

# Effect of Inseminator on Reproductive Performance in Dairy Cattle

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## Research Article

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## **Abstract**

The reproductive efficiency of dairy cattle is critical to the economic success and sustainability of the enterprise. Due to its many advantages, artificial insemination has inevitably taken its place in herd management today and different artificial insemination methods have been developed until today. At the same time, artificial insemination is carried out by commercial artificial insemination operators or do-it-yourself operators in cattle farms. One of the factors affecting the success of artificial insemination is inseminators. The aim of this study is to determine the effect of inseminators on conception rates in reproductive challenges and to reveal the differences between the success rates of inseminators. A total of 227297 artificial insemination acts carried out by 35 inseminators for four years belonging to the Konya Cattle Breeders' Association in Turkey were assessed for this purpose. In the study, the insemination success rate was determined as 41.36%. In addition, the percentage of inseminators with a total insemination success rate of more than 50% is very low, such as 2.9% and the percentage of those who achieved 35.9% and below was 9.3%. As a result, it can be stated that the inseminators having a lower success rate than the overall should be retrained to avoid some costs or losses in farms.

## **Introduction**

The reproductive efficiency of the dairy herd is important to the economic success of the dairy farm, also for the continuity of other yields. Because of its advantages such as reduces the incidence of sexually transmitted diseases and increases the use of genetically superior sires in the selection, artificial insemination is one of the most important reproductive technologies implemented in herd management.

The pregnancy rate of the herd is directly related to the number of inseminations per pregnancy (NIPP). Of course, it is desirable for each cow to become pregnant in single insemination in the herd. While this is theoretically possible, it has not been possible in any herd so far. Because pregnancy is under the influence of many factors such as changes in environment and management for the dam, also the fertility of the bull for semen quality evaluations, adjustments to cell numbers per dose, and culling of ejaculates and/or bulls in fertility among ejaculates and/or bulls released for sale (DeJarnette et al., 2004). In general, failure to detect estrus at the right time is considered and evaluated as the only factor in not being pregnant. However, even if estrus is detected at the right time, the morphology and physiology of the ovum, the cow's readiness for pregnancy, diseases, the quantity and quality of sperm, the correct and complete insemination at the time, the inseminators knowledge and experience are the factors that directly/indirectly affect conception. For this reason, it is almost impossible to achieve pregnancy with only one insemination in practice. This may have been achieved in one cow or a few cows, but it is the average of the herd that matters (Boztepe et al., 2015).

Despite all this, given the complexity of factors such as artificial insemination operator, bull and cow that can affect reproductive performance, it is difficult to distinguish whether the reproductive performance differences observed between herds are due to the insemination category or confounded by other factors (Buckley et al., 2003).

Buckley et al., (2003) reported that the success of artificial insemination operators in the first insemination ranged from 40–60%, but mostly concentrated in the 50% range. Regarding the effect of inseminator on conception rates of nonlactating Holstein dairy heifers during the 42 d artificial insemination breeding period adapted from Rivera *et al.*, (2003a,b), Fricke (2017) stated that it was observed that there were significant differences in terms of getting pregnant between inseminators. As a result, the researchers expressed the success of the second inseminator is very low (6%), the success of the first inseminator is not much different from this (14%). The success of the third inseminator is much higher than both (58%).

Based on all these studies' findings, it is known that many factors related to pregnancy are effective and see that perhaps one of the most important of these factors is the inseminator factor. The timing of artificial insemination in relation to the onset of estrus is depend on the experience and knowledge of the inseminator. For example, if we caught one out of every 4-5 estrus and the inseminator success average is 0.3, this means about 12-15 estrus follow-ups for a pregnancy. If this is multiplied by the time between estrus, that is  $12-15 \times 21 \text{ days} = 252 \text{ to } 315 \text{ days}$ . All these evaluations actually appear as proof that under current conditions in these herds, a calf is taken every two years, not once a year. Also, storage of straws, preparation for insemination and insemination are important factors (Pickett and Berndtson, 1974). In addition, it is among the inseminator mistakes to synchronize animals that do not have problems in the heat cycle and ovulation. In short, a good inseminator is among the most important factors as well as monitoring and detecting estrus for a successful pregnancy (Petrov *et al.*, 2010; Boztepe and Aytekin, 2017).

