

# THE ECONOMIC EFFICIENCY OF USING HEIFERPLUS SEMEN IN DAIRY FARMS

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## Abstract:

*This work aims to increase the economic efficiency of dairy farms by improving the fecundity indicators and increasing the number of cows obtained. The research was carried out in the context in which the slaughter age of cows has decreased to 2.8 lactations, and the herds of dairy cows in our country are in a proportion of 93% held in holdings of up to 5 heads, which endangers the sustainability of these farms. In the context where 0.8% of cattle/year are obtained from a cow, of which only 0.6% are viable and according to the ratio between the sexes, only 0.3% of cattle are born and the exchange of generations in this species is high, 4.8 years, the use of new semen processing technologies is required. One of these technologies is HeiferPlus. This technology uses conventional sperm enhanced with certain enzymes that capacitate spermatozoa carrying X or Y chromosomes depending on the desired direction. The work was carried out at the Research and Development Institute for Bovine Balotesti, on a herd of 89 heads, cows of the Romanian Black Spotted breed, where the efficiency of the use of HeiferPlus semen was analyzed. From the analyzed data, an increase in fecundity was found by 4.03% and the proportion of females obtained was 57.5%. In these conditions, the use of HeiferPlus sperm is recommended because by increasing fecundity, production costs decrease by reducing calving intervals and obtaining more cattle ensures the maintenance/increase of existing herds.*

**Keywords:** *economic efficiency, cows, HeiferPlus semen*

**JEL classification:** *Q01, Q19, Q55*

## INTRODUCTION

This work aims to increase the economic efficiency of dairy farms by improving the fecundity indicators and increasing the number of cows obtained. The research was carried out in the context in which the slaughter age of cows has decreased to 2.8 lactations, and the herds of dairy cows in our country are in a proportion of 93% held in holdings of up to 5 heads, which endangers the sustainability of these farms. In the context where 0.8% of cattle/year are obtained from a cow, of which only 0.6% are viable and according to the ratio between the sexes, only 0.3% of cattle are born and the exchange of generations in this species is high, 4.8 years, the use of new semen processing technologies is required. One of these technologies is HeiferPlus. This technology uses conventional sperm enhanced with certain enzymes that capacitate spermatozoa carrying X or Y chromosomes depending on the desired direction.

## MATERIAL AND METHOD

The work was carried out at the Research and Development Institute for the Breeding Cattle of Balotesti, between May 2020 and December 2021, on a herd of 89 cows of the Romanian Black Spotted breed that belong to the Institute. The analyzed cows were divided into two batches: the first batch consisted of 39 heads and the second one of 50 heads. The batch of 39 cows was artificially inseminated with conventional frozen semen and the batch of 50 cows was artificially inseminated with frozen semen obtained through HeiferPlus technology.

The frozen semen used in the experiment came from the Semtest Craiova resort and the amount of sperm used was collected from the Amadeo bull owned by Semtest. The gloves used for artificial insemination (AI) and the transrectal examination of cows as well as the sequins used for the torch during artificial insemination were purchased from the same Semtest.

The artificial insemination of the cows from the two experimental groups was carried out on a normal heat cycle by the bimanual method. The pregnancy diagnosis was performed 30 days after the artificial insemination. The gender diagnosis was performed 40 days after the confirmation of the pregnancy, respectively 70 days after the artificial insemination. Pregnancy control and gender diagnosis were carried out by specialists from the Institute with the help of a portable ultrasound machine through transrectal examination.

The obtained data were processed statistically with the help of the Microsoft Excel program.

