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Should the Number of Inseminations Per Pregnancy or the Number of Heats Per Pregnancy in Dairy Cattle Be Preferred?

Süt Sığırlarında Gebelik Başına Tohumlama Sayısı mı Yoksa Gebelik Başına Kızgınlık Sayısı mı Tercih Edilmelidir?

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ABSTRACT

Some reproductive criteria were emphasized in this study, and it was debated which ones were more beneficial. Also, it tried to explain that the reproductive parameters discussed should have a connection and harmony. In addition, the importance of the average of days in milk ($\overline{DIM}$) parameter of the herd and how it affects not only the reproductive success of the herd but also the profitability of milk yield was explained in the figures. The deficiencies of the number of insemination per pregnancy (NIPP) criterion, which was the main subject of this study, in showing the reproductive success of the flock were discussed and instead, it was argued that the correct parameter was the number of estrus per pregnancy (NEPP). It was emphasized that the use of the NEPP parameter instead of NIPP eliminated the incompatibility among other parameters.

Keywords: Number of inseminations per pregnancy, number of estrus per pregnancy, calving interval, service period, days in milk

ÖZ

Bu çalışmada bazı üreme kriterleri üzerinde durulmuş ve hangilerinin daha faydalı olduğu tartışılmıştır. Ayrıca ele alınan reprodüktif parametrelerin bir bağlantı ve uyum içerisinde olması gerektiği anlatılmaya çalışılmıştır. Ayrıca sürünün ortalama sağımda geçen gün sayısı ($\overline{DIM}$) parametresinin önemi ve sadece sürünün üreme başarısını değil süt veriminin karlılığını da nasıl etkilediği rakamlarla anlatılmıştır. Bu çalışmanın ana konusu olan gebelik başına tohumlama sayısı (NIPP) kriterinin sürünün üreme başarısını göstermedeki eksiklikleri tartışıldı ve bunun yerine doğru parametrenin gebelik başına kızgınlık sayısı (NEPP) olduğu savunuldu. NIPP yerine NEPP parametresinin kullanılmasının diğer parametreler arasındaki uyumsuzluğu ortadan kaldırdığı vurgulanmıştır.

Anahtar Kelimeler: Gebelik başına tohumlama sayısı, gebelik başına östrus sayısı, buzağılama aralığı, servis periyodu, sağımda geçen gün sayısı

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INTRODUCTION

The prerequisite for sustainability in dairy cattle breeding is regular fertility. As it is known, fertility is necessary for (1) the continuity of the herd, (2) the continuous and highest level of milk production, (3) the selection and sale of breeders, and (4) profitable and sustainable livestock. It is of great importance that the fertility criteria are optimum in understanding the correct management of the herd. One of the most important problems experienced in dairy cattle and perhaps the most important one is the failure to achieve the target of one calf in a year. Although it is very difficult to achieve the target of a calf every 12 months, given the high productivity level of existing cattle, the target of a calf should be approached at least every 13–14 months. Researchers have developed many reproduction parameters to facilitate herd management. In fact, these parameters, which are in relationship with each other, are also a confirmation of the accuracy of the records kept in the enterprise. For example, if the service period is 150 days and the gestation period is around 280-285 days, the calving interval ((150 + 280) or (150 +285)) should be around 430-435 days (~14 months). In most cases, these calculations are either too low or too high. This indicates that the records kept are inaccurate and that due diligence is not shown. So much so that in some cases, the use of bulls to guarantee pregnancy against the failures that may be experienced in artificial insemination in enterprises where artificial insemination is applied, is not included in the records. Hence, the number of inseminations per pregnancy, which is the worst of the reproductive parameters, is very low, and therefore the breeding management of the enterprise appears to be very successful.

Usually reproduction; covers the stages of (1) detection of heat at the right time, (2) insemination at the right time, (3) ensuring pregnancy, (4) birth and obtaining a live calf, and (5) and keeping the calf alive until weaning. Therefore, if you have not been able to obtain a calf from an animal within one year or bring the calf you have obtained to a fertile age, it is meaningless for your reproductive parameters to be perfect. This is how reproduction should be viewed as a whole.

Reproduction criteria can be listed as insemination number per pregnancy, service period, mating interval, calving interval, the average of days in milk ($\overline{DIM}$) at first insemination, postpartum voluntary waiting period, the average days in milk, and percentage of days in milk.

In this study, reproductive criteria will be briefly mentioned, but mainly the disadvantages of using the number of inseminations per pregnancy parameter will be tried to be explained.

