Adoption of Cross Breed Cows Distributed by Adami Tullu Agricultural Research Center in East Shewa and West Arsi Zones, Oromia Region, Ethiopia

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Abstract: Adami Tulu Research center undertaken the composite breed development to improve milk yield and Arsi cow indigenous breed. As intermediate results this research center distributed the cross breed cows to the farmers. So, this study investigated Adoption of cross breed Cows distributed by Adami Tulu Agricultural Research Center in East Shewa and West Arsi Zones, Oromia Region, Ethiopia. Structured questionnaires were used to collect data from 223 (105 Adopters and 118 non-Adopters) respondents purposively selected from designated locations in the study area. The result also revealed that about 71.43% of sample households were adopt cross breed cow. About 113 cows and calves distributed for farmers by Adami Tulu Research Center and the total offspring of cross breed cow ranges from 1 to 14 cows on average about 4 cows. The average value of cross breed cow was on average 144,272.7 Ethiopian birr with minimum 10000 ETB and maximum 800,000 Ethiopian birr for adopters. The gender participation result indicated that the participation of women high all activities of dairy production such as milking, feeding, health management, sold milk and milk product as well as milk processing into butter. The result of Tobit model revealed that, experience in dairy production, Number of cross breed, actual price of Cross breed cow distributed, total annual cash income and extension service on livestock production positively influenced households cross breed Cow decision and intensity of adoption whereas, total livestock number negatively affected sample households cross breed cow decision and intensity of adoption. The study indicated that the government, stakeholders and concerned bodies need to focus on facilitating farmers to experience sharing, increase cross breed cows by improving livestock production, strengthen extension service and improve income of farmers by participating different income generating activities so as to improve adoption decision and intensity of adoption cross breed cows in the study area.

Keywords: Adoption, Adopters, Non-Adopters, Tobit Model

1. Introduction

1.1. Background of the Study

Ethiopia is believed to have the largest livestock population in Africa. Ethiopia has the largest livestock population in Africa 65 million cattle, 40 million sheep, 51 million goats, 8 million camels and 49 million chickens [1]. This livestock sector has been contributing considerable portion to the economy of the country, and still promising to rally round the economic development of the country. It is eminent that livestock products and byproducts in the form of meat, milk, honey, eggs, cheese, and butter supply etc. provide the needed animal protein that contributes to the improvement of the nutritional status of the people [2].

The total cattle population for the country is estimated to be about 60.39 million. Out of this total cattle population, the female cattle constitute about 54.68 percent and the remaining 45.32 percent are male cattle. Regarding age groups, the majority of the cattle population (that is about 63.09 percent) is in the 3 years and less than 10 years age category, with about 28.15 percent male and about 34.94 percent female. Moreover, about 16.9 percent are between age one and three years and those with age category 10 years

and over took small portion i.e. 2.03 percent of the total estimated number of cattle population. On the other hand, the results obtained indicated that 98.24 percent of the total cattle in the country are local breeds. The remaining are hybrid and exotic breeds that accounted for about 1.54 percent and 0.22 percent, respectively. Moreover, 10 distributions of cattle by purpose is given in the same table. Among cattle aged 3 years and less than 10 years, those used for draught purposes accounted for 25.77 percent and the percentage share of beef cattle is the lowest that is about 0.81 percent. Beef cattle here refer to all cattle reared exclusively for meat that is used either for home consumption or for sale [3].

The pathway out of poverty trap of many SSA countries depends on growth and development of the agricultural sector [4]. This is possible by increasing agricultural productivity through distributing technologies in order to sustain food self-sufficient. For many years, the government of Ethiopia working with extension program diffuses agricultural technologies to improve smallholders' productivity and farmers' income.

Ethiopia boasts the largest livestock population in Africa [5]. Livestock production is an integral component of the agricultural system that contributes about 15% of the total GDP, 45% of the agricultural GDP and 31% of the total employment in Ethiopia [6]. The country comprises about 53 million head of cattle, almost all of which are local breeds [5]. The sector plays an important role in economic development which contributing about 12% of the Gross Domestic Product (GDP). The female stock (comprising 55% of the total cattle population) and produces estimated 3.32 and 1.5 billion liters of milk per year in Ethiopia and in the region, respectively [3].

