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IMPACT OF COMMUNITY-BASED SHEEP BREEDING PROGRAMME ON FARM'S PROFITABILITY AND LAMB MORTALITY: THE CASE OF THE AKKARAMAN BREED

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ABSTRACT

This study aimed to evaluate the impact of Community-Based Sheep Breeding Program (CBSBP) on gross profit and lamb mortality by comparing participated farms and non-participated farms by focusing on the case of Akkaraman breed in Niğde province of Turkey. The primary data were collected from 108 sheep farms, 54 farms participated and 54 farms those did not participate in the sheep breeding program. According to average treatment effect results derived by utilizing propensity score matching method, if all farms would participate to CBSBP, each farm acquired 6209.13 Turkish Lira (1094.92 USD) more gross profit and would be 3.47% less lamb mortality rate in the farms. The study indicated that CBSBP provided significant economic benefit and welfare of animal. Hence, further supporting and scaling up of community-based small ruminant breeding programs appears to be one of the best solutions for improving livestock genetic resources of rural communities in developing countries. Accordingly, incentive mechanisms for participating in breeding programs should be more focused on small-scale family farms and especially the young people in the rural area.

Keywords: sheep farming, propensity score matching, counterfactual impact analysis, genetic improvement, profitability.

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INTRODUCTION

Sheep was domesticated for the first time in Anatolia, constitutes 78.54% (45.2 million head) of the small ruminants in Turkey (TURKSTAT, 2021). Turkey ranks eighth in the world in terms of sheep population and ranks second in the EU after England (FAO, 2020). Although Turkey has a great potential in terms of sheep breeding, no significant development has been achieved in the sector for nearly a century (Gürer and Ulutaş, 2021), and even the number of slaughtered animals decreased by 35.4% between 1991-2019 years (TURKSTAT, 2021). Besides, according to the Domestic Animal Diversity Information System of the Food and Agriculture Organization, 41 sheep breeds are listed in Turkey, out of these two indigenous breeds are reported to become extinct and 12 native sheep breeds are reported to be still facing the danger of extinction due to an unplanned crossbreeding program (Yılmaz, 2017; DAD-IS, 2021). Sheep breeding activity is distributed throughout the country, but it is widely carried out with low-yielding domestic breeds, and poor animal care and feeding. Low-yielding domestic breeds constitute approximately 94% of the sheep population in Turkey (Ceyhan *et al.,* 2015). Main reasons of low yielding in sheep rearing are the traditional breeding methods, insufficient genetic improvement programs, weak technical capacity of breeders and inadequate organizational structure.

The protection of native animal genetic resource is of a paramount importance for sustainability of genetic diversity and coping with the challenging climate change. However, conservation and genetic improvement of livestock species continues to be a challenge for developing countries because of necessity of a high input, intensive labour, and supportive institutional regulations. In developing countries, domestic livestock populations are being reared predominantly by smallholders under traditional husbandry practices (Bhuiyan *et al.*, 2017). Besides, in developing countries, without or low farmers' participation in the breeding programs from the design to implementation had resulted in programs failing (Wurzinger *et al.,* 2011). Hence, the community-based breeding programs have displayed as more sustainable and viable for protection and simultaneous genetic improvement of indigenous livestock under smallholders farming system in developing countries (Philipsson *et al.,* 2006; Wurzinger *et al.,* 2011).

Therefore, to solve the main problems of sheep breeding practices and ensure *in-situ* conservation of national local genetic resources in Turkey, community-based small ruminant breeding program was initiated by the Ministry of Agriculture and Forestry of Turkey (MoAF) in 2005. The program has been implemented in whole Turkey and individual farmers as well as national partners are participating in it.,.

