FACTORS AFFECTING THE FARMERS' DECISION ON ARTIFICIAL INSEMINATION: A CASE STUDY OF DIYARBAKIR PROVINCE, TURKEY

AKIN, S.* – KARA, A.

Department of Agricultural Economics, Faculty of Agriculture, Dicle University
21280, Sur/Diyarbakır, Turkey
(phone: +90-412-241-1000; fax: +90-412-241-1048)

**Corresponding author*
e-mail: sakin@dicle.edu.tr

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Abstract. The objective of this study was to determine the factors affecting farmers' decision-making on artificial insemination (AI) to improve milk and beef yields of low-yielding local cattle breeds in Diyarbakir province of Turkey. Primary data were obtained from 546 breeders randomly selected among members and non-members of the Cattle Breeders Association of Diyarbakir Province (DCBA) through structured questionnaires completed during face to face farmer interviews. Descriptive statistical analysis and logistic regression methods were used in the analysis of the data. A significant relationship was found between membership status and AI. However, there was no statistically significant difference between DCBA members and non-members on the willingness to apply AI in case of no government support. Government incentives, number of cross- and purebred cattle, and DCBA as the source of information have a positive significant effect on the willingness of the farmers to employ AI, while breeder age, distance from the closest city centre, farm family size, and share of the crop revenue in the total revenue have a negative effect on the adoption of AI.
Keywords: *cattle breeders, artificial insemination, breeder unions membership, logistic regression, Diyarbakır*

Introduction

Historically, artificial insemination (AI) is the first generation of modern reproductive biotechnologies (Thibier, 1990) and has become one of the most important techniques in livestock to achieve genetic improvement. It has widely been used as the most available management practice for cattle breeders, in addition to making high-genetic-merit bulls available to all (Webb, 2003; Bearden et al., 2004).

Besides genetic improvement, prevention of reproductive diseases, and inbreeding control, another advantage of AI is the provision of accurate breeding records; i.e., insemination dates, pregnancy rates, interestrus intervals, and days to first service (Sinishaw, 2004).

Artificial insemination in many countries started with state orientation. For example, In 1987, BRAC (formerly the Bangladesh Rehabilitation Assistance Committee), together with the aid agency Bangladesh Animal Husbandry Department, began to work on a vaccination program that educates money veterinarians from rural communities that will serve farmers in the local environment (BRAC, 2015).

Artificial-insemination practices started in the 1930s in Turkey. After the private sector was authorized to perform AI in 1985, it gained momentum (Gökçen, 1998) and is widely used today (Aksoy et al., 2012).

Livestock support policies have been implemented in different periods with various weights, and there have been important changes in these policies after 2000. During the

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period of 2004 and 2008, forage crops, milk-incentive premium, artificial insemination, and calf supports became the most important fostering items (Demir and Yavuz, 2010).

In 2016, of the total milk and meat production in Turkey, the share of Diyarbakir was 2.3% and 0.8%, respectively (TUIK, 2016). The Diyarbakir cattle asset consists mainly of 32.36% low-yielding native breeds, 38.72% crossbreeds, and 28.90% pure breeds (TUIK, 2016). Sustainable and economic animal production depends on the availability of high-yielding cattle breeds and, therefore, quality calves (Yavuz, 2011).

While the number of artificial insemination procedures was more than 40,000 in 2015, it decreased to 7,000 after the abolition of AI support in 2016 in Diyarbakir province (DCBA, 2016).

The purpose of this study was to determine the factors affecting the willingness of cattle breeders to employ AI in Diyarbakir province.

Material and methods

Materials

Diyarbakir province is located at 37° 57' 41 N latitude and 40° 13' 54 E longitude, in the southwest region of Turkey. The primary material of the study was the data obtained from 546 cattle breeder members and non-members of DCBA between the years 2014-2015. In addition, official records of the Diyarbakir Agriculture Provincial Directorate were also used as secondary data (*Fig. 1*).

Figure 1. *Map of districts in Diyarbakir province*

Methods

The simple random sampling method was used to determine the sample size. To this end, *Equation 1* for finite populations was employed (Çiçek and Erkan, 1996):

$$n = \frac{N \times s^2 \times t^2}{(N-1) \times D^2 + s^2 \times t^2} \quad \text{(Eq.1)}$$

Where:
n = sample size,
s = standard deviation,
t = standard t value at the confidence level considered;
N = size of sampling frame, population, total number of DCMBA members;
D = margin of error as the percentage of population mean.