The low level of agricultural technology development and innovative technological package transfer system by smallholder farmers are among the important factors contributed to the low productivity [7]. The main factors affecting the transfer of agricultural technological packages to the end-Adopters are knowledge level of the information Adopters, access to information of end Adopters, and readiness of farmers for adoption [8].

Agricultural researches lack effective mechanisms of transferring their technologies to the end Adopters, most of the agricultural technology adoption was conducted focusing on a single commodity or technology, and do not consider the possible inter-relationships between the various practices, lack of responsible body to transfer technology and no attempt of impact assessment after technology is transferred to Adopters are the major challenges. Therefore, the main purpose of this study is to assess the adoption of Cross breed cow distributed by Adami Tulu Agricultural Center and their impact on the farmers' income and constraints so as to indicate the future intervention areas in the country.

1.2. Statement of the Problem

Livestock also plays an important role in providing export commodities, such as live animals, hides, and skins to earn foreign exchanges to the country. On the other hand, draught animals provide power for the cultivation of the smallholdings and for crop threshing virtually all over the country and are also essential modes of transport to take holders and their families' long distances, to convey their agricultural products to the market places and bring back their domestic necessities. Livestock as well confer a certain degree of security in times of crop failure, as they are a "near cash" capital stock. Furthermore, livestock provides farmyard manure that is commonly applied to improve soil fertility and also used as a source of energy [2].

Cattle production plays an important role in the economies and livelihoods of farmers and pastoralists. The share of livestock is estimated at 45% of the gross domestic product. Cattle produce a total of 3.32 billion liters of milk [3]. From the total cattle in the country, 98.24 percent are local breeds. The remaining are hybrid and exotic breeds that accounted for about 1.54 percent and 0.22 percent, respectively [3]. Despite the large numbers, the production and productivity per animal is very low [9, 10]. According to [11], low productivity of the indigenous breeds which are owned by the smallholders and lack of access to improved breeds were the major limited factors for livestock production and productivity.

Attempts, to improve the productivity of cattle, have been made especially in the area of crossbreeding for the last five decades but with little success [9]. For policy design and effective management of extension programmers, information on the adoption and impact of dairy technology on the livelihoods of smallholder farmers is very important and would help to come up with workable recommendations to improve the performance of the sector. The introduction of improved dairy production system in the traditional farming system is likely to have several effects. To measure these effects of the introduction of cross breed cows as a source of milk to smallholder farmers to assess the adoption and impact of introducing crossbreed cows as source of milk. More than 100 cross breed cows were distributed for farmers by Adami Tulu Agricultural Research Center in East Shewa and West Arsi Zones before10 years ago. After cross breed cows' distribution to farmers the adoption rate not studied Therefore, this research conducted on the adoption of cross bred cows distributed to farmers by Adami Tulu Agricultural Research Center in the study area.

1.3. Objectives

The objectives of the study were:
1) To identify the adoption status of crossbreed cow distributed in the study area.
2) To identify factor affecting adoption decision and level of adoption of crossbreed cows.
3) To assess gender participation in crossbreed cow production.

2. Research Methodology

2.1. Description of the Study Area

This study was conducted in East Shewa and West Arsi

Zones of Oromia National Regional State, Ethiopia. West Arsi district is located at 250 km from Addis Ababa towards South direction. It shares borders with Bale Zone in the West, SNNP in the South and East Shewa Zone in the North directions (ZOA, 2019). East Shewa zone is bordered on the South by the West Arsi Zone, on the Southwest by the Southern Nations, Nationalities and Peoples Region, on the West by South west Shewa Zone, on the Northwest by North Shewa, and on the Southeast by Arsi Zone. Adama city is the capital city of East Shewa Zone. It located at 100 km from Addis Ababa towards South–East direction. This zone lies between 60 00' N to 70 35'N and 380 00'E to 400 00'E [12].

2.2. Sources and Methods of Data Collection

Both primary and secondary data were used for this study. Primary data was collected by interviewing sample dairy producer households by preparing semi-structured questionnaire. Secondary data was collected from East Shewa office of agriculture and from published and unpublished sources.

2.3. Sampling Procedure and Sample Size

The target population of this study was the adopters and non-adopters farmers of cross breed cows distributed by Adami Tulu Agricultural Research Center (ATARC) in East Shewa and West Arsi Zones of Oromia National Regional State. Two-stage sampling techniques were employed for this study.

1st *Stage*: Purposive sampling method was used to select cross breed cows adopters and randomly select non-Adopters.

