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Assess Income Contribution of Adopter and Non- adopter of Crossbred Dairy Cows Managed under Smallholder Farmer in Endamehoni District, Southern Zone, Tigray, Ethiopia

Mebrahtom Bisrat
Department of Animal Science, Maichew ATVET College, Tigray, Ethiopia
Corresponding Aothor: Mebrahtom Bisrat, Department of Animal Science, Maichew ATVET College, P.O.Box 67, Maichew, Ethiopia

Abstract
The study was carried out in Endamehoni District Sothern zone of Tigray region, Ethiopia. Objective of this study was to assess income contribution of adopter and non- adopter of crossbred Dairy cow Managed under smallholder farmers in Endamohoni District. The total sampled numbers of household's was 180 dairy cow owners, 90 each from adoptor and non- adopter of crossbred Dairy cow owners respectively. The primary data was collected using semi-structured questionnaire and interview. Before conducting formal survey, pre-test was carried out on the sample of respondents undertaken by using interview with households and key informants. Propensity score matching was also employed to show if non-adopters and adopters of crossbred dairy cow have significantly different income. The result shows that the ATT income earned from adopter of crossbred Dairy cow for nearest neighbor, radius and kernel matching method was significant. The result indicated that adopters crossbred dairy cow have earned more income than non-adopters. The average treatment of the treated (ATT) on per capita income for crossbred cow adopters were 12459.98 birr/annum from nearest-neighborhood, 16702.375 birr/annum radius matching method and 10596.369 birr/annum for kernel matching method was earned more income than non-adopters of cross bred dairy cows respectively. What's more, stratified matching method indicates that the average income earned from crossbred adopters was 668 birr/annum. In general, these results had shown significant effect on adopting of crossbred dairy cows on smallholder farmers' income.
Keywords: psm, Logit, adopter, non-adopter, income ,ATT

Introduction

Ethiopia has large livestock population, which is estimated to be 52.13 million cattle, 24.2 million sheep, 22.6 million goats, 1.96 million horses, 6.4 million donkey, 0.37 million mule, 0.99 million camels, 44.89 million poultry and 4.99 million beehives. Out of this total cattle population, female cattle constitute about 55.57 percent and the remaining 44.43 percent are male. From the total cattle population 98.88 percent are indigenous breed, 0.93 percent are cross and 0.12 percent are exotic bred (CSA, 2012).

The dairy sector in Ethiopia is characterized by a small-scale subsistence milk production system and constrained mainly by low genetic potential of indigenous cows, disease prevalence and feed shortage. Therefore, strategies designed to develop the dairy sector should take into account the existing production characteristics of the area and should focus on a systematic approach to improve the identified limitations by involving all stakeholders in the formulation and implementation of improvement approaches (Asaminew and Eyassu, 2009).

Generally, domestication and the use of conventional livestock breeding techniques have been largely responsible for increases in yield of livestock products that have been observed over recent decades (Leakey, 2009).

Different dairy technology and innovation packages focusing on breeding, management, husbandry, feeds and feeding and health have been identified and introduced to optimize the income contribution of the indigenous and/or crossbred dairy animals. Although these intervention methods can result in improvement of income contribution efficiency of dairy animals with the impact of these technologies on the livelihood of dairy producers is not well studied and documented. Such information can be used as a tool for policy formulation in the dairy sector (breeding, marketing, health and other segments of the sector). It is necessary to evaluate the productive and reproductive performances of indigenous stocks and their crossbred for designing appropriate breeding strategies. Especially, the economics of dairy enterprise is based on an efficient reproductive performance of dairy animals (Sodakar *et al*., 1988). Anywhere, successful adoption of improved agricultural technologies could motivate overall economic growth through inter-sectoral linkage while conserving natural resources (Sanchez *et al.,* 2009). Therefore, this study aims to assess, income contribution of adopter and non-adopter of crossbred Dairy cow on smallholder farmers in Endamehoni District.

Materials and methods

The study was conducted in three different district of the study area**.** The study area was selected based on the majority of adopter of cross breed dairy cows. Proportional sample size of 90 adopter and non adopter cross breed dairy cow household owners leading to a total sample size of 180 dairy cattle owners were selected. The study was selected purposively considering the availability of adopter and non-adopter of crossbred dairy cows on the smallholder farmers. Based on the list of the small holder farmers and information sharing with the development agent, 60smallholder farmers were selected. From each Tabia, 60 smallholder farmers were selected with 30 of them were having indigenous and cross breed dairy cow, respectively.