The parameters used in determination of the sampling size were calculated according to the DCBA records and given in *Table 1*.

Table 1. *The parameters used in determination of sample size*

Sampling frame	Mean (X)	Standard deviation	Margin of error
2045	15.90	10.62	1.59

Sampling sizes for DCMBA members and non-members were calculated separately at 95% confidence level, by adopting 10% of the population mean as the margin of error. Accordingly, the number of sample size was calculated as follows (*Eq. 2*).

$$n = \frac{2045 \times (10{,}62)^2 \times (1{,}96)^2}{(2045-1) \times (1{,}59)^2 + (10{,}62)^2 \times (1{,}96)^2} \quad \text{(Eq.2)}$$

Considering the possibility of the questionnaires being disregarded due to inconsistent data, the calculated sample size was increased by about 5% and the final sample size reached to 167 for DCBA-member cattle breeders. Surveys were conducted with a total of 546 breeders of which 167 were DCBA members, while the rest (379) had no membership in any union or association.

Descriptive statistical analysis and logistic regression methods were used in the analysis of the data. The former was used to determine the current situation of the farmers, as the latter was adopted to determine the factors associated with the willingness of the cattle breeders to employ AI.

In econometric studies, limited dependent variable regression models are used when the dependent variable is qualitative, indicating two states which refers to the presence or absence of an event. In case of occurrence of an event, the dependent variable takes the value of 1, or zero otherwise. There may be many independent variables describing the dependent variables (Gujarati, 1995; Yavuz, 2001). Three types of methods are used to predict such models. The first is the linear probability method, the second is the logit method, and the third is the probit method.

In this study, the "limited dependent variable" regression model and the logit estimation method were used to determine the factors affecting the willingness of the breeders to employ AI (Gujarati, 1995; Akkaya and Pazarlioğlu, 1998). In the present study, the dependent variable has two outcomes or two categories of responses: 1: adoption of AI and 0: non-adoption of AI. The "logit model" as described above is expressed as follows (*Eq. 3*):

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$$P_i = E(Y=1|X_i) = \frac{1}{1+e^{-(\beta_1+\beta_2 X_i)}} \quad \text{(Eq.3)}$$

For the ease of illustration, the formula could be shown as follows (*Eq. 4*):

$$P_i = \frac{1}{1+e^{-Z_i}} \quad \text{(Eq.4)}$$

in which (*Eq. 5*)

$$Z = \beta_1 + \beta_2 X_i \quad \text{(Eq.5)}$$

Pi gives information about the explanatory variable (Xi) and i refers to the possibility of the individual making a certain preference. The model can be tested by the LR (k) (likelihood ratio) test with k degrees of freedom.

The marginal or partial effect measures the effect of (xi) on any one of the independent variables on the mean of the dependent variable y. The marginal effect of an independent x variable is the partial derivative taken with respect to x and is equal to the slope coefficient of the independent variable in the linear regression models. This greatly simplifies analysis in such models. However, interpreting the results of regression analysis can be very difficult in non-linear models such as interactions, categorical variables, or logistic regression, as used in the present study. In such models, it is necessary to see the effect of the independent variables on the dependent variable to interpret the calculated coefficients, in most cases. The calculus and finite difference methods are used in the calculation of the marginal efficiency and the result is not changed in either method, but the finite difference method gives better results in binary variables (Cameron and Trivedi, 2010). In this way, the partial (marginal) effects of independent variables on the dependent variable are calculated according to the finite difference method, in this study. The variables considered in the study were explained in *Table 2*.