On the other hands, in recent years, the programme evaluations have been assigned particular importance for increasing effectiveness and efficiency of policy interventions. However, the fundamental problem arises from the fact that the effect of the policy intervention on groups affected by the programme cannot be directly observed in non-experimental evaluation studies (Michalek, 2012). The literature has long recognized that impact evaluation is essentially a problem of missing data (Ravallion, 2005; Goldstein, 2007) and therefore, determining the counterfactual is widely considered the core of each evaluation design. In this context, researchers have examined the effects of community-based livestock breeding programs from various aspects. Much of studies on this issue have focused on investigating the impact of community-based breeding program on physiological traits of animals such as growth and reproductive performance (Haile *et al.*, 2010; Solaiman *et al.,* 2020; Yakar, 2019). A few studies have examined the effects of the programs on the general characteristics, care and feeding practices of farms (Yapar, 2020; Zengin, 2020). Gebre *et al.* (2014) evaluated the potential consequences of community-based sheep breeding program on herd dynamics. Some studies focused on the relevance, experiences and scaling up strategies of community-based small ruminant breeding programs in different regions of world (Mueller *et al.,* 2015; Mueller *et al.,* 2019; Kaumbata *et al.,* 2020a; Kaumbata *et al.,* 2021; Manirakiza *et al.,* 2021)

However, the effect of community-based livestock breeding program on both economic and structural aspect of farms by implementing a counterfactual situation is poorly documented. Hence, the novelty of the present study was aimed to evaluate the impact of Community-Based Sheep Breeding Program (CBSBP) implemented in Niğde province of Turkey on gross profit and lamb mortality by comparing participated farms and non-participated farms by focusing on the case study of Akkaraman breed. Another distinct feature of the study was providing a deep insight to analyse to what were the determinants affected the farmers' decision in participating in CBSBP. This study may be helpful for guiding policy makers in designing effective community-based livestock breeding programs.

MATERIALS AND METHODS

With the implementation of the national sheep breeding program under farmer conditions in Turkey, the breeders were directed to an organized production style. For this purpose, national stakeholders and breeders were brought together for the development of sheep breeding strategy. Sheep breeders actively participated in the work carried out to increase the productivity of their animals. During the program studies, while the breeders had the opportunity to increase their technical knowledge and experience, they played an important role in data collection, a pre-requisite of every breeding program.

Data for selection is collected by technical staff in each sub-project. Principle of the program is based on pure breeding and basic selection methods (Figure 3). Animal materials of the programme consists of 3 main groups: elite, semi elite and base flocks. Elite flock under full control provides high quality rams for the semi elite and base flock (Daskiran and Ayhan, 2014). The best female or male lambs from base flock are transferred to upper flock. The selection of the best animals in the herd is based on features such as the animal's phenotypic characteristics, pedigree record, live weight and birth weight (Anonymous, 2015). In this way, breeding strategy follows an open nucleus breeding system based on individual performance of animals. Farmers and technical staff record all mating activities. The project leader selects the parents of next generation based on the collected data. Sheep breeders are supposed to rotate rams among flocks. Breeders must be registered to with the provincial Sheep and Goat Breeders Association to participate in the project (Daskiran and Ayhan, 2014).

The minimum number of ewes required in a farm should be 80 heads. In each sub-project, it is aimed to have a sufficient number of elite ewe, which controlled mating is carried out and pedigree records are kept (MoAF, 2020). Within the scope of the programme, incentive payment has been made to the breeders since 2005. The payment in 2020 was 70 Turkish Lira[1] (12.34 USD) per lamb for the elite flock, 40 Turkish Lira (7.05 USD) per lamb for the base flock and 200 Turkish Lira (35.27 USD) per ram in 2020 (MoAF, 2020). The number of sheep in the programme increased from 8300 heads in 2005 to approximately 1.2 million heads in 2020.

