Determinants of Adoption of Artificial Insemination for Dairy Production: in Case of Zala Woreda, Gofa Zone, Southern Ethiopia

Abstract

Despite Ethiopia possessing the largest number of livestock in Africa, its benefit to the country and dairy holder farmers was small. Though the government introduced Artificial Insemination (AI) technology to improve this contribution, but the adoption of AI by dairy farmers was still low. The objective of the study was determinant factors affecting adoption of AI technology for dairy farmers in Gofa zone zala woreda. In this study both qualitative and quantitative data from Primary and secondary sources was collected. Survey questionnaires were used to collect raw data from AI adopters and non-adopters. AI adopters were selected by using purposive sampling because all sampled household heads were the only adopters in the study area whereas non-adopters were selected by using random sampling. The data was analyzed by using SPSS software. Descriptive statistics and binary regression model were used for analyzing data. A binary logit model was used to analyze the determinants of adoption of AI technology. Totally eleven variables were included in the model of which age of household head, training on AI, and frequency of DA contact were found significant at 1% ($P<0.01$) probability level. On the other hand household head's educational level, access to AI information, and distance from AI center were significant at 5% ($P<0.05$) probability level. Finally an effort should be given by the woreda government and livestock and fishery development office in increasing rural adult education, expanding AI center, strengthening DA's regular contact with dairy farmers, strong and appropriate information should be disseminated and training on AI technology should be given, which widens the knowledge of farmers on the technology.

Key words: Artificial Insemination, Dairy farming, binary logit, adoption determinants.

1. Introduction

The livestock sector plays a significant role in sustainability of the world's economy and attainment of food security. According to (Thornton, 2010), livestock production systems occupy about 30% of the planet's ice-free terrestrial surface area and are a significant global asset with a value of at least $1.4 trillion. Livestock production accounts for more than one third of the Global Agricultural GDP in developing countries. The use of

technologies in the livestock sector enhances productivity, reduces threats of diseases and ensures environmental sustainability in productive areas (Ingabire, 2018)This sector employs more than one billion people in the world of which 60% of them were from rural households (Braun, 2010) .

Dairy development in developing countries has played a major role in increasing milk production, improving income level in rural areas, generating employment opportunities and improving the nutritional standards of the people, especially for small and marginal farmers. The dairy technologies encompass the use of crossbred animals, improved feed technology and improved management (Ahmed, et al., 2015).

Ethiopia possesses the largest livestock population compared to any country in Africa, nevertheless its productivity remains marginal (Engidawork, 2018). Ethiopia was an agrarian economy located in the horn of Africa. Agriculture sector employs more than 80 percent of the population and contributes about 43 percent to the total GDP and 90 percent to the foreign exchange earnings (Chipeta, et al., 2015). The contribution of livestock and livestock products to the agricultural GDP of Ethiopia accounts for 40 percent, excluding the values of draught power, transport and manure. Smallholder farming is considered one of the most important in the agricultural sector in Ethiopia. It was a source of income, food security and indicates prestige and social status in the rural community (Hussen, et al., 2008). More than 99 percent of Ethiopia's cattle have been reported to be indigenous breeds and small Zebu types that are poor in major economically important traits.

Comment [a1]: Instead can have current status of AI in Ethiopia.

Even if Ethiopia has a large cattle population the reproductive performance and the productivity of the indigenous cattle breed is low. Usually, cows do not produce their first calves earlier than 35-53 months of age and calving interval is about two years. Cross breeding is an acceptable procedure for profitable livestock production (Mohammed, 2018).

Cattle production system in Ethiopia is mainly small holder substance farming, with animals having multipurpose use and as such no specialized and systematic breeding is used (Tadesse, et al., 2014). Although, Artificial Insemination (AI) has been considered as a promising tool to improve genetic potential of dairy animals, yet, many farmers at

field conditions are unaware about the technology with huge regional variations in terms of knowledge level and adoption of this promising technology (Mohammed, 2018).

Although professionals have pointed out AI as an emerging dairy innovation of importance, but practices about AI is entirely different. With this an attempt was made to study the determinants of adoption of AI and also highlights the benefits of AI technology, suggest the appropriate extension methods for disseminating the technology and suggest strategies that should be put in place to make AI technology sustainable in livestock production for increased productivity (Shehu, et al., 2010). Therefore, the study intended to identify the determinants of adoption AI technology, adoption status and perception on AI by the farmers.