2nd *Stage*: a total of 223 (105 adopters and 118 from non-adopters) sample respondents were selected for the study. From the sample respondents 13.90% from west Arsi Zone while 86.10% from East Shewa Zone based on cows distributed. The majority of respondents about 66% from Adami Tulu Jido Kombolcha districts as the distribution of cross breed cows high in order to benefit the farmers around research center.

***Table 1.** Sample size household heads.*

Zones	District	Number of respondents	Percentage of respondents
West Arsi	Kofale	20	9
	Shashamane	11	5
	Adami Tulu Jido Kombolcha	148	66
East Shewa	Dugda	16	7
	Lume	16	7
	Adama	12	5
Total		223	100

Source: Own survey result, 2022

2.4. Methods of Data Analysis

Descriptive statistics and econometric model were used for analyzing the data.

Descriptive statistics

Descriptive statistics and econometric model was used for analyzing the data. The descriptive statistics like mean, frequency, standard deviation, percentage, Chi square and t-tests were used to describe and see the relationship between variables.

Econometrics model

Tobit econometric model was used to analyses the factors affecting adoption decision and level of adoption of crossbreed cows by farmers.

Adopters: Farmers who produce the cross breed cow distributed from Adami Tulu agricultural research center.

3. Results and Discussion

3.1. Descriptive Statistical Results

The average age and dependency ratio of the sample respondents were found to be about 43 years. The result implies work age group of respondents. The average family size of the sample households was 7 persons per household, which is greater than the national average of 4.6 persons per household [13]. This implies the need for strengthening family planning programs to strike the balance of population growth within the level of economic development. The average dependency ratio of the sample respondents was found to be 0.16. An independent t-test result indicates significant difference between crossbreed adopters and non-adopters sample households in terms of age, family size and dependency (Table 2).

Cultivated and grazing land: Cultivated farmland land is land used by sample farm households to undertake agricultural production. The average cultivated land holding size and grazing of the sample households were 1.89 and 0.23 hectares respectively. The cultivated land size was greater than national average of 0.95 hectares [14]. There was significant difference at 5% level Adopters and non-adopters of Cross breed cows sample household heads in terms of cultivated land size. In terms of grazing land, there is insignificant difference between adopters and non-adopters of cross breed cows sample household heads (Table 2).

Livestock holdings: Livestock is one of the major assets for the farmers and also indicates their level of wealth in the study area. Types of livestock owned by households are oxen, cows, cows, calves, horses, donkey, sheep, goat and poultry. Livestock provides traction power, manure, and is a source of cash that can be used to purchase goods for household consumption and production inputs. The average livestock

holdings measured in terms of tropical livestock unit (TLU) were found to be 8.39. This is relatively a large number in the crop-livestock mixed farming system. An independent sample t-test result shows insignificant mean difference between adopters and non-adopters cross breed cows farmer in terms of livestock holding (Table 2).

Experience in dairy production: The number of years a farmer has been involved in the dairy raring may positively influences his/her management expertise and skills, and his potential to adoption. The mean farming experiences of dairy producers was 15 years. The independent t-test was significant different between cross breed cows adopters and non-adopters farmers. The mean farming experience of cross breed cows' adopters were greater than non-adopters of cross breed cows (Table 2).

Educational level: Out of the total sample household heads, the average grade for formal education was grade seven. This shows that farmers can easily understand agricultural instructions and advice provided by the extension workers. The Chi-square test indicated insignificant difference in educational level of adopters and non-adopters of cross breed cows farmers (Table 2).

Table 2. *Summary of inferential continues variables.*

| Variables | Cross breed cow | | | | | | t-value |
| | Adopters (n=105) | | Non-Adopters (n=118) | | Total sample size (n=223) | | |
	Mean	St.dev.	Mean	St.dev.	Mean	St.dev.	
Age in years	46.43	10.24	39.85	11.00	42.95	11.12	-4.61***
Family size in number	7.92	2.83	6.75	2.75	7.30	2.84	-3.15***
Dependency ratio	0.71	0.58	0.87	0.70	0.79	0.65	1.84*
Cultivated land in Ha	2.22	2.18	1.6	1.77	1.89	1.99	-2.37**
Grazing land in ha	0.27	0.7	0.18	0.40	0.23	0.56	-1.20
Livestock holding (TLU)	8.28	5.18	8.53	5.33	8.39	5.24	-0.36
Experience dairy production in years	16.35	5.51	13.64	8.26	14.91	7.21	-2.85***
Education Level	6.98	3.06	7.54	3.20	7.30	3.14	0.89

***, **,* Significant at 1%, 5% and 10% significance level
Source: Own survey result, 2022

Sex of the household heads: From household heads interviewed, 63% were male-headed while the remaining 37% were female-headed (divorced or widowed) at the time of survey. The result of Chi-square tests indicated insignificant difference in terms of sex of the household heads between sample households cross breed cows adopters and non-adopters (Table 3).