Number of inseminations per pregnancy (NIPP)

NIPP is directly related to the rate of pregnancy in a herd. Of course, it is desirable for each cow to become pregnant with a single insemination in the herd. Although this is theoretically possible, it has not been possible in any herd so far, because pregnancy is under the influence of many factors. In general, failure to detect estrus at the right time is considered and evaluated as the only factor. However, even if estrus is detected at the right time, the morphology and physiology of the egg, the cow's readiness for pregnancy, diseases, the amount and quality of sperm, the correct and complete application (insemination) on time are the factors that directly/indirectly affect conception (Boztepe et al. 2015). There are also some other factors (mastitis, etc.). For this reason, it is almost impossible to achieve a pregnancy with one insemination. In one cow or some cows this may have been achieved, but what matters is the average of the herd. A NIPP of 1.5 is considered normal. Although it is theoretically possible for NIPP to be 1.0, 1.5 can be achieved both theoretically and practically. According to Smith and Becker (1994) and Grusenmeyer et al. (1983), each 0.1 unit increment from the target NIPP average (1.5 NIPP) costs $1.5. NIPP of 0.5 per cow costs about $7.5. This may not be a very high amount per animal, but the cost of a 2.0 NIPP instead of 1.5 in a herd of 1000 heads is $7500/year. In Türkiye, excluding other losses, when only semen and application costs are taken into account, the cost of an insemination is at least $11-17, while the cost of 0.5 insemination is $5.6-8.4. If the problem/problems related to achieving pregnancy in the herd are not resolved, NIPP will continue to increase. The relationships between pregnancy rate (PR) and NIPP are shown in Table 1.

Table 1. The relationship between pregnancy rate and NIPP (Grusenmeyer et al. 1983)

Tablo 1. *Gebelik oranı ile NIPP arasındaki ilişki*

Pregnancy Rate (%)	NIPP (1/PR)
95 - 100	1.0
87 - 94	1.1
80 - 86	1.2
75 - 79	1.3
69 - 74	1.4
64 - 68	1.5
61 - 63	1.6

From Table 1, when the NIPP value is 1.5, it can be seen that the pregnancy rate is approximately 66%. If the NIPP is two, two inseminations are performed for each pregnancy, that is, the pregnancy rate is 50%.

It can be stated that the number of inseminations per pregnancy is not a very accurate reproduction parameter because, it is calculated from inseminations per pregnancy. However, in order for insemination to be carried out, estrus must be detected. Looking at the data and information obtained from the field, cows that did not become pregnant were found even though they were inseminated 10, 16, 17, and even 19 times. Their number is insignificant. The fact that the average DIM is 250 and above in farms that are said to have no problems in our business, not only in Türkiye but also in many countries of the world, confirms this image in the field. The explanation of NIPP not being a good breeding parameter can be explained as follows; 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 case, the NIPP is one (1). Looking at this NIPP value, the business seems to be very successful. Whether this value means the truth or not can be understood by looking at the service period or calving interval. This can be easily detected in the figures on the field. If one or both of the 10-12 heats are caught and pregnancy is achieved when insemination is performed, the NIPP would be 1 or 2. As stated above, this does not reflect the success of the business. Instead, the correct parameter should be the number of estrus per pregnancy (NEPP). It will be seen that when NEPP is used instead of NIPP, it will overlap with other breeding parameters (such as the service period, the calving interval). It can also be understood from the number of inseminations per cow (NIPC) parameter mentioned in the literature that, (NEPP) is more suitable in terms of showing whether the herd is well managed. NIPP is calculated from inseminated and pregnant cows, whereas there are cows in the herd that do not become pregnant after insemination. Real success should be based on the low or high number of inseminations per cow.

Service period

One of the best indicators of reproductive performance is the service period. Service period; It is the time from birth to conception again. The aim of the breeders should be to keep this period around 100-110 days. The optimum of this period is 365-280 = 85 days since the gestation period to reach the calf target every 12 months for cattle is 280 days. Since the gestation period in the herd does not change much, every average value greater than 85 days will cause the calving interval to deviate from 12 months, that is, to prolong it. Smith and Becker (1994) reported a cost of $2-5/day per cow if the service period exceeds 90 days. According to the same researchers, if, for example, a cow's service period is 120 days, this deviates from the normal period by 30 days, resulting in an additional cost of $3 per day per cow, which results in a loss of $30 x 3 = $90. According to another literature (Boztepe et al., 2015), there is a loss of 5-10 (average 7.5) kg/cow for concentrated feed per day for 90 days. Consequently, there will be a concentrated feed loss of 30 x 7.5 = 225 kg/cow for a 30-day deviation. De Vries (2006) reported a loss of $2.11-7.46/cow for each additional day.

Service period are affected by many factors; (1) the time we consciously wait (voluntary waiting period), (2) accurate estrus detection, (3) semen quality, (4) mating technique, (5) cow's reproductive ability, (6) diseases, and (7) weather conditions (Poock et al. 2009).

Poock et al. (2009) reported the cost of each additional day as 0.42 - 4.92 $/day/cow after DIM became 110 days, while an average cost of $2.5/day was taken into account in the calculations. While the average service period of the 336 herds kept was 184 days (between 84-358 days), the country average was 165.8 days. According to this;

184 - 165 = 19 days

19 x $2.5 = $47.5 deviation from the national average cost per cow.

In addition, a service period of 110 days means a deviation of 25 days from the ideal calving interval of 12 months and 10 days more from the target calving interval of 12.5 months. To make the figures more understandable or to concretize the calculations, for example; If there are 500 fertile animals in a holding, the deviation from the target will be a total loss of 5000 days in 10 days, and approximately 14 calves lost (5000 / 365 = ~ 14 calves) from the deviation of only 10 days. At the same time, loss of 14 calves means loss of 14 lactation milk yields. Although this evaluation is not physiologically possible, it was made to embody the damage caused by the time lost.