Today, one of the most important problems encountered in dairy cattle enterprises with high milk-yielding cows is fertility. Problems in fertility are mostly caused by individual cows, feeding and diseases management in these herds (Dzung *et al.*, 2001; Anzar *et al.*, 2003). Of course, artificial insemination personal have also contributed to this failure. The aim of this study is to determine the effect of inseminators on conception rates in reproductive challenges and to reveal the differences between the success rates of inseminators.

## **Material And Methods**

The data set of the research consisted of artificial insemination records for 2016, 2017, 2018 and 2019 years belonging to Konya Cattle Breeders' Association in Turkey. A total of 227297 first artificial insemination records of 35 inseminators in Breeders' Association in these years were used. Considering that part of the problem originates from animals, the other part originates from insemination of different animals by different inseminators, second, third, fourth, fifth or more inseminations were not evaluated to prevent this from being considered an inseminator error in this study (Inchaisri *et al.*, 2011).

## **Statistical analysis**

Based on the first artificial insemination records, inseminator success was determined by dividing the number of calves obtained by the number of inseminations. One-way analysis of variance was applied to analyze the differences between inseminators and years (Montgomery, 2001). Duncan multiple range test was used to determine the significance of the difference between groups (Düzungüneş et al., 1987). Statistical analysis was done with the help of the RStudio statistics package program.

## Results And Discussion

First insemination records of 35 inseminators in Breeders' Association in 2016, 2017, 2018 and 2019 years, number of calves and success rates of inseminators were given in Table 1.

Table 1  
Distribution of artificial inseminations of 35 inseminators by years

Years	Number of Insemination $\bar{X} \pm S_x^-$	Total Number of Insemination (N)	Number of Calves $\bar{X} \pm S_x^-$	Total Number of Calves (N)	Inseminators Success
2016	1908 ± 176	66768	811.4±71.1	28398	0.425 <sup>A</sup>
2017	1655 ± 153	57920	681.4±63.1	23848	0.412 <sup>AB</sup>
2018	1561 ± 121	54628	626.3±48.8	21921	0.401 <sup>B</sup>
2019	1371 ± 136	47981	560.2±59.1	19606	0.409 <sup>B</sup>
Overall	1624±29.79	227297	669.8±19.21	93773	0.413
A, B: (p<0.01)					

A total of 227297 inseminations were made by 35 inseminators in 2016, 2017, 2018 and 2019, and 93773 calves were obtained from these inseminations. While the overall inseminators success was 0.413, the success rates for 2016, 2017, 2018 and 2019 were determined as 0.425, 0.412, 0.401 and 0.409. While the inseminator's success in 2016 was statistically insignificant than in 2017, it differed significantly (p<0.01) from their success than 2018 and 2019 years.

According to a total of 227297 insemination results for the years 2016, 2017, 2018 and 2019 in Table 2, the differences between the insemination success of 35 inseminators were found to be statistically significant (p<0.01). According to the results of the Duncan multiple range test, while the differences of insemination success between inseminator 5 with 47.67% and inseminator 24 with 36.38%, and also four inseminators (8, 10, 24 and 31) were found to be statistically significant (p<0.01), the differences between the others were found to be statistically insignificant. A difference of 15.82% was determined between the

inseminator with the highest success (inseminator 5; 47.67%) and the inseminator with the lowest success (inseminator 9; 31.85%).

Table 2

The results of insemination success of 35 inseminators in four years

Inseminators	Insemination success (%)	Number of calves / Number of Insemination
	$\bar{X} \pm S_x^-$	
1	41.40±0.0297 <sup>ABC</sup>	1956/4717
2	43.23±0.0330 <sup>AB</sup>	2889/6683
3	40.53±0.0530 <sup>ABC</sup>	1157/2841
4	39.75±0.0198 <sup>ABC</sup>	2205/5556
5	47.67±0.0217 <sup>A</sup>	1489/3121
6	44.05±0.0135 <sup>AB</sup>	1793/4077
7	36.25±0.0239 <sup>BC</sup>	2688/7388
8	41.40±0.0136 <sup>ABC</sup>	3187/7660
9	31.85±0.0458 <sup>C</sup>	2206/6801
10	42.23±0.0203 <sup>ABC</sup>	3193/7536
11	43.05±0.0258 <sup>AB</sup>	2660/6207
12	43.70±0.0291 <sup>AB</sup>	2819/6441
13	42.63±0.0217 <sup>ABC</sup>	3268/7678
14	44.45±0.0236 <sup>AB</sup>	4783/10717
15	39.60±0.0282 <sup>ABC</sup>	2701/6920
16	42.72±0.0202 <sup>AB</sup>	2435/5718
17	41.28±0.0135 <sup>ABC</sup>	5244/12681
18	44.63±0.0477 <sup>AB</sup>	3818/8599
19	45.70±0.0398 <sup>AB</sup>	663/1537
20	38.95±0.0084 <sup>ABC</sup>	4775/12281
21	40.98±0.0090 <sup>ABC</sup>	5249/12814

