read and write (Informal schools such as basic and religious), 3= Formal school | + |
| Family size | Continuous | + |
| Household's children >7 years | Continuous | + |
| Total family aged 15-64 | Continuous | + |
| Frequency of extension visit | Continuous | + |
| Training on improved livestock technologies | Dummy:1=yes, 2=no | + |
| Training on improved feeding practices | Dummy: 1=yes, 2=no | + |
| Experience share on dairy management | Dummy: 1=yes, 2=no | + |
| Artificial insemination service | Dummy: 1=yes, 2=no | + |
| Distance to AI service (Km) | Continuous | - |
| Distance to dairy product market (km) | Continuous | - |
| Distance to veterinary services (km) | Continuous | - |
| Total land holding | Continuous | + |
| Total annual income (Birr) | Continuous | + |
| Grazing land (hectares) | Continuous | + |
| Hay land (hectares) | Continuous | + |
| Number of local cows | Continuous | + |
| Credit access | Dummy: 1=yes, 2=no | + |

**Result and Discussion**

**Characteristics of respondents**

The survey has included a total of 240 households from Jimma and Illubabor zones respectively. Households were randomly selected from Metu and Chora districts of Illubabor zone and Kersa, Manna and Shebe Sombo districts of Jimma zone. The result of the survey shows 33 female household head and 207 male household head was included in the survey. Of the total respondents, 43% were not able to read and write and 10% of them can read and write. The rest 47% of respondents were participated on formal schools. There was significant difference between adopters and non-adopters in family size and active labor force (15-64 years) in which adopters were advanced on both variables (See the summary on **table 2**).

**Table 2:** Characteristics of respondents

| **Variables** | **Adopters** | | **Non adopters** | | **Over all** | | | |
|---|---|---|---|---|---|---|---|---|
| | **Mean** | **S.D** | **Mean** | **S.D** | **Mean** | **S.D** | **t** | **P-value** |
| Age of respondent | 42.4 | 13.5 | 39.9 | 13.27 | 41.15 | 13.4 | 1.10 | 0.265 |
| Family size | 7.4 | 2.39 | 6.8 | 2.31 | 7.10 | 2.35 | 1.72 | 0.081* |
| Family (15-64) years | 3.2 | 2.37 | 2.7 | 1.82 | 2.95 | 2.09 | 1.68 | 0.082* |
| Total land (Hect.) | 4.29 | 2.98 | 4.07 | 2.49 | 4.18 | 2.73 | 0.47 | 0.597 |
| Grazing land (Hect.) | 0.63 | 0.69 | 0.80 | 1.18 | 0.72 | 0.93 | -1.30 | 0.343 |
| Number of houses | 1.98 | 1.27 | 1.72 | 0.89 | 1.85 | 1.08 | 1.30 | 0.109 |
| N=240 | | | | | | | | |
| ***=statistically significant at 1%, **=statistically significant at 5%; * = statistically significant at 10% | | | | | | | | |

Source: Survey result, 2015

The socio economic characteristics of respondents also show that Jimma zone farmers have large average oxen and Illubabor farmers have large mean cows, heifer and sheep. However, the significant difference between Jimma and Illubabor zones was seen on number of cow and calves (See the summary on **table 3**).

**Table 3:** Socio economic characteristics of respondents (Livestock ownership)

| Livestock | Jimma | | Illubabor | | Overall | | t | P-value |
|---|---|---|---|---|---|---|---|---|
| | Mean | S.D | Mean | S.D | Mean | S.D | | |
| Ox | 1.6 | 1.51 | 1.4 | 0.85 | 1.50 | 1.51 | 1.26 | 0.213 |
| Cow | 1.8 | 1.37 | 2.3 | 1.57 | 2.05 | 1.71 | -2.59 | 0.011** |
| Heifer | 1.0 | 1.05 | 1.2 | 1.08 | 1.10 | 1.08 | 0.82 | 0.422 |
| Bull | 0.8 | 1.09 | 0.8 | 0.92 | 0.80 | 0.95 | 0.43 | 0.642 |
| Calves | 0.9 | 1.04 | 1.3 | 1.06 | 1.10 | 1.07 | -2.52 | 0.013** |
| Chicken | 2.6 | 3.38 | 2.5 | 2.68 | 2.55 | 2.96 | 0.84 | 0.404 |
| Sheep | 1.2 | 1.96 | 1.7 | 2.06 | 1.45 | 1.71 | -1.27 | 0.205 |
| Goat | 0.9 | 2.15 | 0.6 | 1.80 | 0.75 | 1.45 | 0.99 | 0.283 |
| Donkey | 0.2 | 0.66 | 0.2 | 0.61 | 0.20 | 0.43 | 1.27 | 0.895 |