Le Blanc (2007), in his calculations using the Graenendaalz model, determined the daily cost of extending the service period at 90, 150, and 210 DIM, respectively, as $1.5, $2.10, and $2.5. Based on Overton (2009), the same investigator estimated that the cost of one day of service period was $0.60 for 100 DIM, $2.10 for 150 DIM, $3.25 for 210 DIM, and $3.60 for 250 DIM.

Mating interval

The mating interval is the best indicator of how accurately the heat that may occur after the first insemination is detected. The mating interval (CA) is calculated as follows (Grusenmeyer et al., 1983); CA = (SP Average – DIM at First Mating) / (Number of Inseminations Per Cow-1). If there are no cystic ovaries or embryonic deaths (if estrus in the flock is detected correctly and on time with 100% accuracy), the average mating interval is 21 days. Since it is not possible to detect 100% estrus, if the mating interval falls below 24 days, it means that several cows have been mated without heat. Errors in estrus detection can be found from the average of the mating interval. Table 2 can be used for this.

In Table 2, there is a negative relationship between the increase in the mating interval average and the accuracy of the estrus detection rate. As can be seen from Table 2, when the average mating interval is 60 days, approximately three heats can fit into the interval, which should be 21 days. Therefore, 30% estrus detection accuracy is consistent with this result. In other words, when the average mating interval is 60 days, two of the three heats are missed while one is detected.

Grusenmeyer et al. (1983), in their study on the inconsistency of records kept on farms, examined the reproductive parameters, compatibility or incompatibility between them in seven different herds. Determining the problems of some reproduction criteria based on a few flocks by using the mating interval and how they should be interpreted will be given below according to Table 3. NIPC is usually larger than NIPP. This is due to cows that have never been conceived despite being inseminated. For this reason, NIPC is considered an important reproduction criterion in herd management.

Table 2. Estrus detection rates from the average of the mating intervals (Grusenmeyer et al. 1983)

Tablo 2. *Çiftleşme aralıklarının ortalamasından östrus tespit oranları*

Average Mating Interval (days)	Heat Detection Accuracy (%)	False Detection (%)
23	90	10
26	80	20
30	70	30
35	60	40
41	50	50
50	40	60
60	30	70

Table 3. Condition of mating interval according to some reproductive parameters (Grusenmeyer et al., 1983)

Tablo 3. *Bazı üreme parametrelerine göre çiftleşme aralığının durumu*

Herds	Service Period (days)	$\overline{DIM}$ at first insemination (days)	NIPC*	NIPP**	Breeding interval (day)
1	163	81	1.49	1.26	178
2	136	85	2.03	1.82	49
3	141	85	2.94	2.53	29
4	156	84	2.67	1.14	43
5	91	77	1.43	1.22	33
6	103	69	2.27	1.93	27
7	166	88	4.01	2.91	26

*NIPC: Number of insemination per cow, **NIPP: Number of insemination per pregnancy

In Table 3, herds 1, 4 and 7 appear to have similar problems. The service periods in these three herds are extremely long. In all three herds, the first mating is between DIM 81 and 88 days. In other words, it can be said that starting from the service period, an additional 72-82 days (156 - 84 = 72; 163 - 81 = 82) passed from the first mating to conception in these three herds. This means approximately an additional 3.4 to 3.9 estrus cycles (72 / 21 = 3.43, 82/21 = 3.90). In the first herd, this extra cycle is almost 4. The value in the seventh herd appears to be congruent at 4.01 inseminations per cow. Although there are not many errors related to the recording in this herd (7), the NIPP value of 2.91 indicates the existence of some problems in terms of herd management. The seventh herd's problem is probably the failure to detect estrus. Another important problem in herd 7 is related to ensuring pregnancy. There may be a problem in determining the time of insemination, an untreated disease related to reproduction in the herd, or other reasons.

The NIPP of the fourth herd is an amazing value of 1.14. The problem with this herd is the 43-day mating interval, which means that one of the two heats has been missed in this herd (2 x 21 = 42 days). However, it turns out that approximately 3.5 cycles are missed by dividing the difference between the service period and the DIM at the first mating by the 21-day cycle. There is an inconsistency between the records. It is recommended to re-examine the application of a good heat monitoring program and recording system or to make regular recordings for this herd.

Herd 2 has a fairly high service period. Fifty-one days passed from first mating to pregnancy (136-85=51 days). The fifty-one (51) day period is not incompatible with IBTS and GBTS. Because the number of mating or cycles that can be made during this period is around 2.43 (51/21=2.43). The number of inseminations per cow is 2.03, which is close to it. The fact that the mating interval is 49 days indicates that there is a serious problem. In other words, the interval is expected to be less than NIPC and NIPP. In other words, if NIPC or NIPP is close to 2, at least the mating interval must be between 20-25. On the other hand, the fact that the mating interval is around 49 days according to Table 2 shows that approximately 40% of the heats in this herd can be caught.