Data Analysis

Descriptive statistics, t-test, chi-square and mean comparison

Descriptive statistics such as tables (cross tabulation) to compare the proportion of indigenous cows owners and crossbred cows owners in respect of a particular household characteristics, livestock holding using measure of dispersion tools such as minimum, maximum, mean, frequency, percentage, standard deviation , t- test and chi-square statistics to compare indigenous cows owners and crossbred cows owners. Mean comparison test were used to compare the productive and reproductive performance of indigenous and crossbred dairy cows. The t-test and chi-square tests help to see the presence of statistically significant differences in the characteristics of indigenous cow owners and crossbred cows ownersin terms of some assumed variables. Ranking method was used to rank the variables that prioritize by the small holder farmers like purpose of keeping cattle, major crop type and major constraints of indigenous and crossbred dairy cattle production in the study area of Endamohoni District. Majority of agroecology study area was 60 percent highland, 35 percent mid land and 5 percent low land (BoARD, 2013). The agroecological condition of the selected Tabia for the study was similar.

Econometric Analysis

Econometric analysis was conducted to analyze factors affecting adoption of crossbred dairy cow and its impact on income from livestock sale, crop sale, off-farm activities, credit and total income. Propensity to score matching technique was used to analyze through STATA software Version 10. In this process, choice of best estimator based on certain indicators and balancing tests was conducted to improve quality estimate. Logistic regression model employed to estimate propensity scores for matching treatment household with control households. The dependent variable in this model is binary indicating whether the household was a participant in introducing of crossbred dairy cows which takes a value of 1 and 0 otherwise. The basic idea behind propensity score matching (PSM) is to match each non-adopter with identical adopters and then measure the average difference in the outcome variable between the non-adopters and the adopters. The estimation command in Stata is "pscore.ado," developed by Becker and Ichino, (2002) that describes the "pscore" command estimates the propensity score, which is the probability of getting a treatment for each household, and tests the balancing propertythat is, observations with the same propensity score must have the same distribution of observable characteristics independent of treatment status.

Propensity score matching measuring on the impact of crossbred dairy cows

Propensity score matching (PSM) is a method that improves on the ability of the regression to generate accurate causal estimates by the benefit of its non-parametric approach to the balancing of covariates between the "treatment" and "control" group, which removes bias due to observable variables. The conventional approaches for assessing the impact of an intervention on using with and without method, has essentially been hindered by a problem of missing data. Due to this problem, the impact of intervention cannot be accurately estimated by simply comparing the outcome of the treatment groups with the outcomes of control groups (Heckman *et al.,* 1998). The propensity score matching approach aims to build matched pairs of comparable adopters from the program participants and non-participants that show a similarity in terms of their observable characteristics. This is achieved by grouping households from treated individuals and non-treated individuals simply which shows a high similarity in their explanatory variables. Thus, to assess the impact of crossbred dairy cows on income,PSM method was used.

Empirical model specification

In this study, households who participated in adopting of crossbred dairy cow were considered as the treatment group and households who did not introduce crossbred dairy cows considered as control group. These two groups were compared to evaluate the impact of adopting crossbred dairy cow for market-oriented livestock production on treated group's livelihood. The aim was to compare the level of income contribution of crossbred adopters to that of non-adopters. This ensured that the average treatment effect or effect of crossbredadopters for market oriented livestock production on livelihood could be accurately estimated using mathematical equation as follows.

$$Yi^{T} - Yi^{C} \qquad (1)$$

Where, Yi^{c}= outcome of the untreated individuals' income (i^{th} household who did not adopt crossbred dairy cow).