A, B, C: p&lt;0.01

Inseminators	Insemination success (%)	Number of calves / Number of Insemination
	$\bar{X} \pm S_{\bar{x}}$	
22	36.38±0.0520 <sup>BC</sup>	2623/7148
23	39.60±0.0174 <sup>ABC</sup>	5889/14882
24	44.25±0.0403 <sup>AB</sup>	4305/9682
25	43.60±0.0114 <sup>AB</sup>	3155/7252
26	42.85±0.1160 <sup>AB</sup>	2647/6430
27	36.20±0.0558 <sup>BC</sup>	1262/3538
28	42.33±0.0446 <sup>ABC</sup>	1753/4105
29	41.95±0.0906 <sup>ABC</sup>	3450/8182
30	42.75±0.0481 <sup>AB</sup>	1543/3440
31	43.30±0.0291 <sup>AB</sup>	1407/3233
32	38.75±0.0140 <sup>ABC</sup>	1788/4569
33	39.10±0.0280 <sup>ABC</sup>	1085/2720
34	38.48±0.0320 <sup>ABC</sup>	570/1498
35	42.05±0.0652 <sup>ABC</sup>	1118/2645
Overall	41.36±0.0469	93773/227297
A, B, C: p<0.01		

The results of insemination success of 35 inseminators presented in Table 2 is given graphically in Figure 1 according to years, and too.

As can be seen from Figure 1, an increase in the success percentages (>0.5) of some inseminators was observed in 2018. The highest insemination success rate is around 0.5 in other years. Individually, the lowest insemination success rates were in 2019. It can be stated that the Cattle Breeder's Association should retrain the inseminators with a lower success rate than the overall. If this cannot be done, due to reproductive costs besides more importantly extended calving intervals, feeding costs, calves, lactations and time losses, etc. employment of more successful insemination staff instead of them will increase the

success. For a better understanding of Table 2 and Figure 1, the frequency distributions of insemination success of 35 inseminators in 2016, 2017, 2018 and 2019 are presented in Table 3.

Table 3  
Insemination success distribution of 35 inseminators by years (%)

Inseminator Success Groups (%)	Years								Overall	
	2016		2017		2018		2019			
	f	%	f	%	f	%	f	%	f	%
<35.9	-	0.0	4	11.4	4	11.4	5	14.3	13	9.3
36.0-39.9	7	20.0	7	20.0	14	40.0	11	31.4	39	27.9
40.0-44.9	15	42.9	17	48.6	15	42.9	13	37.1	60	42.9
45.0-49.9	13	37.1	6	17.1	-	0.0	5	14.3	24	17.1
>50.0	-	0.0	1	2.9	2	5.7	1	2.9	4	2.9
Overall	35		35		35		35		140	100

As can be seen from Table 3, the percentage of inseminators with a total insemination success rate of more than 50% is very low, such as 2.9%. Besides, the percentage of those who achieved 35.9% and below was 9.3%. According to the inseminator success range, there was 17.1% in the range of 0.450-0.499, 42.9% in the range of 0.40-0.449, 27.9% in the range of 0.36-0.399 and 9.3% in the 0.359 and below groups. As a result, 87.9% of the inseminators were found to be in the success range of 0.499 and 0.360. This result is also important in terms of demonstrating the success of the inseminator in Turkey. At the same time, as can be seen from Table 2, the success rate is 41.36. The average number of insemination per calf is 2.42. With an optimistic approach, it can be said that success is achieved in one of every two inseminations, in other words, at least two insemination cost is paid for a pregnancy.