At least two problems appear to contribute to the 141-day high service period in herd 3. The first of these is related to pregnancy, and the average NIPP in the herd is 2.53. For this, a pregnancy control is required. Its causes should be thoroughly investigated. The second is the 29-day mating interval. Although the contribution of this value to the high service period is not as high as that of NIPP, the 29-day mating interval means that only about 72% (21 x 100 / 29) of the heats in this herd are determined (Table 2). Little effort in estrus detection will contribute to the reduction of the mating interval.

Herds 5 and 6 have good service periods and DIM at first mating. Each of these herds has different problems. Herd 5 has an excellent average NIPC and NIPP. This entity may have used a "cleaning bull" and not recorded it. The problem with herd 5 has to do with estrus detection. Approximately, only 64 % (21 x 100 / 33) of estrus were caught in this flock (Table 2). On the other hand, herd 6 is very good at estrus detection because the time between mating is 27 days. However, there is a problem with the pregnancy rate because NIPP is 1.93. Despite everything, the herd in the best condition is the sixth herd.

An important conclusion to be drawn from Table 3 is that it shows how serious and vital record keeping is in herd management. Because in terms of criteria, it shows itself in a general evaluation in the herd.

Herd 1 has a special case. There is a mating interval of 178 days and 1.26 inseminations per pregnancy. Here (1) a few heats were detected/not detected correctly, (2) probably mating dates/records were not kept properly, (3) "cleaning bull" might have been used in the herd. The "cleaning bull" could have a serious contribution to 1.26 NIPP, as no records are kept. In addition, in a situation where the service period is 163 days and the time between mating is 178 days, the NIPP value of 1.26 raises the suspicion that some artificial insemination records were not recorded.

Calving interval

The calving interval (CI) is the period between two successful calvings. CI is a reproductive management parameter that is influenced by two important reproductive criteria, such as the service period and the gestation period.

Although the duration of pregnancy is an effective factor, it cannot be changed. However, a dairy producer can control the affected calving interval during the service period. The calving interval is tried to be kept between 12-13 months. Overall, a 12.5-month CI is suitable for most businesses. Losses per cow in case of moving away from the calving interval target are shown in Table 4.

Table 4. Economic losses that may be associated with CI due to administrative errors and labor practices (Smith and Becker, 1994)

Tablo 4. *İdari hatalar ve iş gücü uygulamaları nedeniyle BA ile ilişkilendirilebilecek ekonomik kayıplar*

Calving interval (month)	Loss per Cow ($)
12.6	0.00
13.0	0.36
13.3	14.62
13.6	32.96
14.0	57.54
14.3	88.92

As can be seen from Table 4, while the loss per cow is not calculated at 12.6 months of CI, a loss of $0.36 is mentioned in 13 months. When the calving interval is extended from 13 months to 13.3 months, the loss per cow is $14.62. So, an increase of 0.3 months (10 days) corresponds to $14.26. The cost of CI extending from 13.3 months to 13.6 months (another ten-day increase) is $32.96 per cow, and the cost of the last 10-day increase is $18.34 compared to the previous (compared to 13.3). Likewise, the cost of CI increasing from 13 to 14 months (one-month increase) is 57.54-0.36 $ = $57.18. The cost of the next 10-day increase is $31.38 (i.e. 88.92-57.54). It should be understood from Table 4 that after 13.3 months of CI, the break begins and the loss per cow doubles almost every 10 days.

The study by Smith and Becker (1994) related to the effect of the calving interval is given in Table 5. Smith and Becker (1994), in their study on determining the average lactation milk yield depending on the last calving interval, reported that if the calving interval is 12.5-12.9 months, the average lactation milk yield has the highest value, and the lactation milk yield gradually decreases after 13.5 months (Table 6).

Table 5. Average lactation milk yield (795 herds, 121.773 cows) depending on the last calving interval (Smith and Becker, 1994)

Tablo 5. *Son buzağılama aralığına bağlı olarak ortalama laktasyon süt verimi (795 sürü, 121.773 inek)*

Calving interval (month)	Milk yield average (kg)
11.5 - 11.9	6838
12.0 - 12.4	7911
12.5 - 12.9	8322
13.0 - 13.4	8398
13.5 - 13.9	8110
14.0 - 14.4	8069
14.5 - 14.9	7918
15.0 - 15.4	7260
15.5 - 15.9	7180
16.0 - 16.4	6757

The calving interval also has effects on milk sold per cow, labor per worker and administrative income, in short, the workplace (Table 6).

Table 6. Workplace factors associated with calving interval (CI) (Grusenmeyer et al. 1983)

Tablo 6. Buzağılama aralığı (BA) ile ilişkili işyeri faktörleri

Calving interval (month)	Milk Sold (kg/cow)	Labor and Administrative Income ($/worker)
12.5 or less	6628	19,728
12.5-12.9	6810	21,949
13.0-13.4	6674	20,648
13.5-13.9	6447	18,325
14.0 or more	6538	18,291

It can be seen from Table 7 that the percentage of cows in the herd with a recommended or acceptable 12-13 month calving interval is 48.1% ((27 + 25) / 108 = 0.481). Seventeen (17) heads of cows (15.8% = ((15 + 2) / 108) x 100) have a calving interval of 13-14 months. This may be acceptable for some record keeping businesses as some breeders plan to produce high volumes of milk for 11-12 months.