Table 3. *Sex of sample household heads.*

| Item | F1 cross breed distribution | Percent | Sex | | |
			Male	Female	Total
Cross breed cow	Adopters	No.	60	45	105
		%	57	43	100
	Non-Adopters	No.	80	38	118
		%	68	32	100
Total sample size		No.	140	83	223
		%	63	37	100
χ2-value		2.6988 (NS)			

NS=Not significant
Source: Own survey result, 2022

Participation in off-farm activities: An off-farm activity refers to employment in off-farm such as crop trade, livestock and livestock product trade and livestock fattening. Out of the total households interviewed, 19.33% participated in non-farm activities. The Chi-square test result indicated that there was insignificant difference between adopters and non-adopters cross breed cows farmers in terms of participation in non/off-farm activities (Table 4).

Access to extension services: Agricultural extension services are expected to enhance farmers' skill and knowledge, link farmers with markets and ease liquidity and dairy management constraints. About 53.4% of sample respondents get extension service and 51.12% extension related to livestock production. This implies that the attention to livestock extension is relatively low. The extension services given to sample respondents were mostly focused on health service and artificial insemination services. The Chi-square test showed that there was significant difference between adopters and non-adopters of cross breed cows farmers in both extension service and extension service specifically for livestock production. Relatively percentage adopters of cross breed cows farmers who get extension service were much greater than non-adopters of cross breed cows who had extension service that covers 70.5% and 33.90% respectively (Table 4).

Participation in social organizations: Participation in social organization is believed to enhance information exchange and experience sharing among farm households on adoption

decision. About 43.5% of the sample farmers participated in social organizations, of which 57.14% and 31.36% Cross breed cows adopters and cross, breed cows' non-adopters respectively. The Chi-square test result shows that sample farmers participate in social organization were significant difference between 1 cross breed cows adopters and cross breed cows' non-adopters 1% significance level (Table 4).

Access to credit: Credit service is an important institutional service which was required by the respondents in the study area. During survey season, 13% of the sample farmers had access to credit either in the form of cash or kind. However, the majority of sample respondents (about 87% of them) had not used credit because of high interest rate, shortage of credit service, religious view and inappropriate payback period of received loan. The Chi-square test result showed that significant differences between cross breed cow adopters and non-user farmers with respect to access to credit service (Table 4).

Table 4. Summary of inferential dummy variables.

Variables	Response	Adopters		Non-user		Total sample size		χ2-value
		Freq	%	Freq	%	Freq	%	
Participation in off-farm activities:	Yes	14	13.33	5	4.23	19	8.5	5.8979**
	No	91	86.67	113	97.77	204	91.5	
Extension service on livestock production	Yes	66	62.86	40	33.90	106	47.53	18.6830***
	No	39	37.16	78	66.1	117	52.47	
Participation in social organization	Yes	45	42.86	81	68.64	126	56.5	15.0326***
	No	60	57.14	37	31.36	97	43.5	
Access to credit service	Yes	87	82.86	107	90.7	194	87	3.0039*
	No	18	17.4	11	0.93	29	13	

***, **,* Significant at 1%, 5% and 10% significance level
Source: Own survey result, 2022

Cross breed cow distribution: - About 7.62% farmers get with calve while about 92.38 % farmers get pregnant cow. Therefore about 113 cows and calves distributed for farmers in 1993 academic year.

Table 5. Number of cross breed cow distributed in the study area.

Number of F1crossbred Cows distributed per household	Frequency	Percent
1	97	92.38
2	8	7.62
Total	105	100

Source: Own survey result, 2022

The Total offspring of cross breed cow and current value from such breed:-The total offspring of cross breed cow ranges from 1 to 14 cows on average about 4 cows. They get sufficient income from the cows who adopt it. The average value of cross breed cow was on average 144,272.7 Ethiopian birr with minimum 10000 ETB and maximum 800,000 Ethiopian birr.