Buckley et al., (2003) computed the mean (and range) conception rates for commercial artificial insemination and do-it-yourself operators within this analysis were 53% (37–63%) and 49% (27–69%) in their study on insemination factors affecting the conception rate in seasonal calving Holstein-Friesian cows, respectively. Desalegn et al., (2009) stated that the mean ( $\pm$  SE) conception rate to first inseminations was approximately 27.06%. In the study assessed for a three-year period on 4 855 insemination acts carried out by 5 inseminators in 3 664 cows of 5 different breeds belonging to 1 600 breeders distributed in two areas about the conception rate of artificial insemination in small cattle dairy farms in an Algerian semi-arid area, Mouffok et al., (2019) reported that the success rate recorded in 1st artificial insemination was evaluated at 64%. The insemination success rate determined as 41.36% in this study found to be lower than Buckley et al., (2003) and Mouffok et al., (2019) findings, and also higher

than Desalegn et al., (2009) finding. Alexander et al., (1997) was found that the overall conception ratios ranged from 27.8–58.5% in the Mid Country Wet Zone of Sri Lanka.

On the study of a total of 1112 heads AI mating acceptors and their conception rates conducted by six inseminators for the three frozen semen doses from two sires, Anggraeni et al., (2016) determined that the performance of inseminator 1 (35.3% and 81.6%-89.6%) was the best among the other five inseminators for in terms of getting higher AI mating acceptors (9.5%-22.7%) and conception rates (43.9%-79.7%). As was previously stated, researchers stated that the skill of inseminators was important as a result.

Anzar et al., (2003) found that the conception rates varied significantly due to artificial technicians and ranged from zero and 100%. Also, inseminators success was determined as 27.45% including professional inseminators (34.2%) and technicians (20.0%) in overall from a total of 459 inseminations data including 280 cattle and 179 buffaloes during 1994 and 1995 years by 18 inseminators in Punjab state of Pakistan. Jamel and Lemma (2015) stated that the skill of the inseminator is an important element in the success of the artificial insemination program and regular practice at inseminating time is required to maintain high conception rates. Besides researchers reported that the site of semen deposition has an important role in achieving conception of AI in cattle and so that the deposition of semen in the uterine body resulting in a higher non-return rate than cervical deposition due to inseminated just into the short uterine body. In the study evaluated from the first four successive inseminations of 3 664 inseminated cows during a three-year period, Mouffok et al., (2019) determined that the conception rations of artificial insemination in small cattle dairy farms in an Algerian semi-arid area ranged from 4.3–63.4% and showed that the difference was about 20% between inseminators. Variation in the efficiency of artificial insemination service can be caused by inseminations into the cervix and vagina, site of semen placement in the reproductive tract, sire, and environmental temperature the day after insemination (Gwazdauskas et al., 1981), timing of insemination in relation to the onset of heat, frozen semen technology, factors affecting on drop in post thaw motility or fertility of frozen semen, selection of the appropriate thawing technique, a hygienically pipetting of semen in vagina and properly use artificial insemination devices by inseminators (Bhosrekar, 1990; Dzung et al., 2001). In addition, it has been reported that factors such as breeds, regions, semen (domestic and exotic) and herd management are effective on the conception rate of artificial insemination (Mouffok et al., 2019). In addition, some breeders have used “cleaning bull” for mating in herd management in case inseminators have a high insemination failure (Grusenmeyer et al., 1983).

In this study, the number of insemination per calves which was determined as 2.42 was higher than 1.7 (Hamudikuwanda et al., 1987), 1.99 (Alexander et al., 1997) and 1.88 (Desalegn et al., 2009) and lower than 2.76 (Islam et al., 2004). However, the values reported by these researchers were the number of inseminations per pregnancy, and it is not clear whether calves were obtained as a result of each pregnancy in their studies.