However, more than 13 months of CI is not economical in commercial enterprises, with cows near or below average yields. Eleven (11) cows (10.2%) had CI for more than 14 months. These cows are likely to have had problematic and repeated mating. These types of cows should be closely monitored for cleaning purposes.

Some short CI's also cause a short milk production period. However, it is not very meaningful to make a statement about 28 cows with calving intervals of less than 12 months in Table 7. If cows are bred for the first time between 45-70 days after calving, they have a higher chance or chance of conceiving than those bred before 45 days. Without solving the reproductive problems of the herd or individual cows, no clear conclusion can be reached on the average calving interval. Unplanned short-term lactations have a life-long yield reduction effect due to the increased percentage of dry months.

Table 7. Scatter chart analysis of calving interval (Grusenmeyer et al. 1983)

Tablo 7. *Buzağılama aralığının dağılım grafiği analizi*

	Service Period(SP) (days) Calving interval(CI) (month)								
SP (days)	76>	76-86	87-101		102-116		117-131	132-146	147<
CI (month)	11.7>	11.7-12.0	12.1-12.5		12.6-13.0		13.1-13.5	13.6-14.0	14.0 <
Ear number of Animals	3	12	4	94*	9	132*	7	40	13
	20	18	6	91	26	137	15	103	24
	52	25	10	99	29	140	9		63
	71	35	11	102	30	123	45		91
	104	68	14	106	36	127	60		119
	109	23	17	111	38	130	83		150
	118	78	23	114	50	131	88		41
	124	85	28	116	56		101		84
	128	95	31	121	75		125		100
	143	96	42		81		135		134
		105	54		86		139		151
		107	58		92		142		
		115	70		100		144		
		117	73		103		145		
		120	74		110		146		
		126	77		113				
		138	79		122				
		141	87		129				
Number of Cows	10 (% 9.2)	18 (% 16.6)	27 (% 25)		25 (% 23.1)		15 (%13.9)	2 (% 1.9)	11 (%10.2)

*Other animal numbers are given in the second column.

Average of days in milk ($\overline{DIM}$)

DIM (days in milk) is one of the most important herd management criteria. Individually, DIM simply indicates the number of days an animal has been milked or the day of lactation. However, the average DIM in the herd indicates the average number of milking days in the herd. In other words, it shows how many animals in the herd are milked on average in a year. For example, if the lactation day of these 1000 animals is determined on this day (control day) in a farm with 1000 milkers and the average is taken, this is found as the "average days in milk". In well-managed herds where the births are distributed throughout the year, the average of DIM on any day (control day) in 365 days should be 150-160 days. It is expected that those that started milking on the control day are those on the first, 5th, 55th, 155th, and the 255th day of the DIM, including the end of lactation (animals that have been milked for 300-310 days), that is, animals that will dry out on the control day. With a simple calculation, when we take into account the first day of milking on the control day and the animals that dry up, (1+305)/2 average is expected to be 153 days. Other animals in the herd show a distribution between 1 and 305. In other words, the closer the animal is to 1, the closer it is to 305. Most animals will tend to swarm around the mean (153 days) as they should. In the light of this explanation, the lactation day of all animals on the control day is determined and if the average is taken, the average DIM is expected to be around 150-160 days. Averages close to these values are an indication that the herd is well managed and that it is a profitable business. It is concluded that the management deteriorates in proportion to the deviation from these values. In addition, the fact that this value is well below 150 days indicates that the herd consists of animals that have just started lactation. Sometimes there are herds with an average DIM of 150 or 160 days, the first question to ask then, is the lactation order of the animals in the herd. Because, as has just been stated, these values do not mean anything in terms of herd management in newly established herds. Anger aggregation in the herd might also be another reason.

Based on the monthly summaries of the herd, the 12-month average days in milk should be 160-170 days. In addition to what has been stated above, it can be said that the inspection day is any day out of the 365 days of the year. That is, an average of 365 days.

So, for example, if the $\overline{DIM}$ value is 200 instead of 150, it indicates the presence of animals in late lactation, or the lactation period is longer than it should be, due to reproductive problems (not keeping offspring). Again, milking a large number of late lactation cows leads to a decrease in the average daily milk yield in the herd (Figure 1). Also, $\overline{DIM}$ will change from month to month as a result of breeding problems or irregular calving.

The average milk yield on any day can be accepted as an estimation of the annual (365 days) average of that herd in a business that is formed normally, that is, the births are distributed throughout the year. The annual production/cow can be approximated by multiplying this average by 365. In the estimation of the annual lost milk yield; (1) for example $\overline{DIM}$ 250 days and optimum $\overline{DIM}$ 150 days, there is a deviation of 100 cows/day, (2) this deviation is an average deviation per animal, (3) milk yield at 250 $\overline{DIM}$ is 20 kg, 150 If it is assumed that 27 kg in $\overline{DIM}$, there is a loss of 7 kg/cow/day for 100 days, (4) if 1000 milkers are assumed in the herd, this is 7 x 1000 x 365 = 2 555 000 kg milk/year loss (5) another fact is 100 $\overline{DIM}$ deviation is one deviation per cow, so there are 1000 x 100 = 100 000 days lost/year, (6) 100000 / 365 days (calving interval) = 274 calves/year lost (7), 274 calves/year means 274 lactation losses per year.