Table 2. *Explanations for the variables considered in the study*

Breeder age	Age of the respondents in years
Schooling	Education level of the respondents in schooling years
Household size	Number of people in household of the respondent
Distance to the nearest town	Distance of the respondent's village to the nearest town in km
Milk sales	Status of the respondents if he or she sales milk, if yes 1, otherwise 0
Make use of pastures	Status of respondent's making use of pastures (1 = yes; 0 = otherwise)
Barn type	Type of the barn respondent has (if free stall or half open 1; otherwise 0)
Source of agricultural information	
DCBA	If DCBA, 1; otherwise, 0
Neighbours	If neighbours, 1; otherwise, 0
TV	If TV, 1; otherwise, 0
Agricultural agencies	If agricultural agencies, 1; otherwise, 0
Own experience	If respondent's own experience, 1; otherwise, 0
Source of income	If agriculture is the respondent's primary source of income, 1; otherwise 0
Government supports	Status of making use of govt. supports if: yes, 1; otherwise, 0
AI employment	Status of using artificial insemination If yes, 1; otherwise, 0

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Prior to the regression analysis, correlation analysis was performed to determine the variables to be included in the regression analysis. The correlation matrix is measured by a large number of variables. It can be explained as variable statistics that combine the variables associated with each other to measure and describe these variables with a single variable, thus reducing the variable and allowing the structure to be measured in this way (Stapleton, 1997).

Results

In the study, the mean age of the respondents was 43.74 and 46.61 years for member and non-member breeders respectively, as illiteracy rate of the two groups of breeders were 45.00% and 57.53% in the same order. The distance to the nearest town was 44.05 and 43.47 km for both groups, respectively (*Tables 3* and *4*).

Table 3. *The demographic structure of the producers*

Education status						Family size					
	DCBA		Non-members		Total	Person	DCBA		Non-Members		Total
	N	%	N	%	N		N	%	N	%	
Uneducated	76	45.50	218	57.52	294	1-5	63	37.72	107	28.23	216
Primary	69	41.30	129	34.04	198	6-9	81	48.51	166	43.80	322
High	15	9.00	21	5.54	36	10 +	23	13.77	106	27.96	227
University	7	4.20	11	2.90	18	Total	167	100	379	100	546
Total	167	100	379	100	546						

Table 4. *The demographic structure of the producers*

	Non-member breeders					DCBA member breeders				
	N	Min.	Max.	Mean	$S_{\bar{x}}$	N	Min.	Max.	Mean	$S_{\bar{x}}$
Breeder age	378	19	83	46.61	0.674	166	20	83	43.74	0.961
Schooling	379	0	15	2.46	0.161	167	0	15	3.26	0.264
Household size	379	1	19	7.40	0.192	167	1	14	6.31	0.244
Distance to the nearest town	379	15	125	43.47	0.944	167	18	140	60.93	2.429
Milk sales	379	0	1	0.28	0.023	167	0	1	0.41	0.038
Make use of pastures	379	0	1	0.60	0.025	167	0	1	0.87	0.026
Barn type	379	0	1	0.03	0.009	167	0	1	0.05	0.017
Source of agricultural information										
DCBA	379	0	0	0.00	0.000	167	0	1	0.14	0.027
Neighbours	379	0	1	0.13	0.017	167	0	1	0.13	0.026
TV	379	0	1	0.14	0.018	167	0	1	0.15	0.028
Agricultural agencies	379	0	1	0.08	0.014	167	0	1	0.11	0.025
Own experience	379	0	1	0.67	0.024	167	0	1	0.81	0.030
Agriculture as the source of income	379	0	1	0.73	0.023	167	0	1	0.78	0.032
Make use of government supports	379	0	1	0.04	0.010	167	0	1	0.38	0.038
AI employment	379	0	1	0.33	0.024	167	0	1	0.57	0.038

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Naturally, it is an expected consequence from an agricultural organization that the members of that organization adopt innovations more than non-members. In the present study, 32.98% of non-member breeders and 57.48% of DCBA member breeders applied artificial insemination. In other words, the practice of artificial insemination was 24.5% higher for DCBA member breeders as compared with non-members (*Table 4*). Consequently, 96.9 and 81.6% of the DCBA member and non-member breeders have calves from AI, which implies success in AI is higher for DCBA member breeders. Since AI is one of the most reasonable options to increase milk and meat yields in the next generation, breeders were asked whether artificial insemination increases milk yield or not. Of the respondents, 61.5% of DCBA members and 65.6% of non-member breeders agreed that it did. As a matter of fact, in Turkey, AI has been accepted as the most reasonable option for genetic improvement of farm animals to increase milk and beef production, and it has been supported by the governments in different ways (Terin, 2014).

Adoption of new techniques or innovations suggests sustainable behavioural changes without external interventions. Therefore, the breeders were asked whether they would continue to use AI or not in case of a possible government support cut-off. According to the results, 71% and 61% of DCBA member and non-member breeders replied positively to this question (*Table 5*).