2. Methodology

This study has used multi-stage sampling techniques both purposive and random sampling techniques were applied to select the required sampling units from the total population under study. In this study area there are 34 kebeles among which eight kebeles have access to AI service, while the remaining 26 kebeles do not have access. From Eight kebeles three kebeles were selected randomly. After obtaining list of household heads from those three kebeles, household heads were again stratified in to AI adopter and non-adopter groups, all of the non-adopter households were owner of dairy cows. Three kebeles namely Galma, Zelaynde and Bola were selected purposively based on the adoption of AI technology. Household heads in each kebeles were stratified in to adopter and non-adopter of AI technology. From the total household heads 61 household heads were adopters of AI technology and 784 household heads were non-adopters.

Then using probability proportional to size 70 households from Galma, 44 households from Zelaynde and 50 households from Bola kebeles was selected as AI adopters and non-adopters. In other words, 164 households (61 adopters and 103 non-adopters) were selected and interviewed. The sample size was determined by using Yamane (1967) formula of sample size determination. Yamane (1967) provides a simplified formula to calculate sample sizes. This formula was used to calculate the sample sizes. According to him, for a 95% confidence level and with ±7% precision, size of the sample should be: $n = N/1+ N (e^2)$

Where, n is Sample size, N is the population size and e is the level of precision
Let this formula be used for the population in which N =845 with ±7% precision and 95% confidence level, we get the sample size as

$n = 845/1+ 845 (0.07)^2 =$ **164**

In this study both descriptive statistics and econometric model were used to analyze data. Descriptive statistics was applied to describe the collected data using mean, standard deviation, percentages, frequency, minimum and maximum of the adopter and non-adopter farmers. The statistical significance of the variables was tested for dummy, categorical and continuous variables by using *chi*-square and *t*-tests.

Farmers' perception, especially in low income country like Ethiopia, is influenced by a complex set of socio-economic, socio-psychological, institutional, technical and bio-physical factors (Sisay, 2013). Therefore, to measure farmers' perception towards AI technology, Likert Scale was employed. Subjects are asked to express agreement or disagreement of a three-point scale. Respondents' perception to each statement was recorded as they ''strongly-Agree", ''Agree", "Disagree", ''strongly dis-agree" or "undecided". These responses were converted to an index by assigning numerical value of 1, 2, 3 and 4 for "strongly agree", "Agree", "undecided" and "Disagree" for positive statements and 4, 3, 2, and 1 for negative statements respectively. For both categories, i.e., adopters and non-adopters of AI technology, a set perception statement was developed on the basis of perceived benefit, economic and complexity of AI technology. Accordingly, all items were identified and presented as per the category of respondents. All perception statements presented for all categories based on their exposure towards AI technology.

3. Result and Discussions

3.1 Adoption Status of Dairy Farmers

In this unit the result and discussion of adoption status of AI technology by adopter household heads was described. In this section descriptive statistics was used to analyze to adoption status of dairy farmers in study area. This unit states about 61 respondents

that adopted that AI technology in Zala Woreda. For this purpose, year experience in AI technology, and number of calves' born were used for analysis.

3.1.1 **Years of Using AI Technology**

It was expected that years in dairying might influence adoption of AI technology. This is because experienced farmers have a tendency to be more knowledgeable of the technology. In the study area almost all adopter household heads were experienced in AI technology. This indicates that adoption of AI technology has association with year of experience in AI technology. The table below shows that the minimum and maximum year of experience in AI technology was 5 and 8 year respectively. The mean year experience in AI technology of adopter household heads was found to be 5.82 years with standard deviation of 0.866.

3.1.2 **Number of Calves Borne**

Improved breed calves plays a great role on adoption of AI technology. Almost all adopters in the study had owned improved breed calves by using AI technology. Therefore number of calves' borne by using AI technology has direct relation with adoption of AI technology. The table below shows that the minimum and maximum year of experience in AI technology was 1 and 4 calves respectively. The mean year experience in AI technology of adopter household heads was found to be 0.61years with standard deviation of 0.781.

Table1. Descriptive value of adoption status of AI technology

Adopters					
	N	Minimum	Maximum	Mean	Std. Deviation
Year of using AI	61	5	8	5.82	0.866
Number of calves born	61	1	4	2.61	0.781

3.2 Farmers' Perception towards AI Technology

This section explains the result and discussion part of farmers' perception on AI technology. For this purpose, likert scale measurement method was used. Accordingly, different perception statements were provided to sampled households. Interview schedule was used to collect data on farmers' perception towards AI technology. A perception item includes economic, institutional and complexity of the technology.