Table 6. The total offspring of cross breed cow and current value from such breed.

Variables	Mean	Std.Dev.	Minimum	Maximum
Number of F1crossbred Cows offspring up to now	4.492754	2.687789	1	14
Current value of F1crossbred Cows	144272.7	160926.6	10000	800000

Source: Own survey result, 2022

Actual price of Cross breed cows: The average actual price of cross breed cows during distribution was about 9306.67ETB while Adami Tulu Agricultural research Center provided Cows by discount i.e. 2055.24 ETB. This was done to support farmers and introduce to cross breed cows to the study area.

Table 7. Actual price of cross breed cows.

Item	F1 cross breed distribution	Statistics	Variables	
			F1 price ATARC distributed	Actual price at market
Cross breed cow	Adopters (n=105)	Mean	2055.24	9306.67
		St.dev.	53.32	3615.09

Source: Own survey result, 2022

3.2. Dairy Production and Dairy Product Marketing

Dairy productions were well known in both East Shewa and West Arsi Zone of Oromia. About 86.1% of respondents have dairy cow at survey period. They have on average about three dairy cows per household that ranges from 1 to 20 cows.

There is no significance difference between zones in terms of   dairy owners (Table 8).

Table 8. *Dairy production in the study area.*

| Items | Zones | Percent | Do you have Dairy cow? | | |
			No	Yes	Total
Dairy cow	East Shewa	No.	26	166	192
		%	13.5	86.5	100
	West Arsi	No.	5	26	31
		%	16.1	83.9	100
Total sample size		No.	31	192	223
		%	13.9	86.1	100
χ2-value		0.1493 (NS)			

NS=Not significant

Source: Own survey result, 2022

Total milk supply:-The amount of milk supply to market was on average 32 liters per week during survey season. From total sample only 33% sold milk the remaining sold butter and consumed at home. There is significance difference between cross breed cow adopters and non-adopters in terms of volume milk sold. Cross breed cow adopters sold more milk than non-adopters.

Table 9. *Volume of milk sold per week of households.*

| Item | F1 cross breed distribution | Statistics | Variables |
			Amount of milk sold litter per week
Cross breed cow	Adopters (n=40)	Mean	40.73
		St.dev.	49.56
	Non-Adopters (n=34)	Mean	22.68
		St.dev.	30.45
Total sample size (n=74)		Mean	32.43
		St.dev.	42.58
t-value			-1.8468*

Source: Own survey result, 2022

Cash income from livestock: -The annual average income from livestock product sold was about 61,017.63 in Ethiopian Birr. There was significant difference between cross breed cow user and non-user in terms of livestock product sold. The average annual income cross breed cow user get was higher than non-user.

Table 10. *Annual income livestock product sold of sample households.*

| Item | F1 cross breed distribution | Statistics | Variables |
			Annual income livestock product sold
Cross breed cow	Adopters (n=61)	Mean	83487.28
		St.dev.	98093.23
	Non-Adopters (n=64)	Mean	39601.25
		St.dev.	46030.89
Total sample size (n=125)		Mean	61017.63
		St.dev.	78851.45
t-value			-3.2262 **

Source: Own survey result, 2022

Milk yield:-The average milk yield per day of cross breed was much higher than local breed. The average milk yield of local breed in study area was about 2.22 while cross breed was 6.16 liters per day. Therefore introduction of cross breed cows better for improvement of farmer income.

Table 11. *Average milk yield of local breed and cross breed cows in the study area.*

| Type of breeds | Milk yield per day | |
	Mean	Std.Dev
Local breed	2.22	1.78
Cross breed	6.17	3.29

Source: Own survey result, 2022

3.3. Adoption Status of Cross Breed Cow Distributed in the Study Area

The adoption status of cross breed cows distributed by Adami Tulu Research Center was 71.43 percent. This is due to different reasons such as cows distributed died and some respondents sold the cows.

***Table 12.** Adoption status of cross breed cow distributed.*

Items	Percent	Have you such breed of cross breed cow distributed by ATARC		
		No	Yes	Total
F1 cross breed Adoption status	No.	30	75	105
	%	28.57	71.43	100

Source: Own survey result, 2022

3.4. Gender Participation in Cross Breed Cow Production

Gender participation on dairy production considers the management system, feeding and sold of livestock and livestock products. The participation of women high all activities of dairy production such as milking, feeding, health management, sold milk and milk product as well as milk processing into butter (Table 13).