$_{i}$ = Change in outcome as a result of treatment or change of income for adoptingcrossbred dairy cow

Let the above equation to be expressed in causal effect of notational form, by assigning ***D* i** 1 as a treatment variable taking the value 1 if individual received the treatment crossbred dairy cow) and 0 otherwise. Then, the Average Treatment Effect of an individual (i) can be written as:

$$ATE = E(Y^{T} | D=1) - E(Y^{C} | D=0) \qquad (2)$$

Where, ATE =Average Treatment Effect, which is the effect of treatment on income

$E(Y^T|D=1)$ = Average outcomes for individual, with treatment, if he/she would
Adopted cross bred dairy cow (***D i*** **1)**
$E(Y^C|D=0)$ =Average outcome of untreated, when he/she were non-uses, **D i** **0**
To measure the Average Effect of Treatment on the Treated (ATT) for the sample can be reformulated as:
$ATT = E(Yi^T - Yi^C|D=1) = E(Yi^T|Di=1) - E(Yi^C|D=1)$ _______________ (3)

The fundamental evaluation problem in estimation of impact is that it is impossible to observe a person's outcome with and without treatment at the same time.

The post-intervention, the outcome $E(Yi^T|D=1)$ is possible to observe. However, the counterfactual outcome $(Yi^C|D=1)$ is not observable in the data. Thus, estimation of ATT can give a seriously biased result, due to the fact that the population can be different from the comparison group, not only in terms of treatment status, but also can differ even in terms of other characteristics. This problem is often referred to as the "fundamental problem of causal inference''. Thus, simple mean comparison between the treated and non-treated can be misleading. Yet, taking the mean outcome of crossbred dairy cow non holder as an approximation is not advisable, since adopters of crossbred and non-adopters of crossbred usually differ even in the absence of treatment (Holland, 1986).

Specification of the Logit model

A logit regression of treatment status (1 if a household introduced crossbred dairy cattle, 0 if household is non-adopter) was run for the sampled households; on observations include age, gender education, and family size, labour access, land holding, market distance, veterinary distance, extension services, livestock holding and credit services. The major concern of this regression was to predict the probability of a household to be aware in introducing of crossbred used for market-oriented livestock production i.e. to predict propensity scores, based on which, the treatment and control groups of households were matched using the matching algorithms**.**

Choice of matching algorithm

Estimation of the propensity score is not enough to estimate the ATT of interest. This is due to the fact that propensity score is a continuous variable and the probability of observing two units with exactly the same propensity score is, in principle, zero. Various matching algorithms have been proposed in the literature to overcome this problem. The methods differ from each other with respect to the way they select the control units that are matched to the treated, and with respect to the weights they attribute to the selected controls when estimating the counterfactual outcome of the treated. However, they all provide consistent estimates of the ATT under the conditional independent assumption (CIA)and the overlap conditions are the most commonly applied matching estimators are described. Four of the most widely used are Nearest Neighbor Matching, Radius Matching, Kernel Matching and Stratification Matching.

The Stratification method consisted of dividing the variety of variation of the propensity score in intervals such that within each interval, treated and control units have on average the same propensity score. For practical purposes the same blocks identified by the algorithm that estimates the propensity score can be used. Then, within each interval in which both treated and control units are present, the difference between the average outcomes of the treated and the controls is computed. The ATT of interest is finally obtained as an average of the ATT of each block with weights given by the distribution of treated units across blocks. One of the drawbacks of the Stratification method is that it discards observations in blocks where either treated or control units are absent. This observation suggests an alternative way to match treated and control units, which consisted of taking each treated unit and searching for the control unit with the closest propensity score; i.e., the Nearest Neighbor. Although it is not necessary, the method is usually applied with replacement, in the sense that a control unit can be a best match for more than one treated unit. Once each treated unit is matched with a control unit, the difference between the outcome of the treated units and the outcome of the matched control units is computed. The ATT of interest is then obtained by averaging these differences. While in the Stratification method, there may be treated units that are discarded because no control is available in their block, in the Nearest-Neighbor method, all treated units find a match. However, it is obvious that some of these matches are fairly poor because for some treated units the nearest neighbor may have a very different propensity score, and, nevertheless, he would contribute to the estimation of the treatment effect independently of this difference.

Nearest neighbor matching: is one of the most straightforward matching procedures. An individual from the comparison group is chosen as a match for a treated individual in terms of the closest propensity score (or the case most similar in terms of observed characteristics). Variants of nearest neighbor matching include "with replacement" and "without replacement," where, in the former case, an untreated individual can be used more than once as a match and, in the latter case, is considered only once.