N=240

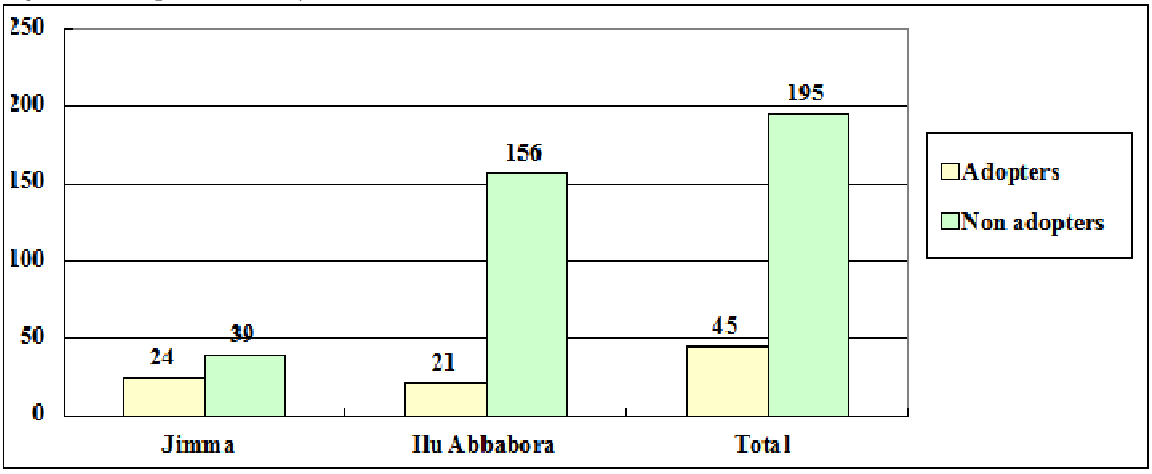
***=statistically significant at 1%, **=statistically significant at 5%; * = statistically significant at 10%

Source: Survey result, 2015

**Adoption status of cross breed cattle**

The survey was tried to show livestock adoption status on two zones. The total number of adopters of cross breed livestock was 45 households (18.8%). Of total adopters, 53% respondents exist in Jimma zone. About 38% of total respondents of Jimma zone are adopters and only 25% of total respondents of Illubabor zone were adopters.