Sources of data and study area: The study was carried out in the province of Niğde in Turkey. According to TURKSTAT (2021) data, there were approximately 615 thousand sheep in the province of Niğde in Turkey. Sheep breeding is intensively carried out in the province. The required primary data were obtained from the face-to-face survey conducted with sheep breeders who were

[1] 1 USD= 5.67 Turkish Lira (TL) at the time of the study

non-participated and participated in Niğde Akkaraman 1 and Niğde Akkaraman 2 sub projects of Community-Based Sheep Breeding Programme (CBSBP).

The Stratified Random Sampling method of Yamane (1967) was used to determine the sample size. The farmers were divided into two strata: participating in CBSBP as the treatment group and non-participating in CBSBP as the control group. In total 108 sheep breeding farms were selected as sample, whereby 54 farms corresponded to treatment group and 54 farms corresponded to the control group in the study.

Description of analytical model: The identification of the effect of the programme on the outcome variables requires development of a meaningful counterfactual, i.e., the potential outcome of farmers who participated had they not participated at all. Therefore, a non-parametric propensity score matching approach first proposed by Rosenbaum and Rubin (1983) is widely used when evaluating government programmes to identify cause-effect relationship (see e.g. Michalek, 2007; Michalek, 2009; Pufahl and Weiss, 2009; Çobanoğlu *et al.,* 2017; Namiotko *et al.,* 2019).

In this study, the policy evaluation parameters (ATET and ATE) were calculated on the basis of estimated propensity score matching using to evaluate the effects of CBSBP on our outcomes of interest (lamb mortality and gross profit) in Turkey for Akkaraman breed. The method is outlined and discussed in the following section.

Propensity score matching (PSM) method: Estimation of propensity score is the first step in PSM technique. In the case of non-experimental studies, the propensity score must be estimated by using a logit or probit model (Lopez *et al.,* 2017). Therefore, in this study, a binary logistic regression was used. The general form of the logit model is written in Equation 1:

$$L_i = \ln\left(\frac{P_i}{1-P_i}\right) = \beta_0 + \sum_{j=1}^{m} \beta_i X_{ij} \quad (1)$$

where P stands for the probability of participation in CBSBP, X represents the independent variables, β denotes the regression coefficients.

Next, a binary logit regression produced propensity values. The propensity value is the probability value if a farm does not participate in CBSBP. The propensity score was defined as the “coarsest” balancing score b (X), where (X) is “a function of observed covariates X such that the conditional distribution of X given (X) is the same for the treated and control units”, $X \perp T \mid (X)$ (Lopez *et al*., 2017). Two assumptions are essential for constructing a valid control group by using the propensity score. These are the conditional independence assumption and overlap assumption.

The conditional independence assumption states that treatment assignment is independent of potential outcomes after conditioning on a set of observed co-variates (Guo and Fraser, 2015) and it is specified in Equation 2:

$$(Y_{0i}, Y_{1i}) \perp (D_i|X_i) \quad (2)$$

where Y_{1i} indicates the outcome if the i_{th} unit was treated (participated in CBSBP), Y_{0i} stands for the outcome if the i_{th} unit was not treated (non-participated in CBSBP), D_i represents a binary variable that equals 1 if the i_{th} unit was treated (participated in CBSBP) or 0 otherwise, X_i denotes a vector of observed characteristics for the i_{th} unit (Namiotko *et al.,* 2019).

The overlap assumption implies that there is overlap in the covariate distributions between the participated and non-participated in CBSBP and it is formulated in Equation 3:

$$0 < P(D_i = 1|X_i) < 1 \quad (3)$$

Groups are then matched based on propensity scores. In Equation 4, the propensity score (Xi) is formally described as unit i’s conditional probability of being treated, given a set of known and observable pre-treatment covariates Xi (Rosenbaum and Rubin, 1983).

$$e(X_i) = Pr(D_i = 1 \mid X_i) = E(D_i \mid X_i) =$$
$$e(X_i) = pr(D_1 = d_{1 \ldots\ldots} d_n | X_1 = x_1 \ldots\ldots x_n) = \prod_{i-1}^{N} e(x_i)^{d_i}\{1-e(x_i)\}^{1-di} \quad (4)$$