Radius matching: is to avoid the risk of poor matches; radius matching specifies a "caliper" or maximum propensity score distance by which a match can be made. The basic idea of radius matching is that it uses not only the nearest neighbor within each caliper, but all of the comparison group members within the caliper. In other words, it uses as many comparison cases as are available within the caliper, but not those that are poor matches (based on the specified distance).

Kernel and local-linear matching:are non-parametric matching estimators that compare the outcome of each treated person to a weighted average of the outcomes of all the untreated persons, with the highest weight being placed on those with scores closest to the treated individual.When applying kernel matching, one also has to choose the kernel function and the bandwidth parameter(Caliendo and Kopeinig, 2008) and (Becker and Ichino, 2002).

Testing the matching quality:

This is to check all covariates on the propensity score if the matching procedure is able to balance the distribution of the relevant variables in both the control and treatment groups. The primary purpose of the PSM is that it serves as a balancing method for covariates between the two groups which differences in covariates are expected before matching that avoided after matching. Consequently, the balancing tests is to check whether the propensity score is adequately balanced or examine if at each value of the propensity score, a given characteristic has the same distribution for the treated and comparison groups. The basic approach is to compare the situation before and after matching of the differences (Caliendo and Kopeinig, 2008).

T-test: Two-sampled t-test used to check if there are significant differences in covariate means for both groups (Rosenbaum and Rubin, 1983). Before matching differences are expected, but after matching the covariates should be balanced in both groups and hence non-significant differences should be found.

Dependent variable (Yi)

The dependent variable for this study is adopting of crossbred dairy cow which takes the value of 1 if the household adopted crossbred dairy cow and zero otherwise.

Outcome variables

This study considers total income of a household from different sources (livestock sale, crop sale, off/non-farm activities, etc.) in Ethiopian birr as a measure of economic impact. Acceptance of crossbred is assumed to increase total income of the households if total income increased from livestock cover in the study area.

Independent variables

1. **Age of household head**: It is a continuous variable measuring the age of the household head in years. Age of the household head might be affect to the decision of technology adoption.

2. **Gender**:it is a dummy variable where 1 represented male and 0 represented female. It is expected to encourage the adoption of crossbred dairy cow, since females are involved in dairy production to increase source of income for their family member. Female household head are mostly involved in livestock production than crop production.Generally female have positive impact on adoption of crossbred dairy cows.

3. **Education level of household head:** It is a continuous variable measuring the grade level of formal schooling a farm household head has completed during the survey period. Educational attainment by the household head could lead to awareness of the possible advantages of modernizing agriculture by means of technological inputs; enable them to read instructions on fertilizer packages and diversification of household incomes which, in turn, would enhance households' food supply and livelihood improvement.

4. **Family size:** This is a continuous variable measured in the number of family members and expected to affect the household's adoption of this technology. This is because as total family size is the source of labor in the rural households, more family member means that proportionally, the number of active working group in that household is expected to be high.

5. **Access of labor force:** It is a dummy variable represented by 1 if households have surplus labor and 0 otherwise. It is referring to the access of labor force in the household, so that labor availability was one of the main important parameters which can influence the adoption of crossbred dairy cow positively

6. **Land Holding:** It is a continuous variable expressed in terms of hectares of cultivable land. It is expected to have a positive effect on the adoption of the crossbred. This is because farmers who have more cultivable lands are expected to have enough land to cultivate improved forage and crop residue for their dairy cow feed.

7. **Extension services:** This is a dummy variable represented by 1 if have and 0 other wise. It is defining, when extension agent and district experts explain income contribution of crossbred dairy cows for smallholder farmers. Similarly the assistance of those extension agent and district experts on feeding, housing, breeding, effective veterinary services and experience sharing among the non-adopters and adopters of crossbred dairy have positive impact on adoption of the crossbred in the study area. This may be extension service is expected to support technology adoption and practice by the farmers.

8. **Livestock holding (TLU):** It is a continuous variable measured as the number of the market-oriented livestock that, the household is holding measured in Tropical livestock unit (TLU). The number of live animals the family is rearing has a positive contribution for introducing or adopting of crossbred dairy cows.

9. **Access to credit:** It is a dummy variable taking a value of 1when the household has access to credit and 0 otherwise. Access to credit is hypothesized to have a positive effect on technology adoption as it improves the financial capability of the farmer to adopt the crossbred.