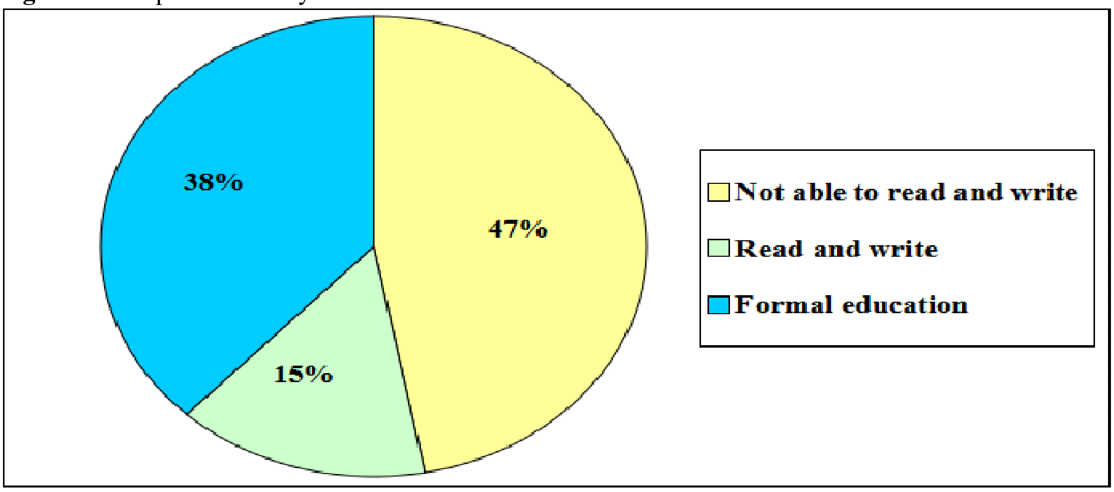
**Figure 1:** Adoption status by Zone




Source: Survey result (N=240), 2015

When we see the adoption status of respondents by education, 47% of respondents exist under the category of uneducated and 38% of them was educated and participated on formal education. However, only 15% of respondents were able to read and write through adult education and religious schools.

**Figure 2:** Adoption status by education




Source: survey result (n=240), 2015

Different improved livestock technologies were disseminated and the result of the survey witnessed that, the technology adoption is very stagnant and the technologies disseminated were very scant. Accordingly, only one cross breed ox exists among respondents of two zones. The number of cross breed cow exist among respondents of the study area was only six and 38 improved chicken was found during the survey. The best thing is the status of adoption of artificial insemination which is active in both zones. About 80 respondents used the service and the increase in number of calves might be the output of the adoption of this technology. Significant number of technology was seen between two zones on cross breed chicken and AI service provided (**See table 4).**

**Table 4:** Livestock technology adoption status

| Technology | Description | Zones | | Total | t | P-value |
|---|---|---|---|---|---|---|
| | | **Jimma** | **Illubabor** | | | |
| Oxen | Cross breed | 1 | 0 | 1 | 1.00 | 0.321 |
| Cow | Cross breed | 3 | 3 | 6 | 1.06 | 0.289 |
| Heifer | Cross breed | 0 | 2 | 2 | -1.41 | 0.158 |
| Bull | Cross breed | 4 | 10 | 14 | 0.08 | 0.913 |
| Calves | Cross breed | 6 | 22 | 28 | 0.23 | 0.818 |
| Chicken | Cross breed | 34 | 4 | 38 | 2.57 | 0.013** |
| AI services | Service provided | 31 | 49 | 80 | 1.68 | 0.093* |

N=240
***=statistically significant at 1%, **=statistically significant at 5%; * = statistically significant at 10%

Source: Survey result, 2015

Livestock nutrition was also the technology which was disseminated to different beneficiaries. However, its adoption status is also very poor in both zones. The most important fodder known and used by farmers, however, was elephant grass and Sasbania approximately which were used by 36 and 22 farmers respectively. Significant difference between the zones was seen on Elephant grass and Sasbania fodder awareness. Similarly, the utilization of Elephant grass between the two zones was also significant at 5% significance level (See **table 5**).

**Table 5:** Fodder adoption status

| Fodder | Awareness | | | Utilization | | |
|---|---|---|---|---|---|---|
| | Jimma | Illubabor | P-value | Jimma | Illubabor | P-value |
| Urea treatment | 2 | 2 | 0.275 | 1 | 2 | 0.169 |
| Oil seed cake | 2 | 4 | 0.691 | 2 | 1 | 0.346 |
| Wheat burn | 2 | 3 | 0.480 | 1 | 1 | 0.104 |
| Oat/vetch | 1 | 6 | 0.465 | 1 | 2 | 0.108 |
| Elephant grass | 6 | 43 | 0.013** | 3 | 33 | 0.013** |
| Tree lucerne | 1 | 3 | 0.954 | 0 | 1 | 0.890 |
| Sasbania | 14 | 21 | 0.045** | 9 | 13 | 0.318 |
| Leucanea | 4 | 4 | 0.120 | 1 | 0 | 0.127 |
| Alfalfa | 2 | 3 | 0.480 | 1 | 0 | 0.093* |
| Dismodium | 1 | 1 | 0.443 | 0 | 1 | 0.333 |

N=240
***=statistically significant at 1%, **=statistically significant at 5%; * = statistically significant at 10%

Source: Survey result, 2015

**Impact of dairy technologies**

**Impact of adoption on productivity**

The study tried to show milk yield difference between local and crossbreed species of cow for the two zones. The result shows the average milk yield during early months of lactation was 1.57 litters and 6.7 litters for local and crossbreed cows respectively. This milk yield diminished to 0.22 liters and 2.8 litters during late periods of lactation for local and crossbreed cows respectively. Despite, there was a significant difference between milk yield of cross and local breed in all lactation periods (See **table 6**).