Table 5. *Artificial insemination opinions of the breeders*

Status of artificial insemination application						**Whether or not calves born from artificial insemination**					
	No applying		**Applying**				**No**		**Yes**		
	N	**%**	**N**	**%**	**Tot.**		**N**	**%**	**N**	**%**	**Total**
Non-members	254	67.02	125	32.98	379	Non-members	23	18.40	102	81.60	125
DCBA	71	42.52	96	57.48	167	DCBA	3	3.13	93	96.87	96
Opinion whether artificial insemination increases milk yield or not						**Status of artificial insemination in case of no support**					
	Increased		**Not increased**				**No apply**		**Apply**		
	N	**%**	**N**	**%**	**Tot.**		**N**	**%**	**N**	**%**	**Total**
Non-members	82	65.60	43	34.40	125	Non-Members	49	39.00	76	60.80	125
DCBA	59	61.46	37	38.54	96	DCBA	28	29.00	68	70.80	96
						$X^2 = 2.408$, $p = 0.121$(non-significant)					

Causes of not using artificial insemination method					
	1. Reason	**2. Reason**	**3. Reason**	**Stack total point**	**%**
Unnecessary	65	0	1	196	35.89
Low success in native breeds	25	3	0	81	14.83
Expensive	22	3	0	72	13.18
No habit	19	2	1	62	11.35
Having own bull	19	2	0	61	11.17
Sin	11	4	0	41	7.50
Lack of knowledge	5	0	1	16	2.93
No assistance of agr. inst.	2	0	0	6	1.09
Lack of time	2	0	0	6	1.09
No assistance of DCBA	1	1	0	5	0.91
Total	546				

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This suggests that a significant behavioural change was achieved with regard to AI employment. However, we may also infer that there was not any behavioural change in about 30% of the respondents. The difference between the two groups was not significant (P > 0.05). The reasons for not using AI were non-essentiality, low success rate in local breeds, expensiveness, sinful act, and bull ownership, in respective order (*Table 5*).

According to the results of regression analysis (*Table 7*), breeder age and family size had an insignificant negative effect on the adoption of AI, whereas schooling years, membership in an association, barn type, and use of neighbours as a source of agricultural information had a positive but insignificant effect. Again, distance to the nearest town and proportion of crop revenues in the total farm income had a significant negative effect (P < 0.01) on the employment of AI, while milk sales and TV as the source of agricultural information had a significant positive effect on the use of AI at the 90% confidence level. Once more, benefiting from common pastures and the use of agricultural agencies as the sources of information had a significant positive effect (P < 0.05) on the adoption of AI, while support payments, cross- and purebred cattle ownership, and the use of DCBA as the source of agricultural information had a strong, positive effect (P < 0.01).

When considering the marginal effects of the factors on the adoption of AI, it is obvious (*Table 5*) that the use of DCBA as the source of agricultural information, desire to make use of support payments, use of agricultural agencies as information sources, ownership of cross- or purebred cow, desire to benefit from common pastures, and use of TV as the source of agricultural information increase the possibility of adopting AI by 34.2, 26.5%, 18.1, 17.6, 14.4, 11.9%, respectively. On the other hand, one-unit increments in the distance to the nearest town and in the proportion of crop revenues in the total farm income reduce the likelihood of AI use by 18.9 and 0.03%, respectively.

Discussion

Between 2004 and 2015, all support payments for livestock farmers including AI were made via associations of big- and small-ruminant breeders. Breeders that were members and non-members of DCBA were paid TRY 145 and TRY 92 (USD 32.2 and USD 20.4) per calf from AI, respectively, until 2015. However, the difference between the breeder groups regarding support payments paid per calf disappeared after 2016. All calves from AI or natural insemination cost the same amount of money, and so there are no advantages for DCBA members at all (Anonymous, 2017a).

Age is an important factor affecting the attitudes and behaviors of producers in carrying out agricultural activities (Köksal, 2009). In similar studies on artificial insemination, it has been reported that there is a negative relationship between the age of the producer and the possibility of applying artificial insemination (Sezgin et al., 2008; Sezgin, 2010; Aksoy and Yavuz, 2011; Howley et al., 2012). However, some studies also reported a positive correlation between the age of the producer and artificial insemination (Gençdal et al., 2015; Tambi et al., 1999; Kaaya et al., 2005).