A total of 12 perception statements were developed for both adopter and non-adopter household heads. The response for each question was coded with numbers (1= strongly-agree, 2= Agree, 3= Not decided, 4= Disagree for positive statements) and (4= strongly dis-agree, 3= Disagree, 2= Not decide, 1= Agree, for negative statements). As indicated earlier, adopter and non-adopter of AI technology were provided with all perception statements. Of all statements provided for adopters; all statements were found to be reliable to analyze their perception towards AI technology. In similar way, out of seven statements provided for non-adopters, four statements were found to be reliable to analyze their perception towards AI technology.

The output obtained from the table, reliability analysis indicated that respondents' perception towards AI technology was influenced by a set of perception item. Of the total adopters 76.3% respondents were strongly agreed and 14.9% respondents were agreed on the importance of AI technology which increases the breed quality. Of the total adopter respondents, 66.8% were strongly agreed and 22.1% respondents were agreed that AI technology improves household food security. This implies that AI technology has a potential to increase the quality of breed and to improve household food security. Similarly, 60.6% adopters were strongly agreed and 37.2% adopters were agreed on the importance of AI technology which increases dairy production potential. This implies that adoption of AI technology is one of the attributes contributing to high dairy production potential (Sisay, 2013)

Also 44.5% and 55.3% of non-adopters also agreed that AI technology increases breed quality and improves household food security. Therefore most of the adopter respondents were shown that there was strong positive relationship between AI technology in

increasing breed quality, dairy production potential and improved household food security in improving their household income.

Concerning the feeding requirement of AI technology was that, improved breeds needs more feed as presented by both groups. Of the total respondents, 52.8% adopters and 60.3% non-adopters strongly agreed that improved breeds needs more feed. This implies that dairy farmers who have improved breeds should give consideration to animal feeding. From the total adopters and non-adopters respondents 81.8% and 72.6% were agreed that AI technology was cheap.

Generally perception or awareness regarding AI technology has direct linkage with adoption AI technology. It is evident that the majority of AI adopters and some of non-adopters have a positive perception towards the AI technology. Therefore, it is obligatory for the responsible authorities to create conducive environment for small dairy farmers to adopt AI technology and become active participant in the whole process of modernizing the dairy industry in the country. Small dairy farmers those aware of AI technology ware adopted the technology than that of non-adopters. Household heads that were perceived AI technology were strongly agreed that AI technology increases breed quality, improves household food security and increases dairy production potential. Therefore, perception of AI technology was vital for adoption of AI technology. The government should give emphases for awareness creation on small dairy farmers to perceive AI technology.

Table 2: Adopter Farmers' Responses to Perception Statements of AI Technology

No.	Farmers perception statement	Adopters Response					
		Strongly agree	Agree	Undecided	Disagree	Strongly dis-agree	Total

1	AI increases breed quality	76.3	14.9	4.4	4.4	0.0	100
2	AI Increases dairy production potential	60.6	37.2	0.0	2.2	0.0	100
3	AI improves household food security	66.8	22.1	4.4	6.7	0.0	100
4	AI is appropriate dairy technology	10.3	65.2	6.7	17.8	0.0	100
5	Improve breeds needs more feeding	52.8	22.2	13.3	6.1	5.6	100
6	AI is time saving technology	28.9	44.4	8.9	17.8	0.0	100
7	AI technology is cheap	13.8	81.8	0.00	4.4	0.0	100

3.3. Determinants of Adoption of AI Technology

Binary Logistic Regression Model was applied to identify determinant variables in adoption of AI technology. In this section, procedures followed to select independent variables (continuous and dummy) and results of logistic regression analysis conducted to identify determinants of adoption of AI technology in study area. In the Logit model, a household heads that used AI technology was considered to be “an adopter”. The logit model was used in this study to estimate the effects of the hypothesized independent variables on adoption of AI technology.

Eleven independent variables were included in the model. These independent variables are; age, sex, year of experience in dairy production, education level, training on AI technology, availability of AI, access to information, distance from AI center, frequency of DA contact, herd size, and farm land size on AI technology. These variables were

selected on the bases of theoretical explanation and the results of various empirical studies.