10. **Market distance:** It is a continuous variable measured as the distance in kilometer (km) that the household travel to reach the nearby market. Those farmers having access to agricultural market have better market information. It hypothesized to have a positive contribution to the adoption of crossbred dairy cow.

11. **Distance from veterinary:** It is a continuous variable measured as the distance in kilometer (km) from the households head resident to veterinary center for treat their dairy cow if the cows were affected by diseases. Access to veterinary service is hypothesized to have a positive effect on technology adoption as it improves the financial capability of the farmer to adopt the crossbred.

Results

Table 21.Demographic and socio-economic characteristics of sample households

Variable	N	Minimum	Maximum	Mean	SD.
Crossbred cattle adoption (number)	180	0	1	0.50	0.50
Age of household head (year)	180	30	67	47.51	7.53
Educational background (grade)	180	0	10	1.14	2.65
Land holding (hectare)	180	0.03	1.50	0.59	0.27
Family size (number)	180	1	8	4.79	1.41
Livestock number per household in (TLU)	180	0.90	10.54	4.24	1.55
Distance from veterinary centre (km)	180	3	22	9.04	4.63
Market distance (km)	180	2	21	9.03	4.97

TLU=Tropical Livestock Unit (1 TLU = 250 kg of animal weight); SD= Standard deviation, N=Number of respondents.

Table 2. Summary statistics and mean difference test between continuous variables

Variables	Non-adopter(N=90)		Adopters (N=90)		Total (N=180)		t-test
	Mean	SD.	Mean	SD.	Mean	SD.	(p-value)
Age (year)	51.46	6.87	43.57	5.95	47.51	7.53	0.000***
Education (Grade)	0.13	0.64	2.14	3.42	1.34	2.65	0.000***
Landholding (hectare)	0.60	0.28	0.57	0.26	0.58	0.26	0.57(ns)
Total family size (number)	4.77	1.52	4.81	1.33	4.80	1.40	0.83(ns)
Livestock number /household (in TLU)	4.01	1.61	4.47	1.45	4.23	1.54	0.04**
Veterinary distance from the center (km)	8.71	4.45	9.25	4.874	9.04	4.63	0.34(ns)
Market distance from the center (km)	8.62	4.59	9.33	5.407	9.03	4.96	0.26(ns)
Total household Income (Birr)	24,691	8,690	34,288	11,105	29489	11046	0.000***

*** =P<0.01; **= P<0.05; ns=non-significant; N= Number of respondents; SD= Standard deviation, Conversion factor of TLU= See in the appendix (Table 1)

Table 3. Labor access, extension and credit service under smallholder farmers

Household profile		Non-adopter		Adopters		Total		X^2
		N	%	N	%	N	%	(p-value)
Gender	Male	82	91.1	60	66.7	141	78.9	0.000***
	Female	8	8.9	30	33.3	38	21.1	
Labour access	No	46	51.1	54	60.0	100	55.6	0.23(ns)
	Yes	44	48.9	36	40	80	44.4	
Extension service	No	35	38.9	10	11.1	45	25	0.000***
	Yes	55	61.1	80	88.9	135	75	
Credit service	No	29	32.2	13	14.4	42	23.3	0.05**
	Yes	61	67.8	77	85.6	138	76.7	

Significant level: *** =P<0.01; **= P<0.05; ns=non-significant; N= Number of respondents; SD= Standard deviation

Table 4. Source of income for adopters and non-adopters in the study area

Variable	Non-adopters			adopters			t-test (p-value)
	N	Mean	SD.	N	Mean	SD.	
Total household income (birr)	90	22,664	8216	90	30,123	10,607	0.000***
Off-farm activities	90	840	1734	90	2469	4506	0.002***
Total income from crop sale	90	13874	6257	90	16506	7074	0.009***
Income from livestock sale	90	4,529	1,374	90	7,878	2,341	0.000***

*Significant level:***= P<0.01; N= Number of respondents; SD= Standard deviation*