The level of education is closely linked to the developments in the individual's environment and understanding and solving their problems (Yildirim, 1994). Gençdal et al. (2015) determined schooling years to be 4.9 and 4.1 for the farm enterprises that employed and did not employ AI, respectively. In present study, schooling years were calculated to be 3.5 for the respondents preferring AI and 2.1 for those not preferring AI. The difference between the breeder groups regarding schooling years is highly significant (P < 0.01).

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Table 6. *The correlation matrix*

	AI	Age	EP	P	D	M*	MS*	BP*	BT*	DCBA*	N*	TV	AA*	OE*	RR*	S*	CPB*
AI	1,00	-0,169**	0,214**	-0,184**	-0,091*	0,230**	0,276**	0,241**	0,03	0,263**	0,110*	0,174**	0,202**	-0,03	-0,177**	0,291**	0,267**
Age	-0,169**	1,00	-0,285**	0,379**	0,03	-0,105*	-0,149**	-0,169**	-0,05	-0,01	0,01	-0,04	-0,04	0,05	0,02	-0,08	-0,108*
EP	0,214**	-0,285**	1,00	-0,203**	-0,04	0,115**	0,164**	0,100*	0,07	0,07	0,128**	0,199**	0,172**	-0,01	-0,129**	0,192**	0,08
P	-0,184**	0,379**	-0,203**	1,00	0,03	-0,139**	-0,164**	-0,120**	-0,03	-0,03	-0,07	-0,216**	-0,01	0,01	0,07	-0,08	-0,08
D	-0,091*	0,03	-0,04	0,03	1,00	0,329**	-0,290**	0,04	-0,05	0,03	0,07	-0,02	0,03	0,178**	0,03	-0,01	0,150**
M*	0,230**	-0,105*	0,115**	-0,139**	0,329**	1,00	0,126**	0,211**	0,05	0,402**	-0,01	0,01	0,142**	0,125**	0,05	0,444**	0,366**
MS*	0,276**	-0,149**	0,164**	-0,164**	-0,290**	0,126**	1,00	0,315**	0,04	0,093*	-0,01	0,06	0,085*	-0,086*	-0,07	0,172**	0,329**
BP*	0,241**	-0,169**	0,100*	-0,120**	0,04	0,211**	0,315**	1,00	-0,03	0,04	0,03	0,06	0,07	0,02	-0,04	0,05	0,447**
BT*	0,03	-0,05	0,07	-0,03	-0,05	0,05	0,04	-0,03	1,00	0,05	0,00	-0,06	-0,02	-0,02	-0,03	0,06	-0,03
DCBA*	0,263**	-0,01	0,07	-0,03	0,03	0,402**	0,093*	0,04	0,05	1,00	0,093*	0,105*	0,151**	-0,06	-0,05	0,391**	0,153**
N*	0,110*	0,01	0,128**	-0,07	0,07	-0,01	-0,01	0,03	0,00	0,093*	1,00	0,365**	0,01	0,07	-0,07	0,04	-0,04
TV*	0,174**	-0,04	0,199**	-0,216**	-0,02	0,01	0,06	0,06	-0,06	0,105*	0,365**	1,00	0,109*	0,06	-0,146**	0,01	-0,04
AA*	0,202**	-0,04	0,172**	-0,01	0,03	0,142**	0,085*	0,07	-0,02	0,151**	0,01	0,109*	1,00	-0,110*	-0,06	0,204**	0,118**
OE*	-0,03	0,05	-0,01	0,01	0,178**	0,125**	-0,086*	0,02	-0,02	-0,06	0,07	0,06	-0,110*	1,00	0,02	-0,05	0,135**
RR*	-0,177**	0,02	-0,129**	0,07	0,03	0,05	-0,07	-0,04	-0,03	-0,05	-0,07	-0,146**	-0,06	0,02	1,00	-0,01	0,01
S*	0,291**	-0,08	0,192**	-0,08	-0,01	0,444**	0,172**	0,05	0,06	0,391**	0,04	0,01	0,204**	-0,05	-0,01	1,00	0,171**
CPB*	0,267**	-0,108*	0,08	-0,08	0,150**	0,366**	0,329**	0,447**	-0,03	0,153**	-0,04	-0,04	0,118**	0,135**	0,01	0,171**	1,00