A number of independent explanatory factors (farmers, economic, and institutional characteristics) were hypothesized to influence the adoption of AI technology. Out of eleven explanatory variables hypothesized to affect farmers' decision to adopt AI technology, six explanatory variables were found to be statistically significant. These factors include age of household head, Education level of household head, access to information, distance from AI center, frequency of DA contact, and training on AI technology. The household heads sex, farm land size, herd size, and access of service were insignificant. All the significant variables were found to statistically significant with expected signs.

Age of Household Head (AGHH)

Age of household head was agreement with our prior expectation. It was negative and statistically significant at 1% probability level to influence adoption of AI technology.

The odds ratio for age of household head indicated that keeping the influence of all other factors constant, being an adopter of AI technology will decrease by a factor of 0.885 as the age of household head increases by one year. This implies that adoption of AI decreases as dairy farmers get older. This implies that young dairy farmers become more likely to adopt AI technology compared to the older dairy farmers. This situation prevails because the majority of young dairy farmers in the study area perceive AI technology as one of the aspects for increasing the productivity in the study area. Their positive attitude contributes positively to the adoption of AI technology in the study area. According to (Ingabire, 2018) the older dairy farmers trust on old production practices which do not have any significant impact on dairy productivity and likewise technology adoption among the older farmers is low because of their trend of depending on outdated practices.

Household Head's Educational Level (EDULVL)

It was positive and statistically significant at less than 5% probability level to influence adoption of AI technology. Furthermore, the odds ratio showed that keeping other factors constant, the decision of use of AI technology increases by a factor of 0.264 as education

level increases by a single class. This implies that household heads those attained secondary and above education level or those with higher education level more likely to adopt AI technology compared to their colleagues with lower education status. According to (Ingabire, 2018), small dairy farmers with higher education status can adopt AI technologies in order to improve production and productivity. **Access to Information (ACSINFO)**

It was found statistically significant at less than 5% probability level, positively related with adoption AI technology and similar with the previous expectation. The odds ratio indicated that keeping other factors constant, the decision of the use of AI technology increases by a factor of 0.691 as access to information increases by single information. This implies that dairy farmers those have access to information about AI technology have more advantage to adopt AI technology than those who have less or no access to information about AI technology. The result of this study stated that adopters of AI technology have more access to different sources of information than non-adopters. Similar findings of (Admassie & Ayele, 2009) stated that farmers who better information about improved technology adopt new technology than those who have no or insufficient information.

Distance from AI center (DISTANCE)

This variable was statistically significance at less than 5% of probability level and positively related to the adoption of AI technology and it was similar to the prior expectations. The odds ratio indicated that keeping other factors constant, the decision of use of AI technology increases by a factor of 0.048 as distance from AI center increases by half hour. This result showed that dairy farmers who live near to AI centers were more likely to adopt and use the technology when compared to their counterparts who live farther from the AI center. The result showed that AI adoption by dairy farmers was greatly influenced by distance from AI center, meaning that most dairy farmers with a walking hour of 0.31 adopted AI technology, whereas those more than 1 and 30 hour away from AI centers chosen natural service. Similar findings were reported by (Ingabire, 2018) stated that distance from technological centers can determine the level of adoption among small dairy farmers.

Training on AI (TRAIN)

As hypothesized creating awareness on AI technology retains a positive and significant relation with adoption of AI technology at 1% probability level. The odds ratio indicates that giving training on AI technology increases the probability of being an adopted by a factor of 0.159. The result showed that dairy farmers having training on AI technology increase the probability of adopting AI technology. The result indicated that all adopters in the study have participated on AI awareness creation but above 90% of non- adopters were not participated in AI training. This shows training on AI technology was a vital issue for adoption of AI technology in the study area.

Frequency of DA Contact (DACONTA)

Regular contact with development agent (DA) was also highly significant at 1% probability level. The odds ratio of indicated that keeping other factors constant, the decision in favor of the use of AI technology increases by a factor of 0.227 as frequency of DA contact increases by a single day. The statistical result indicated that dairy farmers who have regular contact with DA have better advantage to adopt AI technology when compared to non-adopters who had infrequent contact with DA. Similar findings reported by (TEMBA, 2011) stated that dairy farmers who had more contact with development agent (DA) were more likely to adopt AI technology.