Table 5. Logistic regression results for adoption of crossbred cows

Crossbred dairy cattle	Coef.	Std. Err.	z	P>|z|
Age (year)	-0.2449238	-0.0486753	-5.03	0.000***
Gender)	-1.321076	0.6038682	-2.19	0.029**
Land holding (ha)	-0.0912935	0.8705266	-0.10	0.916
Educational status (grade)	0.5556762	0.1604682	3.46	0.001***
Family size (number)	-0.8010022	0.3218753	2.49	0.013**
Labour access	-2.615319	0.9486669	-2.76	0.006***
TLU (number)	0 .0389837	0.1608787	0.24	0.809
Distance veterinary (km)	0.0198604	0.1036661	0.19	0.848
Market distance (km)	-0.0015972	0.10271	-0.02	0.988
Extensions service	1.553224	0.5728089	2.71	0.007***
Credit service (birr)	1.44874	0.5740734	2.52	0.012**
constant	14.26617	3.410623	4.18	0.000

Significant level: ***= P<0.01 ***= P<0.05; Coef = Coefficient; Std. Err= Standard error deviation; z=; TLU= Tropical livestock Unit.

The region of common support is [0.01874656, 0.99988695]. In the logistic regression the common support condition is imposed and the balancing property is set and satisfied in all the regressions at (p<0.01) and (p<0.05) significance level. The reason for the positive contribution of those variables on the dependent variable and indirectly on the outcome variables could be those farmers having more experience on age, educational status, labour access and extension service at (P<0.01) significance level. Similarly, gender, family size and credit service were significant (p<0.05) probability level. This variation of variables contributes for increasing the production and productivity of livestock and their products in their income contribution for smallholder farmers.

Table 6. Income contribution on adopter of crossbred cows

Model	N. treats.	N. cont.	ATT	Std. Err	t-value
Nearest-Neighbor Matching	90	23	12459.98	2869.845	4.342***
Radius	4	4	16702.375	9457.660	1.77*
Kernel	90	73	10596.369	2511.835	4.219***
Stratification	90	59	668	1820.739	0.378(ns)

Significant level: ***= P<0.01; **=P<0.05, ns=non-significant; ATT=average treatment effect on treated; Std. Err= standard error

Discussion

Demographic and socio-economic characteristics of sample households

The household characteristics of the sampled respondents such as age, gender, land holding, education level, family size, availability of labor, livestock holding, veterinary distance, market distance, extension services, credit service and total income sources were assumed to affect introducing of crossbred dairy cows in turn the outcome variables such as income from out of agriculture, income from agriculture, income from credit services, income from livestock sale and total income of the households are (Table 1).

Descriptive statistics and mean difference test between continuous variables

The major variables which were hypothesized to influence for rearing of indigenous or crossbred cattle under smallholder farmers are presented in Table 2. The average age of household head was 51.46 and 43.7 for non-adopter and adopters of crossbred cattle were respectively. Similarly as shown in the Table 2, the mean educational level of sampled respondents was 0.13 and 2.14 for crossbred non-adopters and adopters respectively. Moreover, the average total income of sampled households was birr 29489. There was also statistical significant difference on the average age, education and average total income between crossbred adopter and non-adopters at (P<0.01). Moreover, the average number of livestock holding (in TLU) was 4.01 and 4.47 for non-adopters and adopters in that order with statistical significant difference at (P<0.05). This variation in holding of livestock per household was to feed access, cultivation of improved forage and keeping of improved breeds to enhance better production.

The average land holding in the study area was 0.60 and 0.57 ha for indigenous and crossbred cattle owners, respectively. Average land holding of the sampled household head was 0.58 in hectare (Table 2).

This average land holding size of sampled households indicated that small and this might be due to increasing population size.

In addition, the average family size of non-adopters and adopters were 4.77 and 4.81, respectively, (Table 2). The mean family size of the total sampled household in the study area was 4.80, which is lower than the national average of family size 5.2 persons per household (CSA, 2012). This decreasing average number of family size as compared to CSA (2012), this is due to the awareness on the family planning strategy.