The NIPP value of 1.5 is considered normal in herd management (Şekerden & Özütük 1990). While it is theoretically possible for NIPP to be 1.0, 1.5 of the NIPP value can be achieved both theoretically and practically in the herd management (Boztepe and Aytekin 2017). According to Smith and Becker (1994) and Grusenmeyer et al. (1983), each 0.1unit increment from the target NIPP average (1.5 NIPP) costs 1.5 \$. This cost may not be a huge amount per animal, but the cost of NIPP 2.0 instead of 1.5 in a herd of 1000 heads is 7500 \$/year. Considering only semen and application cost except for other losses in Turkey, while the cost of one insemination is at least 100-150 TL, the cost of 0.5 insemination is nearly 50-75 TL in Turkey. Besides, NIPP will continue to increase if the problem/problems related to achieving pregnancy in the herd are not resolved and the costs will, even more, increase as a result (Boztepe & Aytekin 2017). Although the number of inseminations per pregnancy is one of the reproductive parameters in herd management, it is not a very accurate approach in the evaluation of reproductive performance because of calculating from inseminations per pregnancy according to Boztepe and Aytekin (2017). To put it clearly, estrus must be detected in order for insemination to be carried out. Evaluating the data and information obtained from the dairy farms, cows that did not become pregnant can be found even though they were inseminated 10, 16, 17 and even 19 times. This problematic reproduction management situation is also seen by the evaluation of the average DIM values of the enterprises.

The fact that the average DIM is 250 and above in farms that are said to have no problems in dairy cattle enterprises confirms this situation in the field. The explanation of NIPP not being a good breeding parameter can be explained as follows; for example, it showed estrus 10 times, but the first nine could not be detected, the last one was caught, inseminated and the animal became pregnant. In this situation, if the data is evaluated, the GBTS is one (1) and herd management looked very successful as a result. However, whether this value reflects the truth or not can be understood by looking at the service period or calving interval. For an accurate evaluation, the parameter should be the number of estrus per pregnancy (NEPP), which is more compatible with other breeding parameters such as service period and calving interval instead of NIPP.

Also, it can also be understood from the parameter of insemination per cow (NIPC) that NEPP is more favorable. To further explain this situation, NIPP is calculated from those who are inseminated and conceived in a herd. However, there are also cows in the herd that does not get pregnant after insemination. From this perspective, real success in herd management should be based on the low or high number of inseminations per cow. Whichever of these evaluation parameters, the skill of the inseminator is still an important element.

## Conclusion

The desire to increase milk production per cow day by day causes some problems related to reproduction and health in animal husbandry. This causes lower conception rates in cows with high milk yields. Artificial insemination is an important part of herd management due to multiple benefits. However, there are many factors that affect its success. For example, they are the timing of artificial insemination in

relation to onset of estrus, experience and knowledge of inseminator, the condition, storage and quality of the sperm, breed, lactation period, body condition, disease and malnutrition conditions.

The results of this study showed clearly that a successful pregnancy depends on the inseminator's experience at insemination. As a result, further study should be conducted on assessment of the fertility levels of herds at a local and national level and education of inseminators with low success could be required. Besides, it is required to increase the success of inseminators by taking account of other factor's effects on pregnancy in these studies for successful insemination.

## **Declarations**

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### **Authors' contribution**

OS, SB and MU designed the study. Statistical analysis of the study was done by IK and IA. All authors wrote and approved the manuscript.

### **Data Availability**

Data will be provided by corresponding author on reasonable request

### **Conflict of Interest**

The authors declare that they have no conflict of interest.

### **Informed consent**

All authors have given their consent that this work is valid and represent their views of the study and have given their consent for this work to be published.

### **Statement of animal rights**

This work did not involve the use of animal for laboratory studies. There is no violation of animal right.