***Table 13.** Gender participation in cross breed cow production.*

Activities	Gender									
	Men		Children		Women		Children and women		Men and women	
	No	%	No	%	No	%	No	%	No	%
Milking	1	0.95	0	0	96	91.42	5	4.76	3	2.86
Feeding	15	14.29	3	2.86	51	48.57	23	21.90	13	12.38
Watering	13	12.38	9	8.57	43	40.95	30	28.57	10	9.52
Health management	42	40	0	0	42	40	10	9.52	11	10.48
Sold milk and milk product	4	3.81	13	12.38	73	69.52	11	10.48	4	3.81
Milk processing to butter	1	0.95	2	1.9	89	84.76	11	10.48	2	1.9

Source: Own survey result, 2022

3.5. Factors Affecting Households' Adoption Decision and Level of Cross Breed Cows' Adoption

The model specification was carried out using the Ramsey-reset test, and the result is insignificant (prob>F= 0.1977) indicating that there were no problem of omitted variables in the model. Variance inflation factors (VIF) was computed for all explanatory variables that are used in the Probit model and the result shows VIF values of less than 10 indicating multicollinearity was not a problem (Table Appendex2). Robust method was also employed to correct the possible problem of heteroscedasticity. Outliers were checked using the box plot graph so that there were no serious problems of outliers and no data get lost due to outliers. The model appropriates test was done for Hickman two stages, tobit and double hurdle. Finally the data was censored that tobit model appropriate for this research analysis.

The Tobit model result shows that the model being statistically significant at 1% level of significance, indicating the goodness of fit of the model to explain the effects of the hypothesized variables on the dependent variable in terms of at least one covariate. The estimation result also revealed that the adoption decision and intensity of farmers' adoption cross breed cow was influenced significantly by experience in dairy production, total livestock number, Number of cross breed, actual price of Cross breed cow distributed, total annual cash income and extension service on livestock production (Table 14).

***Table 14.** Factor affecting adoption decision and level of adoption cross breed cow.*

Variables	Coefficient	Robust Std.Err	P > t	Marginal effect
Sex	0.098	0.096	0.310	0.098
Age	0.004	0.0045	0.398	0.0038
Education status	-0.025	0.052	0.633	-0.025
Family size	-0.004	0.017	0.796	-0.004
Experience in dairy production	0.0153**	0.0072	0.037	0.0153
Livestock holdings (TLU)	-0.018**	0.008	0.022	-0.018
Number of cross breed	0.151***	0.037	0.000	0.151
Actual price of Cross breed cow	0.000024*	0.000013	0.068	0.000024
Access to credit service	0.042	0.113	0.713	0.042
Total Annual cash income in ETB	2.56e-07**	1.13e-07	0.026	2.56e-07

Variables	Coefficient	Robust Std.Err	P > t	Marginal effect
Access extension service livestock	0.362***	0.116	0.002	0.362
Constant	-0.522	0.420	0.217	

***, **,*: implies statistical significance 1%, 5% and 10% levels,
Log pseudo likelihood = -59.356 Pseudo R^2= 0.4202, F(11, 94) = 7.76, Prob> chi^2 = 0.0000 N =105, Source: model result, 2022.

Experience of dairy rearing: Experience of the household head in dairy production had positive relationship with adoption decision and level of adoption cross breed cow as prior expectation significantly at 5% significance level. The result shows that previous experience in dairy production increases by 1.53% the probability of F1cross breed cow adoption decision and level of adoption keeping all other factors constant. Farmers who had experience in dairy farming can better deal with the technical and management of cross breed cow and are more prone to accept it. They are more confident that cross breed cow might ultimately be beneficial. This result is in conformity with the finding of [15].

Livestock holdings: Livestock holding size, which is a proxy for measuring wealth status of household head, is found to have a negative and significant influenced on cross breed cow adoption decision and level of adoption at 5% level of significance. This result implies that for each additional tropical livestock unit, the households would 1.8% less likely to adopt F1cross breed Cow and level of adoption; keeping all other factors constant suggesting that a farmer with large number of livestock are less likely to potato adopt than others. Thus could possibly be explained farmers large livestock not care for cross breed rather more concern with large number of livestock holding. This is contradicting with the findings of [16].