**Table 6:** Milk yield difference milking seasons among adopters and non-adopters

| Species | Jimma | | | Illubabor | | | Overall | | |
|---|---|---|---|---|---|---|---|---|---|
| | Early | Mid | Late | Early | Mid | Late | Early | Mid | Late |
| **local** | 1.64 | 0.97 | 0.66 | 1.54 | 0.9 | 0.07 | 1.57 | 0.95 | 0.22 |
| **X-breed** | 6.54 | 4.5 | 2.9 | 6.9 | 5.4 | 2.4 | 6.7 | 4.8 | 2.8 |
| **P-value** | | | | | | | 0.001*** | 0.000*** | 0.003*** |

N=240
***=statistically significant at 1%, **=statistically significant at 5%; * = statistically significant at 10%

Source: survey result, 2015

**Impact of adoption on the income of farmers**

Impact of adoption of improved dairy technologies on income of farmers were measured by number of houses the households had, number of local cattle, sheep, goat, horse, mule, donkey and income collected from the sale of those livestock. It is hypothesized that farmers with high income from improved dairy products tends to build more house and receive large income from sale of cattle. On other hands, number of local livestock of the adopter is hypothesized as higher than that of non-adopters because of two important reasons. First, the income the adopters receive from improved dairy cow milk is used to buy additional livestock and to build new house. Second, the income collected from improved dairy cows saves the sale of cattle and other livestock and increases the number of livestock in the stock. The finding of the study revealed that significant difference between adopters and non-adopters was seen on number of local bulls, number of chickens and income from sale of cattle (See the summary on **table 7**).

**Table 7:** Economic impact of adoption

| Variables | Adopters | | Non-adopters | | P-value |
|---|---|---|---|---|---|
| | Mean | S.D | Mean | S.D | |
| Number of houses | 1.98 | 1.27 | 1.72 | 0.89 | 0.109 |
| Local oxen | 1.33 | 1.35 | 1.46 | 0.99 | 0.486 |
| Local cow | 2.33 | 1.91 | 2.16 | 1.42 | 0.559 |
| Local heifer | 1.27 | 1.03 | 1.09 | 1.08 | 0.315 |
| Local bull | 1.07 | 1.23 | 0.75 | 0.89 | 0.046** |
| Local calves | 1.31 | 1.26 | 1.22 | 1.02 | 0.608 |
| Chickens | 3.51 | 3.66 | 2.50 | 2.67 | 0.048** |
| Sheep | 1.93 | 2.73 | 1.40 | 1.84 | 0.116 |
| Goat | 0.80 | 1.80 | 0.66 | 1.93 | 0.649 |
| Donkey | 0.20 | 0.69 | 0.23 | 0.61 | 0.728 |
| Horse | 0.27 | 0.84 | 0.26 | 0.86 | 0.94 |
| Income from cattle sale | 14689.00 | 4548.16 | 5913.30 | 1910.50 | 0.043** |
| Income from sheep/goat sale | 1400.00 | 434.00 | 1769.00 | 609.40 | 0.637 |