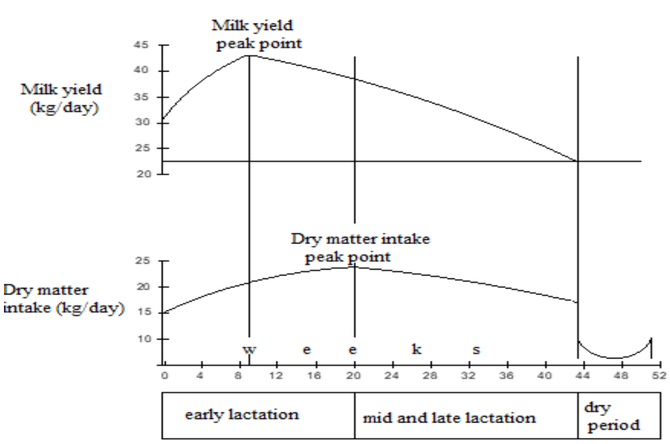

Figure 1. Distribution of milk yield and dry matter consumption throughout lactation (modified from Yavuz 2017)

Şekil 1. *Laktasyon boyunca süt verimi ve kuru madde tüketiminin dağılımı (Yavuz (2017)'den uyarlanmıştır)*

Figure 1 is plotted regarding a normal lactation curve and dry matter consumption during lactation.

Figure 1 shows the 8th-9th days of lactation. It is seen that the milk yield peaks in weeks. Although milk yield decreased from the 9th week, dry matter consumption continued to increase until the 20th week. In the following period, dry matter consumption tended to decrease with the decrease in milk yield. Accordingly, if the $\overline{DIM}$ is 150 days versus 200 days (ie at the 30th week compared to the 20th week), there is more dry matter consumption for milk production, and the cost of milk increases.

A high average DIM value means a large number of cows that are not adequately evaluated. As mentioned above, milking a large number of late-lactation cows leads to a decrease in the average daily milk yield of the herd (Figure 2-3).

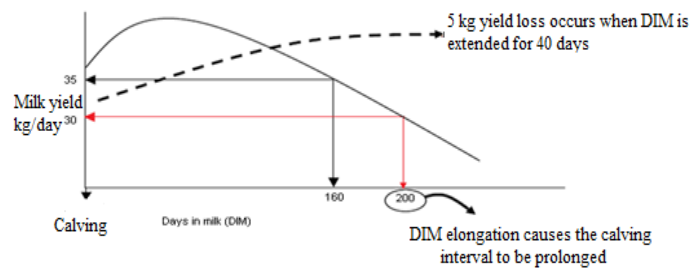

Figure 2. Effects of $\overline{DIM}$ elongation on milk yield and calving interval (Ahmadzadeh and Heersche, 2011; Ahmadzadeh, 2017)

Şekil 2. *$\overline{DIM}$ uzamasının süt verimi ve buzağılama aralığı üzerindeki etkileri*

As can be seen from Figure 2, the extension of $\overline{DIM}$ for 40 days (200-160) means a loss of milk yield of 5 kg/cow/day (35-30 kg). In addition, due to missed estrus or fertility problems, the prolongation of the $\overline{DIM}$ also causes the calving interval to be prolonged.

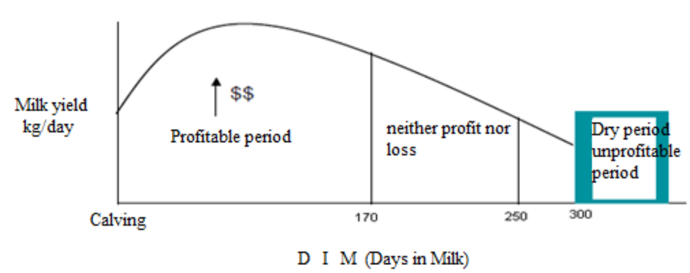

Figure 3. The effects of $\overline{DIM}$ on profitability by periods (Ahmadzadeh and Heersche, 2011; Ahmadzadeh, 2017)

Şekil 3. *Dönemlere göre $\overline{DIM}$'in karlılık üzerindeki etkileri*

Figure 3 shows that well-managed herds yield up to 170 $\overline{DIM}$, but in the next 80 days, neither profit nor loss period begins. It is understood that the damage period starts from 250 $\overline{DIM}$ and then at 300 $\overline{DIM}$, the animals are already dried out and there is no yield, so it is an unproductive period. In fact, from 300 $\overline{DIM}$, during the seemingly unproductive period, the fetus grows faster and the animal is prepared for the next lactation. In this respect, the dry period can be considered as a kind of fallow.