## **References**

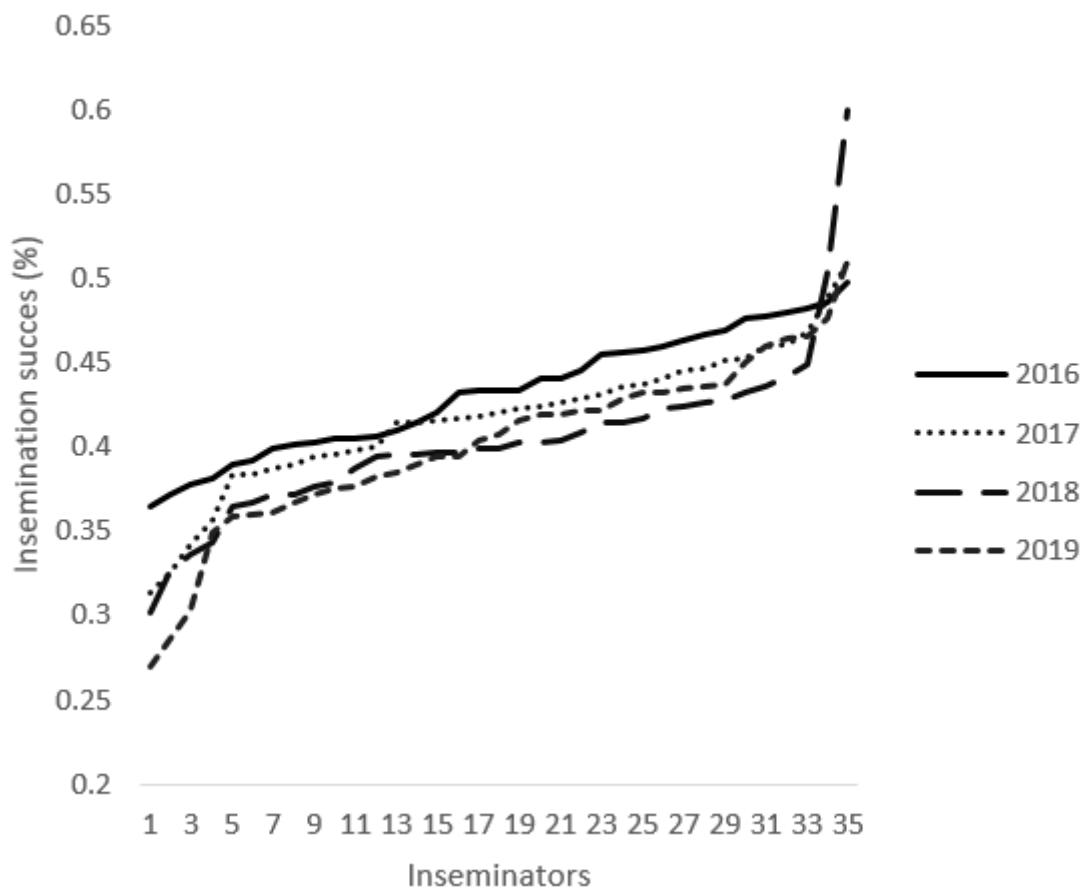
1. Alexander, P.A.B.D., Abeygunawardena, H., Perera, B.M.A.O., Abeygunawardena, I.S., 1997. Current status and factors affecting the success of artificial insemination in small-holder farms in the mid country wet zone of Sri Lanka. Tropical Agricultural Research, 9: 204-216