Number of crossbreed owned: The coefficient for the number of cross breed cattle had a statistically significant and positive relationship cross breed Cow adoption decision and level of adoption at 1% significant level. The result implies that an additional unit of education would increase farmers' cross breed cow adoption decision and level of adoption by 15.1% than others, keeping all other factors constant. Farmers who had cross breed better to know management practice and the advantage of cross breed over local than others. This is in line with the findings of [17].

Actual price of Cross breed cow: Actual price of cross breed cow was found to have a positive and significant influenced on cross breed cow adoption decision and level of adoption at 10% level of significance. Higher price of cross breed cow at market price makes farmers more adopt since they get with minimum price from ATARC. A unit additional price cross breed cow at market of was 0.002%more probability of cross breed cow adoption decision and level of adoption than others respectively, keeping all other factors constant.

Total Annual cash income: Total Annual cash income had positive relationship with cross breed cow adoption decision and level of adoption as prior expectation significantly at 5% significance level. This implies the farmers who had higher cash income more adopt F1cross breed cow because they had

not sold cow as shortage of cash income. Additional cash income increase by one ETB the F1cross breed cow adoption decision and level of adoption increase by 0.00003% keeping all other factors constant. This is in line with the findings of [18].

Access to extension for livestock production: Access to extension for livestock production was found to have F1cross breed Cow adoption decision and level of adoption at 1% level of significance. The result implies that an access to extension on livestock would increase farmers' cross breed cow adoption decision and level of adoption by 36.2% than others, keeping all other factors constant. Because it improves the technical knowhow and skill of the farmers thereby exchange of experience was improve the adoption. This is in line with the findings [19].

4. Conclusions and Recommendations

4.1. Conclusions

The descriptive and inferential analysis indicated significant difference between cross breed cow adopters and non-adopters sample households in terms of Age, education status, experience in dairy production, access to extension service, participation in social organization, access to credit and cash income from livestock products. In terms of adoption status about 71.43% of sample households were adopt cross breed cow. About 113 cows and calves distributed for farmers by Adami Tulu Research Center and the total offspring of cross breed cow ranges from 1 to 14 cows on average about 4 cows. The average value of cross breed cow was on average 144,272.7 Ethiopian birr with minimum 10000 ETB and maximum 800,000 Ethiopian birr for adopters.

The result of tobit model revealed that, out of total 11explanatory variables included in the model. Total of six variables found significantly determined sample farmers adoption decision and intensity of adoption. To this effect, experience in dairy production, number of cross breed, actual price of Cross breed cow distributed, total annual cash income and extension service on livestock production positively influenced households cross breed cowdecision and intensity of adoption whereas, total livestock number negatively affected sample households cross breed cow decision and intensity of adoption.

4.2. Recommendations

Based on the findings of this study, the following recommendations are made.

Experience in dairy production significantly and positively affect cross breed cow adoption decision and level of

adoption. Therefore farmers should exchange experience in dairy production and management.

Annual cash income was significantly and positively affect cross breed cow adoption decision and level of adoption. Therefore farmers should participate into different income generating activities like production of cash crops and intensify the dairy production to improve income to adopt cross breed cows.

Extension service on livestock production was significantly and positively affect cross breed cow adoption decision and level of adoption. Therefore district livestock agency experts should provide livestock extension with great attention for awareness creation on importance of cross breed cows over the local as well as dairy management and improved animal feed expansion.

Conflicts of Interest

The authors declare no conflicts of interest.

Appendix

Table A1. *Conversion factors used to compute tropical livestock units (TLU).*

Livestock Categories	Conversion factor
Cow/Ox	1
Bull	0.75
Cow	0.75
Calf	0.2
Horse/Mule	1.1
Camel	1.25
Sheep/Goat	0.13
Donkey	0.7
Poultry	0.013

Source: Stork *et al*., 1991

Table A2. *Multicollinearity test.*

Variables	VIF	1/VIF
Sex	1.63	0.611850
LIVESTOCKExtension	1.53	0.652386
EXPEDAIRY	1.48	0.676431
Ecucs	1.47	0.681240
Age	1.37	0.728166
CROSSBREED1	1.30	0.769445
TFZ	1.25	0.801390
ACTUALPRICE1	1.17	0.852798
TLU	1.11	0.903708
Totalincome	1.08	0.922242
Creditservice	1.08	0.929701
Mean VIF	1.32	

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