Woodley (2003) examined the decrease in milk yield and consequent decrease in income with the progression of DIM. Milk yield of 35 kg/cow/day and income close to \$20/cow/day at 150 DIM decreased to 30 kg/cow/day milk yield and \$15-16/cow/day income at 200 DIM. How this situation, named as the progression of DIM, affects individual milk yield is understood by De Vries (2006) from yield records in the University of Florida flock (Table 8). For example, the first cow's milk yield at 611 DIM is 62.8 lb/day (approximately 28.5 kg/day), while the second cow's milk yield at 201 DIM is 97.6 lb/day (approximately 44 kg/day). From the data, the yields of animals with low DIM have higher milk yield than those with high DIM. From the same data, the negative effect of DIM elongation on calving interval can also be observed. For example, the first cow gave birth for the last time on 28.05.2004 and was bred for the last time almost a year later 10.05.2005. If the animal has not become pregnant, the DIM (OPEN; ON) and calving interval will continue to be extended, and if the animal has not dried out, the milk yield will be minimal. Even assuming that it is pregnant, the calving interval will approach approximately two years due to the 12 months wasted and additional gestation period, causing the loss of a calf.

The average milk yield at 200 DIM of the lactation curve in a herd of 100 cattle with an average of 11800 kg of milk yield adjusted for 305 days is 35 kg/day. If an improvement in pregnancy rate was achieved in this herd, a cow at 180 DIM would give 36.4 kg/day of milk based on the lactation curve. If the income from milk is \$ 0.40, \$0.10 of this is the cost of feed. The remaining \$0.30 is multiplied by 36.4 – 35 = 1.4 kg between 200 DIM and 180 DIM milk yield, resulting in a difference of \$0.30 x 1.4 kg = \$0.42/kg/cow/day. This, multiplied by 365 days and 100 cows, gives an annual loss of 0.42 x 365 x 100 = \$15330, or a profit of \$15330 by providing 180 DIM instead of 200 DIM (Le Blanc (2007) quoted from Overton (2006)).

Table 8. $\overline{DIM}$-milk yield relationship in University of Florida flock (De Vries, 2006)

Tablo 8. *Florida Üniversitesi sürüsünde* $\overline{DIM}$ *-süt verimi ilişkisi*

University of Florida Dairy Research Herd
Sorted by Insemination Value (IN\$), February 14, 2006

Index	DIM	Lact#	LastCalv	DIM_Tst	LastBredMDY	Milk	STATUS
4709	627	1	5/28/04	611	10/5/05	62.8	OPEN
4735	217	2	7/12/05	201	1/14/06	97.6	BRED
4706	651	1	5/4/04	635	9/27/05	62.3	OPEN
4671	272	2	5/18/05	256	1/20/06	77.8	BRED
4679	146	2	9/21/05	130	1/13/06	128	BRED
4562	177	2	8/21/05	161	1/18/06	102	BRED
4770	193	2	8/5/05	177	1/5/06	89	OPEN
4703	223	2	7/6/05	207	1/27/06	98.5	BRED
4673	182	2	8/16/05	166	2/9/06	99.8	BRED
4462	351	2	2/28/05	335	1/4/06	55.7	OPEN
4420	480	2	10/22/04	464	10/27/05	64.2	PREG
4232	156	4	9/11/05	140	1/27/06	85	BRED
4451	211	2	7/18/05	195	1/4/06	87	OPEN
4608	146	2	9/21/05	130	1/15/06	96.2	BRED
4659	181	2	8/17/05	165	2/3/06	82.9	BRED
4723	156	2	9/11/05	140	1/17/06	89.6	BRED
4727	147	2	9/20/05	131	2/9/06	93.6	BRED

Until now, the negative effects of the deviation of the DIM value from the optimum on milk yield and feed consumption have been discussed. As explained earlier, if the average DIM value is 250, its deviation from 150 is 100 days. So, there is a loss of 100 days per cow. Assuming that there are 1000 milking cows in the herd, there is a loss of 1000 x 100 = 100 000 days per year. Assuming that the calving interval is 365 days, 100 000 / 365 = 274 calves/year are lost. This also causes a loss of 274 lactations/year. All these are profit losses for businesses that seem to be making a profit. This shows that $\overline{DIM}$ should be used more in controlling herd management and revealing the profitability of the business.

Some talk about efforts to reduce, ie $\overline{DIM}$, in the herd by removing problem animals from the herd. This is nothing but a postponement of the problem. If the deficiencies in herd management are not eliminated, the previous scene will be repeated after a while.