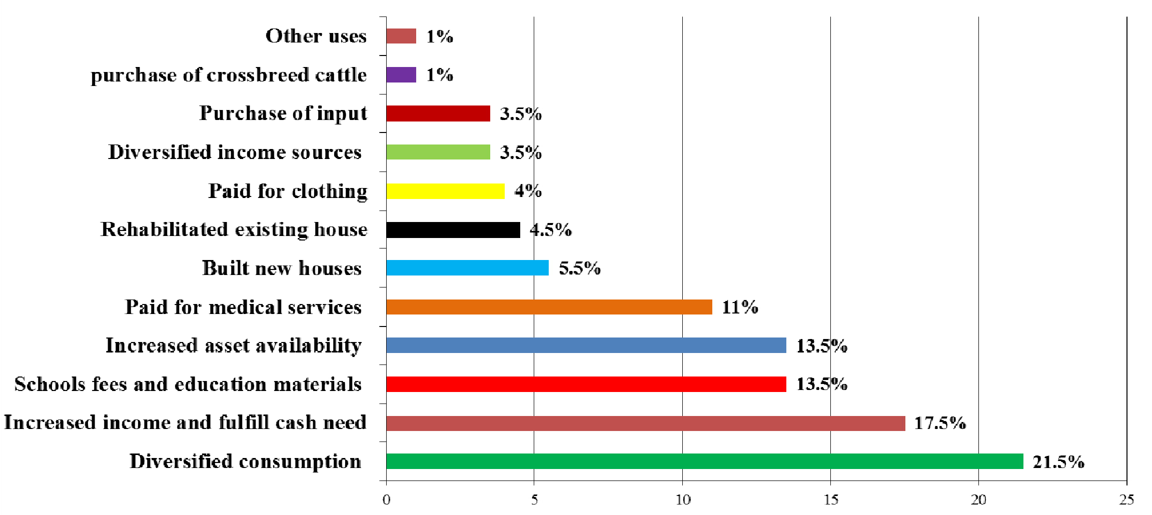
N=240
***=statistically significant at 1%, **=statistically significant at 5%; * = statistically significant at 10%

Source: survey result, 2015

**Impact of adoption on the livelihood and nutrition**

The impact of specific improved technologies on the livelihood of the farmer is measured in different indicators. Few of those indicators are impact on income and income diversity of the farmers, cash needs of the family, asset availability, new house construction and rehabilitation of the old, school fees and purchase of educational material of children, medical fees, clothing fees, seed purchase and purchase of livestock and crop for the family size. On other hands, household food diversity and food availability are the criterion for the nutritional effects of adoption. The result of the study shows 21.5% and 17.5% of respondents responded that adoption of improved livestock technologies had an impact on improvement of nutrition diversity and availability for the family member and on income diversity and fulfillment of family's cash needs respectively. The chi-square results of those variables was also significant at 5% and 10% significance level respectively.

**Figure 2:** Impact of dairy technology adoption on the livelihood of farmers




Source: Survey result, 2015

**Accessibility of technologies for women**

The impact of adoption on women is measured by its accessibility to them. The adoption status result shows that, the improved livestock technology was relatively dominated by men though 20% of adopters are women. The result shows there is progress in women participation towards improved technologies which is not satisfactory and needs emphasis as women in developing countries are characterized by dependency and resource constraint. Training on management of cross breed cattle was given to 99 respondents. Of those respondents, 12% of them were women participated on the training and 15% of adopters participated on training. On other hand of total respondents, no any women have been participated on the experience sharing of improved dairy management practices.

**Determinants of adoption**

The logistic regression included only few of demographic and geographical factors (zones and family size), institutional factors (distance to AI services and distance to market), information effect (frequency of extension services and training) and socio economic factors (education, land holding and annual income) because of specification problem. The classification table on the logistic regression indicates that coefficients can describe our dependent variable by 93.7% which is high and satisfactory. The fitted logistic regression model has explained 0.7069 = 70.69% of the variability in the dependent variable.