Calculating average treatment effect: The impact of participation in CBSBP for individual farm i, noted δi, is determined as the difference between the potential outcome in case of participation in CBSBP and the potential outcome in case of non-participation in CBSBP and it is formulated in Equation 5:

$$\delta_i = Y_{1i} - Y_{0i} \quad (5)$$

Comprehensive assessment of CBSBP’s impact requires separation of various programme effects of which the most important are:

a) Effect on an average group randomly selected from the pool of CBSBP’ participants and nonparticipants (Average Treatment Effect – ATE).

b) Effect on groups which participated CBSBP (Average Treatment Effect on the Treated - ATET)

In general, according to Equation 6, the mean impact of the programme is acquired by averaging the impact across all the individuals in the population and is known as Average Treatment Effect or ATE:

$$ATE = E(\delta)=E(Y_{1i} - Y_{0i}) = E(Y_{1i} \mid D=1) - E(Y_{0i} \mid D=0) \quad (6)$$

where E(δ) indicates the average or expected value.

However, considering the non-experimental nature of this study, sheep breeders (termed as farmers throughout the text) who are participated in CBSBP may differ systematically from non-participated farmers in CBSBP. Thus, evaluating the impact of CBSBP needs for a distinct econometric approach to conduct a counterfactual scenario for participated farmers. In consistent with evaluation literature (Imbens and Rubin, 2015), the average treatment effect on the treated (ATET) was estimated by employing propensity score matching method. The ATET may be written in Equation 7 as:

$$ATET = (Y_i1 - Y_i0 \mid D_i = 1) = E(Y_{1i} \mid D_i=1) - E(Y_{0i} \mid D_i=1) \quad (7)$$

Conditional independence puts forward that treatment assignment is essentially independent of the potential outcomes when adjusting for differences in observable pre-treatment covariates (Rubin, 1990). On the other hand, the overlap assumptions imply that there is a positive probability of being treated and not treated for each set of pre-treatment covariates (Lopez *et al.,* 2017). Rosenbaum and Rubin (1983) term "strong ignorability" if both assumptions are valid. Therefore, Equation 7 may be rewritten in Equation 8 as:

$$ATET = E(Yi1 \mid Di = 1) - E(Yi0 \mid Di = 1) = E[E\{Yi1 - Yi0 \mid Di = 1, e(Xi)\}] = E[E\{Yi1 \mid Di = 1, e(Xi)\} - E\{Yi0 \mid Di = 0, e(Xi)\} \mid Di = 1] \quad (8)$$

Definition of variables: Data for socio-economic and farming characteristics of farms collected to compare the control and treatment groups in the model. Considering of economic theory, priorities and previous studies are crucial in determining the variables to be included in the model (Blundell *et al.,* 2004). Hence, the variable selection to be added to the analyses was decided according to the model that gave the best goodness of fit, considering the aforementioned issues. The variables used in the model were presented in Table 1. In the model, the dependent variable was the participation in CBSBP. Farmers who participated in CBSBP were given a value of 1 and those who did not participated in CBSBP were given a value of 0. There were two outcomes that it was hypothesized to be affected by CBSBP discussed above. These were gross profit value per animal unit and lamb mortality rate. The independent variables that were suspected to influence the participation of farmers in CBSBP, consisted of seven components: the age (years) and education of farmer (years), farmer's experience of sheep breeding (years), the size of the herd in terms of AUE (Animal Unit Equivalent), the ratio of family labour use in the total labour use in sheep breeding (%), grazing duration for a year (days) and the proportion of supports received for sheep breeding in gross income (%).