Labor access, extension and credit services under smallholder farmers

The gender composition of sample respondents for non-adopter and adopters were 91.1% and 66.7% male household headed while, 8.9% and 33.3% were female household headed, respectively (Table 3). In addition to that the availability of extension service for non-adopters and adopters were 61.1% and 88.9%, respectively. Access to credit service for non-adopters and adopters in the study area were 67.8% and 85.6%, respectively. The descriptive analysis of Pearson's chi-square proportion difference test between non-adopters and adopters of crossbred cattle for dummy explanatory variables shows that statistically significant difference in terms of gender and extension services at (p<0. 01) level and credit services at (p<0.05) between non-adopters and adopters of crossbred cattle in the study area. This is due to the gender variation in participating of dairy production, effective extension service by extension agents, availability of credit to buy improved breed and introducing of zero grazing in order to efficiently use of man power on the adopters than non-adopters in the study area. Non–adopters use free grazing while adopters used to confine their animals in their house. Thus, Labour shortage problem can be solved in the study area by introducing of zero grazing of the adopters than non-adopters.

Source of income for non-adopters and adopters in the study area

The average total income of the respondents was 22,664 and 30,123 birr for non-adopters and adopters, respectively. This income was gained from different sources of income like off- farm activities (example petty trade, payment and food for work) 840 birr for non-adopters and 2469 for adopters, income from crop 13874 birr for non-adopters and 16506 birr for adopter, income from livestock 4,529 and 7,878 birr for non-adopters and adopters, respectively. The result showed there was statistically significant difference in terms of total income of household, income from livestock, income off-farm activities and income from crop at(p<0.01) probability level (Table 4).

Logit model determinants of crossbred dairy cow adopters

By using the binary logit regression model the important variables explaining adoption of crossbred dairy cow technology for market-oriented livestock production were identified. The results showed that out of eleven descriptive variables which were hypothesized to affect adopting of crossbred dairy cow and which in turn affects the outcome variables, only seven variables were found to be statistically significant while four of the variables out of eleven variables did not show significant variation on adopting of crossbred dairy cows in the study area (Table 5). The variables which showed significant variation on the adoption of crossbred cattle were age, gender, educational status, family size, labour access,extension services and credit service. However, variables such as; land holding, TLU, market distance and distance from veterinary centre were not affecting the adoption of crossbred dairy cow in the study area.

PSM of crossbred impact on income contribution for adopters

The estimation results which are presented in Table 6 provide a supportive evidence of statistically significant difference at different levels between adopters and non–adopters in terms of the total household income contribution. The average treatment of the treated (ATT) on per capita income for crossbred cow adopters were 12459.98 birr/annum from nearest-neighborhood, 16702.375 birr/annum radius matching method and 10596.369 birr/annum for kernel matching method was earned more income than non-adopters of cross bred dairy cows respectively. The total annual income household earned from the result shows that there was significant at (p<0.01) probability level for nearest-neighborhood and Kernel matching method and (P<0.10) for radius matching method. What's more, stratified matching method indicates that the average income earned from crossbred adopters was 668 birr/annum. While, the stratification matching did not result in significant (P>0.01) difference in the impact on households of adopting crossbred dairy cows on income contribution in the study area. In general, these results had shown significant effect on adopting of crossbred dairy cows on smallholder farmers' income.

The current result was in line with Getahun (2012), Quddus (2012) and Kassahun and Jeilu, (2012) who reported that the average income of adopters is 5427.17 birr/annum and exceeds the average income of the non-participants by 26% in the southern Region of Ethiopia, Bangladesh and Ada'a and Lume districts of central Ethiopia. The rate of milk yield was increase 1.32 times higher when the number of technology used by the farmers. It had greater contribution in milk yield and the dairy farm household's income in both districts of Ada'a and Lume districts of central Ethiopia. This is significantly raised due to adoption of dairy technologies about 92.9 % and

88.9 % of the respondents in Ada'a and Lume districts respectively. The higher income of those households is highly attributed to the sale of whole milk in Ada'a and Lume districts. Generally, the crossbred cows adopter of smallholder farmers had higher income than non- adopters smallholder farmer in the study area.

CONCLUSION

The results of the present findings of the descriptive analysis showed that there was a significant difference in income between non-adopters and adopters of crossbred dairy cow technology which indicated an improvement in the livelihood of farmers participating in adoption of cross breed dairy cows. Adopters of crossbred dairy cows were preferred in case of productivity, reproductively and income source from sale of live animal and their products at market. From this finding there by introducing of crossbred dairy cattle the genetic diversity of our cattle are conserved rather than distinction of indigenous breeds. The crossbred have 50 percent of local gene and 50 percent of exotic gene to maintain biodiversity of the animal genetic resources

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