Table 3. The Maximum Likelihood Estimates of the Binary Logit Model

Variables	Estimated Coefficient (B)	Standard error	Wald Statistics	Sig. Level	Odds ratio
AGHH	-.123***	0.044	7.841	0.005	0.885
EDULVL	1.332**	0.636	4.381	0.036	0.264
EXTCONTA	1.485***	0.522	8.087	0.004	0.227
SEX	-.353	1.076	0.108	0.743	0.703

ACCESSAISERV	0.022	2.021	3.062	0.348	1.022
ACSINFO	370**	0.152	5.919	0.015	0.691
YREDP	0.031	-1.218	1.204	0.214	0.971
SERVNEARBY	3.031**	1.189	6.501	0.011	0.048
FRMLNDSIZE	-.316	0.278	1.286	0.257	0.729
TRAIN	1.841***	0.448	16.907	0.000	0.159
HRDSIZE	-2.269	3.266	0.483	0.487	0.103
Constant	-1.025	0.527	3.778	0.052	0.359

Significant at 1% probability level ***, and Significant at 5% probability level **

Source: Own Survey Result, (2021)

4. Conclusion and Recommendations

4.1 Conclusion

In the face of rising rural population, shortage of grazing land and deficiency of dairy product made the significance of AI technology not only a questionable, but also a survival strategy. Possibly AI technology was the exact intervention for attaining household food security. Adopters of AI have increased their household income significantly as compared to the non-adopters of the AI technology. This shows that AI has a positive effect on household income.

The adoption of AI technology ensures various socio-economic benefits among the dairy farmers. Different characteristics of both AI adopters and non-adopters were determined.

Based on the empirical findings, the majority of dairy farmers in study area shown a positive attitude towards AI technology by examining its essentiality in growing productivity through the breed improvement of their stock.

Factors that affect adoption of AI technology can be categorized as positively and negatively influencing adoption of AI technology. On the basis of these categories factories that affect adoption of AI technology positively include household head's

educational level, experience of year in dairy production, training on AI technology, access to information, distance from AI center, and frequency of DA contact.

Whereas, factories that affect adoption of AI technology negatively include age of the household head, herd size and farm land size. From this we can conclude that household heads with higher education level was better adopted than non-educated dairy farmers. Therefore attention should be given on training of dairy farmers regarding AI technology. The other and most important one was access to information and AI center nearby dairy farmers. Dairy farmers with better information about the technology and those who have AI center nearby were better adopted the technology, hence attention should be given to diffuse information about the technology and also to establish possible AI centers nearby dairy farmers. Training on AI technology has also a major effect on adoption of AI technology. The household heads who participated on AI technology training were better adopted the technology than that of not participated on AI technology. Therefore attention should be given in participating household heads on AI technology training.

4.2 Recommendations

Based on the finding of the study, the following points are recommended to increase adoption of AI technology.

There is a need to give greater emphasis to educate the farmers on complete information and to create a better perception regarding artificial insemination. The study revealed that dairy farmers who have attained secondary and above education better adopted AI technology than that of no of no educated. Therefore expanding adult education and teaching dairy farmers regarding AI may encourage adoption of AI technology in the study area. The government and NGO's working on animal husbandry should give emphasis for adult education.

Dairy farmers who are nearby AI center better adopted the technology than those who have no AI center nearby. This shows that AI center plays a great role in adoption of the technology. Therefore building additional AI service provision centers near the vicinity of dairy farmers would encourage dairy farmers to adopt the technology.

DA's have a great role on disseminating new technology to farmers. In this study also frequent contact with DA was found to be an important factor influencing adoption of AI technology. This suggests that regular contact of DA with dairy farmers plays an important role in enhancing adoption of AI technology. Development agents who were specialized on animal production should give emphasis for dairy technology development especially for AI technology to enhance dairy production and productivity.

The probability for adoption AI technology increases as training on AI technology increases. Participating household heads on AI training accelerates adoption of AI technology than those who were not participated on AI training. Therefore, the government and NGO's should give attention in participating farmers on training of AI technology.

Generally the present day status of adoption of AI technologies in Zala Woreda was at lower level. Zala Woreda has owned thousands of dairy cattle but dairy production is still below potential. Since livestock sector plays a great role in national economy, emphasis should be given for breed improvement through AI technology. Still the sector was not supported with adequate budget and material; even there is no enough number of trained AIT. Therefore, to increase dairy production and productivity, the government, NGO's, rural co-operatives and other concerning bodies should support the sector with adequate budget, material and training adequate number of AIT to increase adoption of AI technology.

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