**Table 8:** Determinants of adoption of livestock improved technologies

| Variables | B | S.E. | P-value | Exp(B) |
|---|---|---|---|---|
| Zone [Jimma] | 2.430 | 1.714 | 0.156 | 11.35 |
| Education [Not able to read and write] | 0.033 | 0.121 | 0.783 | 1.034 |
| Family size | 1.162 | 0.527 | 0.027** | 3.196 |
| Total family aged 15-64 | -0.434 | 0.412 | 0.293 | 0.648 |
| Frequency of extension visit | 5.468 | 2.807 | 0.051* | 237.0 |
| Training on livestock technologies | 1.682 | 0.958 | 0.079* | 5.376 |
| Distance to AI | -0.997 | 0.442 | 0.024** | 0.369 |
| Distance to market | 4.747 | 3.863 | 0.219 | 115.2 |
| Total land holding | 0.626 | 0.353 | 0.076* | 1.870 |
| Total annual income | 0.000 | 0.000 | 0.053* | 1.000 |
| Constant | -1.158 | 3.706 | 0.755 | 0.314 |

N=240; *** = statistically significant at 1%; ** = statistically significant at 5% ;* =statistically significant at 10%; Goodness of fit = 70.69% (Naglekerke $R^2$)

Source: survey result, 2015

The result shown on the table above revealed that family size of the respondents, frequency of visits by extensionists, training on livestock improved technologies, distance to AI services, total land holding and total annual income significantly affects adoption of improved livestock technologies. However, there was no statistical evidence to conclude variability in location (zone), education, family size aged 15-64 years (active labor force) and distance to dairy output market affects adoption of livestock technologies.

The coefficient of family size is positive and significant. The result shows that, households with large family size are voluntary to adopt the technology by 3.2 times which is consistent with the hypothesized sign and with the finding of Howley et al., 2012 and Dehinenet et al., 2014. The coefficient of frequency of extension visit is positive and statistically significant which is consistent with hypothesized sign. The implication behind this is as a farmer frequently got extension visit, the likelihood to adopt the improved livestock technology increases by 237 times. The finding corroborate with the study conducted by Kaaya et al., 2005 and Dehinenet et al., 2014.

Training on improved livestock technologies creates its awareness and is expected to affect its adoption positively. The result concurs with the findings of Kaaya et al., 2005, Lemma et al., 2012, Quddus, 2013 and Dehinenet et al., 2014 and with the hypothesized sign. The coefficient of distance to AI service is negative and significant. As the distance to AI service increases, the probability adoption decreases by 0.369 times which corroborate with the hypothesized sign. The expected reason is that; first, the farmers do not want to implement the service as the transport cost is high and secondly, AI service should be conducted in 24 hours after heat period starts.

The coefficient of total land holding is positive and significant which is consistent with the hypothesized sign. Large land holding is related to relatively large crop production, large grazing land and large income, and moreover related to moderate to high livelihood status. Thus, those groups are voluntary to buy and use the improved technologies. Total annual income positively and significantly related to adoption of livestock technologies. When income of the farmers increases, the inclination of the farmers to use the improved technologies also increases which is consistent with the hypothesized sign.

**Determinants of extent of adoption**

The study was also tried to assess factors related to the intensity (extent) of adoption of improved dairy cattle. The results seen on the table below shows that, Illubabor zone has adopted more improved livestock technology than that of Jimma zone counterparts with positive coefficient (2.026) which is significant at 1% significant level. On other hands, non-educated farmers or respondents adopted more livestock than who participated on formal and informal education which is also significant at 5% significance level. The finding, however, is not consistent with the hypothesized sign.

Number of family size of the household affects the extent of adoption of dairy technology negatively and significantly which is not consistent with the hypothesized sign. The possible reason behind could be income constraint those households have. However, number of 7 years less children of the household affects the extent of adoption positively and significantly which could be due to milk demand of the households for children which is consistent with the hypothesized sign.

Number of local cows has increased the extent of adoption of improved livestock technologies with positive and significant coefficient. This means that with increase in local cows holding, the farmer will have additional 0.542 more cross breed cows. Provision of AI services has positive and significant coefficient (1.401) which corroborate with the hypothesized sign. It means a single year service of the experts increases 1.401 more cross breed cattle. Distance to veterinary service also affects extent of dairy technology adoption negatively and significantly (-1.74) which is consistent with the hypothesized sign. However, Dehinenet et al., 2014 found that availability of veterinarian affects intensity of dairy cattle adoption positively and significantly. Trainings on the management of improved dairy technologies affects the extent of adoption positively and significantly (2.747) which is consistent with the hypothesized sign. It means farmers will have 2.747 more improved cattle, if a single training on improved livestock management is provided which is consistent with the finding of Dehinenet et al., 2014. Frequency of extension services and access to credit services affects the extent of adoption positively and significantly at 5% and 10% significance level respectively which both also corroborate with Dehinenet et al., 2014 and with the hypothesized sign.