2. Anggraeni, A., Herawati, T., Praharani, L., Utami, D., Argis, A., 2016. Conception Rates of Holstein-Friesian Cows Inseminated Artificially with Reducing Frozen Semen Doses. *Media Peternakan*, 39: 75-81
3. Anzar, M., Farooq, U., Mirza, M.A., Shahab, M., Ahmad, N., 2003. Factors affecting the efficiency of artificial insemination in cattle and buffalo in Punjab, Pakistan. *Pakistan Veterinary Journal*, 23:106-113
4. Bhosrekar, M.R., 1990. Semen production and artificial insemination (1st ed.), BAIF Development Foundation, India. pp. 4-205.
5. Boztepe, S., Aytekin, İ., Zulkadir, U., 2015. Süt Sağırçılığı. Selçuk Üniversitesi Basımevi. Konya.
6. Boztepe, S., Aytekin, İ., 2017. Süt Sağırçılığında Karlılığın Anahtarı "Days in Milk (Dim)" ve Üreme Ölçütlerine Yeni Yaklaşımlar. SAGE Yayıncılık ve Matbaacılık Ankara
7. Buckley, F., Mee, J., O'Sullivan, K., Evans, R., Berry, D., Dillon, P., 2003. Insemination factors affecting the conception rate in seasonal calving Holstein-Friesian cows. *Reproduction Nutrition Development*, 43: 543-555
8. DeJarnette, J.M., Marshall, C.E., Lenz, R.W., Monke, D.R., Ayars, W.H., Sattler, C.G., 2004. Sustaining the fertility of artificially inseminated dairy cattle: the role of the artificial insemination industry. *Journal of Dairy Science*, 87: E93-E104.
9. Desalegn, G.M., Merga, B., Azage, T., Kelay, B., 2009. A paper presented at the 17th Annual Conference of the Ethiopian Society of Animal Production (ESAP), September 24–26 held at the Ethiopian Institute of Agricultural Research (EIAR). Addis Ababa, Ethiopia, pp. 87–104.
10. Düzgüneş, O., Kesici, T., Kavuncu, O., Gürbüz, F., 1987. Araştırma ve Deneme Metodları (İstatistik Metotlar II). Ankara Üniversitesi Ziraat Fakültesi Yayınları: 1021, Ankara.
11. Dzung, C.A., Cuong, L.X., Long, V.N., Cai, D.V., Chung, D.P., Hai, P.H., 2001. Constraints on efficiency of artificial insemination and effect of nutrition on reproductive performance of dairy cattle in small holder farms in Viet Nam. *Radioimmunoassay and Related Techniques to Improve Artificial Insemination Programmes for Cattle Reared Under Tropical and Sub-Tropical Conditions*, IAEA-TECDOC-1220, IAEA, Vienna. 67–78.
12. Fricke, P.M., 2017. Reproductive Challenges of High Producing Dairy Cows, <https://dysci.webhosting.cals.wisc.edu/wp-content/uploads/sites/94/2013/11/Fricke-Reproductive-Challenges.pdf>, Access date: 10.09.2021
13. Grusenmeyer, D., Hillers, J., Williams, G., 1983. Evaluating reproductive status using DHI records. *Western Reg. Publ*, 67
14. Gwazdauskas, F.C., Lineweaver, J.A., Vinson, W.E., 1981. Rates of Conception by Artificial Insemination of Dairy Cattle. *J Dairy Sci*, 64: 358-362
15. Hamudikuwanda, H., Erb, H.N., Smith, R.D., 1987. Effects of sixty-day milk yield on post partum breeding performance in holstein cows. *J. Dairy Sci*, 70 : 2355-2365.
16. Inchaisri, C., Jorritsma, R., Vernooij, J.C.M., Vos, P.L.A.M., Van der Weijden GC & Hogeveen H 2011 Cow effects and estimation of success of first and following inseminations in Dutch dairy cows.

Reproduction in Domestic Animals, 46 :1043-1049

17. Islam, S.S., Ahmed, A.R., Ashhraf, A., Khanam, N., 2004. Genetic and Phenotypic Parameters on Reproductive Traits of Crossbred Cattle in a Selected Farm of Bangladesh. Pakistan Journal of Biological Sciences, 7: 1269-1273
18. Jemal, H., Lemma, A., 2015. Review on Major Factors Affecting the Successful Conception Rates on Biotechnological Application (AI) in Cattle. Global Journal of Medical Research: G Veterinary Science and Veterinary Medicine Volume 15 Issue 3 Version 1.0 Year 2015 Type: Double Blind Peer Reviewed International Research Journal Publisher: Global Journals Inc. (USA) Online ISSN: 2249-4618 & Print ISSN: 0975-5888.
19. Montgomery, D.C., 2001. Design and Analysis of Experiments (Fifth Edition). John Wiley & Sons, Inc.
20. Mouffok, C., Allouni, A., Semara, L., Belkasmi, F., 2019. Factors affecting the conception rate of artificial insemination in small cattle dairy farms in an Algerian semi-arid area. Livest. Res. Rural Dev, 31: 1-9.
21. Petrov, P., Todorova, T., Todorov, Y., 2010. Stimulation and synchronization of ovulation problem in animal breed Limouzin. Sbornik dokladov na nauchnata konferentsiya: Traditsii i s'vremennost v'v veterinarnata meditsina, 43-46.
22. Pickett, B.W., Berndtson, W.E., 1974. Preservation of bovine spermatozoa by freezing in straws: a review. Journal of dairy science, 57: 1287-1301
23. Smith, J.F., Becker, K.A., 1994. The reproductive status of your dairy herd. Guide D (USA).
24. Şekerden, Ö., Özktük, K., 1990. Büyükbaba Hayvan Yetiştirme. Çukurova Univ. Zir. Fak. Yay. Ders Kitabı No: 122, Adana.

## Figures



**Figure 1**

Individually insemination success status of all inseminators by four years