To calculate gross profit, total annual variable costs of sheep breeding were subtracted from total annual gross income of sheep breeding. The annual gross income of sheep breeding consisted of the cash receipts of the income acquired from animal sales, milk sales, manure, wool, and stock residual value. All variables of the model were calculated as an Animal Unit Equivalent (AUE) to adjust the different kinds and classes of livestock in a common form (Gürer, 2020). The AUE coefficients used in the study were established according to the Pasture Regulation no 1998/23419 (Anonymous, 1998). Lamb mortality rate was calculated by dividing the number of lambs died in the flock by the total number of lambs born for one year.

Herd size was calculated as Animal Unit Equivalent for each farm. The variables of farmer experience, age and education were calculated as number of years. Grazing duration for sheep breeding was expressed as the days spent on the pasture for one year. Family labour using was taken as the percentage of man-days of family members spent on sheep breeding in total labour force of sheep breeding for one year. For each farm, the share of sheep breeding subsidies received (included the incentives for CBSBP) in total gross income was taken as the subsidy rate.

RESULTS

Characteristics of farmers and factors influencing farmers to participate in CBSBP: The descriptive statistics of the means and the differences in means for participating farms and non-participating farms of CBSBP in the study areas are given at Table 2. The table indicated that the means of both outcome variables (gross profit per AUE and lamb mortality rate) were significantly different between participating and non-participating farms before matching was done ($p<0.05$). A comparison of annual gross profit per AUE from sheep breeding revealed that participated farms in CBSBP earned 4576.75 Turkish Lira (807.07 USD) on average, while non-participated farms earned of 3683.04 Turkish Lira (649.47 USD). Family labour using and feed costs per AUE for non-participated farms in CBSBP were found to be higher than the farms involved in CBSBP, while the annual gross income values were calculated close to each other for both groups. This implied that the resources were not used effectively in farms that did not participate in CBSBP. Lamb mortality rate for participating farms (6.56%) was lower than those who did not participated in CBSBP (10.41%).

Other variables such as herd size, farming experience, farmer' age, family labour using in sheep breeding, grazing duration and subsidy rate in gross income had means which differed significantly between two groups ($p<0.05$). According to the table, these results implied that farmers participating in CBSBP had more herd size per AU, farming experience, benefited more from subsidies for sheep breeding, and older than non-participants of the programme. Moreover, participating farms used less family labour and benefited less from pastures during the year than those who did not.

The existence of significant difference between the two groups for selected variables suggests that they may have an influence on farmers participation in CBSBP. It is therefore important to use econometric analysis to understand motivation for participation.

Conditional probabilities for participation in CBSBP were computed by estimating a binary logit model. The results of the logistic regression model were given in Table 3. The coefficient of determination (R^2)

was computed using Cox and Snell R^2 and Nagelkerke R^2 tests to check the association of variables in the model. The values of Cox & Snell R^2 and Nagelkerke R^2 was found to be 60% and 80%, respectively by indicating a strong association of selected independent variables with dependent variables. The Log likelihood (-2LL) value corresponding to R^2 in the multiple regression was computed as 50.832 and the model was found to be statistically significant at a 1% level ($p<0.01$). The significance of value of Hosmer-Lemeshow (H-L) test was found as 0.079 which was greater than 0.05, indicating that the goodness of fit of the model was acceptable. The overall rate of correct classification was estimated to be 93.5%.

According to the logit regression model, only the variable of incentives payments received by farms in the scope of sheep breeding was found to be significantly related to participation in CBSBP ($p<0.01$). In other words, it was clear that one unit increase in amount of supports received by the farmers was associated with an increase of 2.24 times in the probability of participation of CBSBP.

Table 1. Variable description.