**Table 9:** Tobit result of extent of adoption of dairy technologies

| Variables | Coefficient | S.E | t | P-value |
|---|---|---|---|---|
| Zone [Illubabor] | 2.026 | 0.638 | 3.18 | 0.002*** |
| Sex of the head [Male] | 0.071 | 0.800 | 0.09 | 0.929 |
| Age of the head | 0.024 | 0.021 | 1.16 | 0.247 |
| Education of the head [Non educated] | 0.020 | 0.008 | 2.43 | 0.016** |
| Family size | -0.247 | 0.131 | -1.89 | 0.060* |
| Head children >7 years | 0.729 | 0.225 | 3.24 | 0.001** |
| Total land holding(hectares) | 0.095 | 0.125 | 0.76 | 0.446 |
| Grazing land (hectares) | -0.122 | 0.284 | -0.43 | 0.668 |
| Hay land (hectares) | -1.282 | 0.806 | -1.59 | 0.113 |
| Number of local cows | 0.542 | 0.177 | 3.07 | 0.002*** |
| Artificial insemination service | 1.401 | 0.580 | 2.41 | 0.017** |
| Distance to veterinary services (km) | -1.740 | 0.747 | -2.33 | 0.021** |
| Training on cross breed dairy management | 2.747 | 1.149 | 2.39 | 0.018** |
| Training on improved feeding practices | 0.537 | 0.752 | 0.71 | 0.476 |
| Experience share on dairy management | 2.012 | 2.558 | 0.79 | 0.432 |
| Distance to dairy product market (km) | -0.069 | 0.088 | -0.79 | 0.439 |
| Extension service access | 1.233 | 0.590 | 2.09 | 0.038** |
| Credit access | 4.107 | 2.366 | 1.74 | 0.084* |
| Constant | -19.27 | 8.106 | -2.38 | 0.018** |
| / Sigma | 3.138 | 0.280 | | |

N=240; Prob > chi$^2$ = 0.000; Log likelihood = -267.4477; Pseudo $R^2$=36.33
***=statistically significant at 1%, **=statistically significant at 5%; * = statistically significant at 10%

Source: Survey result, 2015

**Summary, Conclusion and policy recommendation**

This study assessed the adoption and impact of improved livestock technologies on the livelihood of farmers. The result shows that significant advantage of adopters was seen on milk yield, number of local bulls, number of chickens, income from sale of cattle, diversity and availability of nutrition and availability of farm assets. However, the result revealed the existence of progress regarding gender equality and accessibility of the technology to women among respondents in the study area even though a gap to fill in this regard. Thus, greater efforts will be needed to close the gender gap in access to, and use of, improved technology.

The finding of the study also revealed that family size, distance to veterinary services and distance to dairy product market affects the extent of adoption of dairy technology negatively and significantly and number of local cows, provision of AI services, training on the management of improved dairy technologies, frequency of extension services and access to credit services affects the extent of adoption positively and significantly.

Symmetrically, distance to artificial insemination service affected the adoption decision of farmers negatively and significantly which suggests the concerning bodies to emphasize on good AI service environment by facilitating transportation and infrastructural facilities as the cost of AI service is more feasible than the supply of pure breeds and crop breed cows from other localities.

Economic factors such as land, labor and income or cash was also seen as positive and significant relation to the adoption. Those three variables are related to wealth of the household which drives the household to adopt. Therefore, credit should be facilitated to rural households specifically for the scaling up of dairy technologies. The core finding of the study also suggested that frequency of extension visits and training affects the adoption decision positively. Thus, huge attention should be provided in changing and building farmers' awareness, understanding and perception through training, demonstration, field visits, experience sharing and others at district and zonal level. The results from this study generally confirmed the potential direct role of dairy technologies on improving rural household productivity, welfare and livelihood.

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