According to Young (2002), the increase in the $\overline{DIM}$ value (for example, over 200 days) is primarily due to reproductive disorders. High DIM negatively affects milk production because as $\overline{DIM}$ increases, the percentage of late lactating cows increases. The longer the lactation, the lower the milk yield. Dairy producers with long DIM averages who want to increase their daily milk production per cow are disappointed with the decline in milk yield. It is necessary to compare the milk yields of cows with different lactation numbers (orders) by adjusting for the number of lactations. For example, the difference between a group of cows lactating 28 kg in the 1st lactation ($\overline{DIM}$230 days) and a group of cows lactating 32 kg in the 3+ lactation (($\overline{DIM}$) = 160 days) appears normal until a correction for $\overline{DIM}$ is made. After making the fix, there is no difference or not a significant difference between the two. The adjusted value of $\overline{DIM}$ for 230 days in the first lactation was 28 kg, while the adjusted value of $\overline{DIM}$ for 160 days in 3+ lactations was 28.5 kg. Assuming the loss for each day of $\overline{DIM}$ is 50 g (0.05 kg), there is a difference of (230 - 160) x 0.05 = 3.5 kg, which is 32 kg when subtracted from 32 kg for 160 days $\overline{DIM}$. 3.5 = 28.5 kg. To summarize, lactation groups should not be compared without adjustment for ($\overline{DIM}$).

The calculation of ($\overline{DIM}$) from the calving interval is given in Table 9.

In the calculations below, optimum ($\overline{DIM}$)is taken as 160 days, a year as 365 days.

(Calf Interval (days) x $\overline{DIM}$ (days)) / 365 (days) (If 160 days $\overline{DIM}$is optimal in the 365-day optimum calving interval, how much is $\overline{DIM}$in the 460-day calving interval?)

Likewise, calving interval from annual ($\overline{DIM}$):

($\overline{DIM}$ (days) x 365 (days)) / Optimal $\overline{DIM}$ (days)

Calculation of the estimated number of estrus missed from $\overline{DIM}$ and calving interval;

In calculating the number of estrus missed from $\overline{DIM}$, the ratio established below is how many normal days one (1) optimum $\overline{DIM}$ day corresponds to.

If the optimum $\overline{DIM}$ is 160 days in 365 days,

How many days is 1 $\overline{DIM}$ in x days? From this x = (365 x 1) / 160 = 2.28125 days.

Accordingly, the optimum $\overline{DIM}$ is subtracted from the herd's $\overline{DIM}$, then this is converted to a normal day and the missed estrus is estimated by dividing by the time between heats. These calculations are shown in Table 10.

When calculating from the calving interval, the optimum calving interval of 365 days is subtracted from the current calving interval and divided by the period between heats.

Table 9. Calculation of average DIM ($\overline{DIM}$) from calving interval and calving interval from $\overline{DIM}$

Tablo 9. Buzağılama aralığından ortalama DIM'in ($\overline{DIM}$) ve $\overline{DIM}$ 'den buzağılama aralığının hesaplanması

Calving Interval (CI) (days)	Yearly $\overline{DIM}$ (days)	Calculating the Calving Interval from $\overline{DIM}$	Practical Calculation of Calving Interval from $\overline{DIM}$
460	(460 x 160) /365 ~202	(202 x 365) / 160 ~460	202 x 2.28* ~ 460
440	(440 x 160)/ 365~ 193	(193 x 365) / 160 ~ 440	193 x 2.28 ~ 440
420	(420 x 160)/ 365~ 184	(184 x 365) /160 ~ 420	184 x 2.28 ~ 420
400	(400 x 160)/ 365~ 175	(175 x 365) /160 ~ 400	175 x 2.28 ~ 400
380	(380 x 160)/ 365~ 167	(167 x 365) / 160 ~ 380	167 x 2.28 ~ 380
365	(365 x 160)/ 365~ 160	(160 x 365) / 160 ~ 365	160 x 2.28 ~ 365

*How to calculate the coefficient of 2.28 is explained below.

Table 10. Average DIM ($\overline{DIM}$) or estimation of the number of estrus missed from the calving interval

***Tablo 10.** Ortalama DIM ($\overline{DIM}$) veya buzağılama aralığında kaçırılan östrus sayısının tahmini*

Yearly $\overline{DIM}$ (days)	Estimated Number of Estrus Missed from Annual $\overline{DIM}$ (pcs)	Calving interval (days)	Estimated number of Estrus Missed from Calving Interval (pcs)
202	((202-160) x 2.28) / 21 = 4.5	460	(460 - 365) / 21 = 4.5
193	((193-160) x 2.28) / 21 = 3.6	440	(440 - 365) / 21 = 3.6
184	((184-160) x 2.28) / 21 = 2.6	420	(420 - 365) / 21 = 2.6
175	((175-160) x 2.28) / 21 = 1.7	400	(400 - 365) / 21 = 1.7
167	((167-160) x 2.28) / 21 = 0.7	380	(380 - 365) / 21 = 0.7
160	((160-160) x 2.28) / 21 = 0.0	365	(365 - 365) / 21 = 0.0

CONCLUSION

Some reproductive criteria, their shortcomings, and their applicability are mentioned and discussed in this study. It has been argued that the number of inseminations per pregnancy is not an accurate parameter in terms of showing the success of reproductive management in the herd, but instead, the number of estrus per pregnancy (NEPP) is a more accurate parameter. We have also tried to explain that, when the correct parameters are kept and used, the harmony between the parameters can be seen. In addition, we again tried to explain that the days in milk (¯DIM) parameter of the herd is a very important and practical parameter in terms of not only showing the reproductive management of the herd but also showing the general management and profitability.

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