Variables	Explanation
Dependent variable	Program participation (D=1 for CBSBP participation and D=0 for otherwise)
Output variables	
GP	Gross profit (Turkish Lira/AUE)
LMR	Lamb mortality rate (%)
İndependent variables	
AGE	Farmer's age (years)
EDU	Farmer's education level (years)
EXP	Farmer's experience (years)
HS	Herd size (AUE)
FLU	Family labour using in total (%)
GD	Grazing duration (days)
RSGI	Subsidy rate in gross income (%)

Table 2. Descriptive statistics of variables used in the study

Variable	Participating farms mean (S.D.)	Non-participating farms mean (S.D.)	Difference in mean (p-value)
Outcome Variables			
GP (Turkish Lira)	4576.75 (807.07) (2695.97)	3683.04 (649.47)	893.71
(Equivalent USD)		(2132.44)	(157.60) (0.033)*
LMR	6.56 (3.18)	10.41 (4.69)	-3.85 (0.000)*
Independent Variables			
Herd size (AU)	33.97 (14.59)	22.58 (14.43)	11.39 (0.000)*
Farmer's experience (years)	25.72 (11.94)	19.37 (10.73)	6.35 (0.004)*
Education (years)	6.37 (2.67)	6.72 (2.48)	-0.35 (0.221)
Age (years)	45.33 (11.54)	40.00 (11.39)	5.33 (0.017)*
Family labour using in total (%)	80.22 (18.24)	93.07 (10.20)	-12.85 (0.002)*
Grazing duration (days)	235.00 (59.24)	248.89 (11.72)	-13.89 (0.007)*
Subsidy rate in gross income (%)	10.66 (3.05)	1.89 (2.51)	8.77 (0.001)*

* Indicate statistical significance at 5% level
S.D. Standard Deviation

Impact of CBSBP on Gross Profit and Lamb Mortality of Farms: Propensity score matching analysis, which is one of the counterfactual situation analyses methods, was used to reveal the net effect of the CBSBP on the gross profit and lamb mortality rate in the farms in the study. Propensity scores matching values which are obtained by logistic regression model were given in Table 4. According to the Table 4, CBSBP had statistically significant effect on all outcome variables (the gross profitability and lamb mortality rate). The average treatment effect (ATE) from the propensity score matching estimator is the average of the differences between observed and potential outcomes. The average treatment effect (ATE) for CBSBP participants on the gross profit of farms had a positive and statistically significant ($p<0.01$). The result of ATE for gross profit indicated that the participation in CBSBP had a higher gross profit by 6209.13 Turkish Lira (1094.92 USD) for whole farms. The average treatment effect on the treated (ATET) for gross profit indicated that, the gross profit value of a farm which was participated in CBSBP (in treated group) increased by 1551.42 Turkish Lira (273.58 USD) when compared with the case that it was not participated in CBSBP. This effect was statistically significant at %5 importance level.

Similarly, CBSBP had a decreasing and significant impact on lamb mortality rate in the farms (p<0.01). According to Table 4, it was found that the effect of CBSBP decreased the lamb mortality rate in flock by 3.47% for all sample farms. Specifically, the estimate of the average treatment effect on treated (ATET) showed that farms that participate in CBSBP had on average, less lamb mortality rate of 2.78% than those who had not participated in CBSBP.

Table 3. Logistic regression model results

Variables	Coefficient	Std. Err.	P-value	Odds Rate	95% Conf. Interval	
					Lower	Upper
Constant	-5.316	2.878	0.055*	0.005	0.000	13.128
AGE	-0.039	0.059	0.513	0.962	0.857	1.080
EDU	-0.121	0.164	0.461	0.887	0.643	1.223
EXP	0.083	0.055	0.126	1.087	0.977	1.210
HS	0.013	0.028	0.625	1.013	0.960	1.070
FLU	-0.003	0.016	0.844	0.997	0.966	1.028
GD	0.001	0.010	0.954	1.001	0.980	1.021
RSGI	0.804	0.153	0.000**	2.235	1.627	3.070