AI: Application artificial insemination , EP: Education period, P: Population, D: Distance, M: Membership association , MS: Milk sales, BP: Benefitting pasture, BT: Barn type, DCBA: Diyarbakır Cattle Breeders Association, N:Neighbour , AA: Agricultural agencies, TV: television, OE: Own experience, RR: Revenue rate in crop production, S: Support, CPB: Having cross-breed and pure breed

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Table 7. *Logistic regression analysis results*

Independent variables	Coef.	Std Err.	z	p > ItI	Marginal effect (dy/dx)
Age	-0.013	0.008	-1.48	0.138	-0.003
Education period	0.036	0.034	1.08	0.282	0.008
Population	-0.045	0.318	-1.43	0.154	-0.010
Distance	-0.012	0.005	-2.54	0.011	-0.003
Membership to association*	0.284	0.288	0.99	0.324	0.068
Milk sales*	0.429	0.229	1.88	0.060	0.101
Benefit to pasture*	0.628	0.254	2.47	0.014	0.144
Barn type*	0.091	0.568	0.16	0.872	0.021
DCBA*	1.434	0.500	2.87	0.004	0.342
Neighbour*	0.397	0.270	1.47	0.141	0.096
TV*	0.494	0.267	1.85	0.065	0.119
Agricultural agencies*	0.742	0.309	2.40	0.016	0.181
Own experience*	-0.028	0.249	-0.11	.0.909	-0.006
Rate in crop production*	-0.780	0.238	-3.28	0.001	-0.189
Support*	1.088	0.349	-3.12	0.002	0.265
Cross and pure breed*	0.768	0.256	3.00	0.003	0.176
_cons	0.176	0.583	-0.30	0.763	

*dy/dx is the discrete change of dependent variable when independent dummy variable shifts from 0 to 1

When we look at the family structure today, we see that the nuclear family structure is common in urban areas whereas the family size increases in rural areas (Anonymous, 2017b). The average family size in rural areas in Diyarbakir is 7.2 persons (Anonymous, 2011). In present study, the average family size was 6.3 persons for the respondents preferring AI and 7.6 persons for the respondent groups ignoring AI. Again, family size was also 6.3 and 7.4 persons for DCBA members and non-members, respectively. Accordingly, a negligible and insignificant relationship between family size and artificial insemination was found in this study, which is in line with the reports of Gençdal et al. (2015), who stated that there was no relationship between AI and family size. As found in this study, a positive and significant relationship between membership and AI was also reported by similar studies, which claimed that membership in an association increased the possibility of AI use (Sezgin, 2010; Aksoy and Denizli, 2012).

In this study, we found that the distance between the breeder’s village and the nearest town had a significant negative effect on the likelihood of AI use (P = 0.011). A one-unit (1 km) increase in distance will reduce the likelihood of AI use by 0.3%. Similar findings were reported by Gençdal et al. (2015), Aksoy and Yavuz (2011), and Murage and Ilatsia (2011).

Conclusions

The low-yielding local cattle asset and the misperception among breeders that artificial insemination in native breeds is not successful are very important problems to tackle, especially for the breeders with no membership status. However, the main causes

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of low success rate in artificial insemination are failure in heat detection in cows, untimely insemination practices and poor semen quality. Nevertheless, the support payments paid for per calf born from artificial insemination were the most important driving force for the success of artificial insemination until 2015. Since the year 2015, the scope of support payments has also covered the calves born from natural insemination. This caused the members of the DCBA to give up the use of artificial insemination.

On the other hand, we can infer from the results that breeders with good relations to agricultural agencies are significantly and positively tended more to employ AI. For that reason, in order to develop the genetic material of the cattle asset of the farms, artificial insemination is an easy and cost effective tool to be considered. However, low conception rate experienced in artificial insemination practices due to untimely applications, failures in heat detection and poor semen quality were the most important reasons for the breeders not to employ artificial insemination. Whereas, support payments paid for the calves born from AI were the main drive for the breeders to prefer AI instead of natural service despite of existing barriers against AI. We can infer from the results that in order to achieve the successful results, more sustainable, robust and long-term policies should be developed and implemented to tackle the existing problems impeding the success of AI.

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