* p<0.10, ** p<0.01; Hosmer Lemeshow p=0.079, Negelkerke R^2=0.80

Table 4. Propensity score matching method results

Output variables	Impact parameters	Coefficient	Standard Error	z value	P value	%95 Confidence Interval	
						Down	Upper
Gross profit	ATE	6209.13	70.52	88.05	0.00**	6070.91	6347.35
	ATET	1551.42	768.10	2.02	0.04*	45.96	3056.88
Lamb mortality rate	ATE	-3.47	0.46	-7.53	0.00**	-4.38	-2.57
	ATET	-2.78	0.46	-6.00	0.00**	-3.68	-1.87

* *p<0.05,* ** *p<0.01*

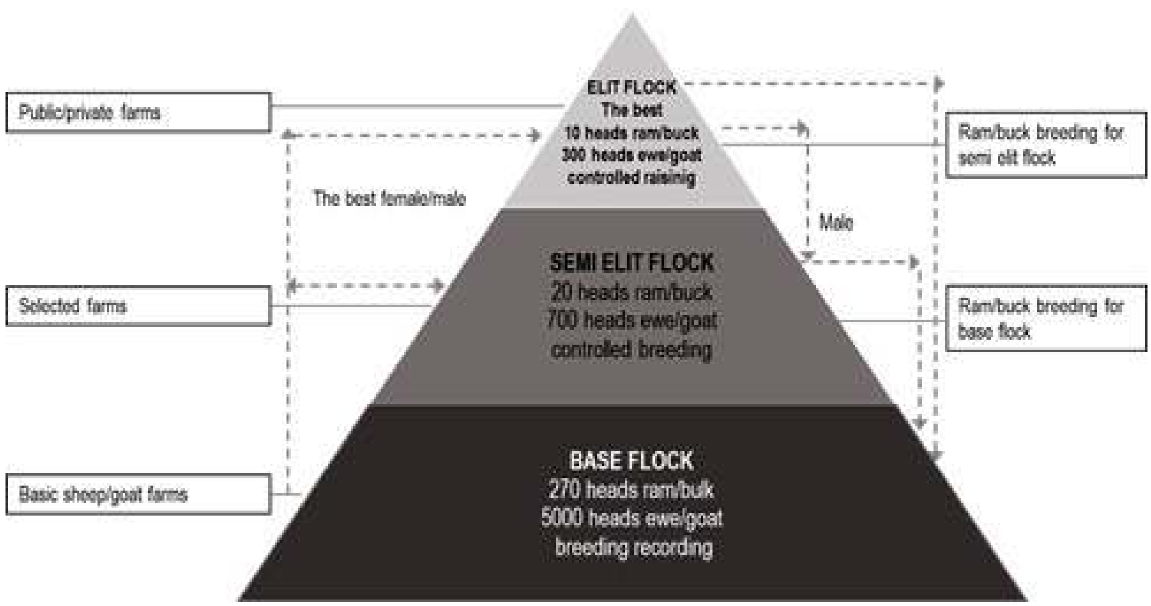

Figure 1. The structure of the national sheep and goat breeding program of Turkey. Source: Daskiran and Ayhan, 2014.

DISCUSSION

According to the result of the logit analysis, incentives for sheep breeding significantly influenced the farmers' participation in CBSBP. The experiences gathered from other CBBPs highlight the ongoing need for full technical support and external financing in the successful implementation of community-based small ruminant breeding programs (Iniguez, 1998; Kosgey and Okeyo 2007; Wurzinger *et al*. 2011; Mueller *et al.* 2015; Weldemariam and Mezgebe 2020).

The results derived from the propensity score matching method indicated that farmers' participation in CBSBP had a statistically significant positive effect on profitability and lamb survival in the flock. The value of the coefficient of the Average Treatment Effects for whole sample (ATE) independence and self-sustained programmes are almost impossible in smallholder systems are better than the Average Treatment Effects for treated farms (ATET) for both gross profit and lamb survival status. This finding indicates that higher incomes and lower lamb mortalities implies a positive impact of participation in CBSBP on wellbeing of overall farms. These findings confirm with other studies in the literature (e.g. Haile *et al.* 2020; Weldemariam and Mezgebe 2020; Kassie *et al.* 2021; Wurzinger *et al.,* 2021; Habtegiorgis *et al.* 2022) which shows that community-based breeding programmes participation boosts the profitability of farms and welfare of animals.

Many studies have reported that community-based small ruminant breeding programs can help local communities generate income sustainably and encourage local community participation by better addressing local needs (Haile *et al.,* 2011; Mirkena *et al.,* 2012; Haile *et al.,* 2020; Kaumbata *et al*., 2020b; Haile *et al*., 2023). In this regard, community-based small ruminant breeding programs can contribute more to the strengthening of the local economy compared to other genetic improvement programs. This contribution primarily becomes possible through achieving genetic improvement. Community-based breeding programs aim to enhance the genetic characteristics of local animal breeds. Animals with better genetic traits can offer advantages such as higher reproductive rates, faster growth, and better production productivity. This can increase the quantity of products produced per animal and, consequently, enhance income. Previous studies indicated that community-based breeding programmes focusing on local genotypes were being advocated as the strategy of choice for genetic improvement of small ruminants (Sölkner *et al.,* 1998; Kosgey and Okeyo, 2007; Haile *et al*., 2011).

In addition to genetic improvements, community-based breeding programs offer farmers opportunities for education and capacity development in animal care, and disease management. Participating farms in CBSBP have been provided the supports such as regular record keeping in the farms, technical information in matters such as herd management, animal feeding and care by the experts in cooperation with the ministry, association, and universities. Therefore, the most important contribution of the programme to the farms was to provide the decreasing of production costs by ensuring the efficient resource using. Through improved nutrition, health services, and animal housing, it is possible to ensure that the animals have better health conditions and higher productivity. Haile *et al.* (2020) found that the implementation of CBBP significantly affected the husbandry practices of the participants which in turn maximizes the flock size and quality per household. Mustafa *et al.* (2014) stated that controlled breeding and better management before lambing and care of lambs from birth to four months of age can play an important role in reducing the mortality. At the same time, healthier animals in participant farms can prevent income losses by reducing veterinary costs. Similarly, Mirkena *et al.* (2012) and Weldemariam and Mezgebe (2020) documented the positive impact of CBBP in improving smallholder livelihoods through performance traits improvements.

Moreover, community-based breeding programs can enhance the capacity of animals to better adapt to local environmental and climatic conditions. This, in turn, enables to respond better to market demand with higher-quality and more productive animals. In other word, it provides farmers the opportunities to sell their products at higher prices and to sell more sheep. The present study showed that participant farmers earned more income from sheep sales compared to non-participant farmers. This finding is consistent with Haile *et al.* (2020) and Habtegiorgis *et al.* (2020).

Besides, community-based livestock breeding programs can bring local communities together, promoting collaboration and solidarity. Through joint projects and cooperatives, farmers can access larger markets and make bulk sales. Gutu *et al.* (2015) stated that cooperatives had better management and financial resources, better selection and management of breeding rams and the sustainability of CBBP largely depended on effective and well-functioning breeder cooperatives.

Conclusion: The community-based livestock breeding programmes are an emerging method for both the sustainability of genetic diversity of the livestock species and increasing of the livelihoods of farmers. Therefore, this indicates that CBBP not only contribute to increased income but also have the potential to development of local communities. Participating farmers in these programs acquire better skills in managing their livestock and effectively controlling diseases. As a result, this not only enhances food security within families but also broadens their access to trade and markets. Accordingly, providing the incentive mechanisms, empowering of breeder associations or similar bodies and their joint actions have substantial importance in ensuring the sustainability of CBBP in developing countries.

Major limitations of the study are the relatively small sample size, lack of physiological data records on growth performance of animals in control group farms and studying of a single breed because of shortage of time and financial source. Further, studies are needed to evaluate the long-term effects of CBSBP on more genetic parameters and profitability of farms to make possible better comparability.

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