## RESULTS AN DISCUSION

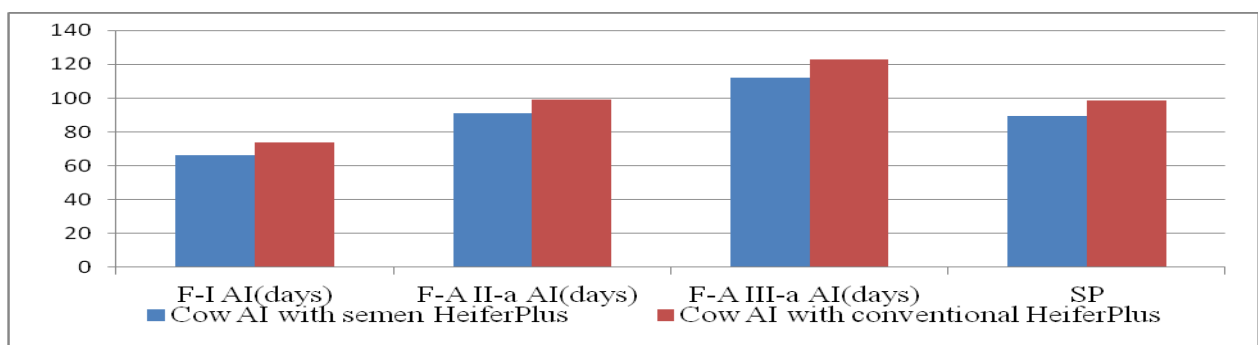
Table number 1 shows the fecundity analysis of cows from the two experimental groups. Fecundity represents the ability of animals to reproduce. This is achieved by the union and fusion of the two cells, the ovule and the sperm. In both females and males, fecundity is a hereditary characteristic influenced by many factors such as: the morphofunctional state of the genital system, the quality of the gametes, age, climatic factors, the use regime of the breeders, etc. Fecundity is assessed by the number of females that remained pregnant or by the number of artificial inseminations required to obtain a fertilization. The ideal fecundity in this species requires obtaining one calf/year (Jill Peine, 2022).

**Table 1. Fecundity analysis and number of artificial insemination / gestation**

Bull name/ frozen semen used	AMADEO HeiferPlus	AMADEO conventional	Frozen semen HeiferPlus/ Frozen semen conventional
n	50	39	
% FECUNDITY I IA	66	51,3	28,65%
% FECUNDITY II IA	78	74,3	4,97%
% FECUNDITY III IA	80	76,9	4,03%
No AI/G	1.8	2	
Fecundity semen HeiferPlus ~ fecundity semen conventional			0,340936 (p>0.05)

Table 1 shows that the fecundity obtained at the first insemination in the group of cows artificially inseminated with m.s.c. HeiferPlus was 66% which represents good fecundity (Cheryl Waldner 2022). This increased fecundity may be due to the higher movement speed of HeiferPlus spermatozoa (Heather R Ruenke 2022). The fecundity analysis of the group of cows inseminated with conventional semen shows that the fecundity obtained at the first insemination was 51.3%, which equates to low fecundity. The fecundity difference between the two groups analyzed at the first artificial insemination was approximately 29% higher in the group inseminated with HeiferPlus sperm. The results obtained at the second insemination show that in both batches of cows, fecundity exceeded 70%, which equates to good fecundity. The difference in fecundity between the two batches at the second artificial insemination was approximately 5% higher in favor of the HeiferPlus sperm. From the fecundity analysis obtained at the third artificial insemination, it is found that in the batch of cows where HeiferPlus frozen semen was used, this was 80%, which equates to a very good fecundity according to the specialized literature. The fecundity recorded in the group of cows where conventional frozen semen was used was somewhat lower, at 76.9%. The fecundity difference between the two batches was 4.03% higher in favor of the group of cows inseminated with HeiferPlus semen. If we relate this difference to what the manufacturer claims, namely that this sperm increases by 5-15% the chances of obtaining a pregnancy, we find that the result obtained in this experiment is close to the minimum threshold of progress ensured by the manufacturer. The analysis of the coitus index shows that in the group of cows artificially inseminated with HeiferPlus semen, the AI/G number was 1.8, which equates to good fecundity. In the batch of cows artificially inseminated with conventional semen, 2 inseminations were necessary to obtain a pregnancy, which equates to good fecundity. When the fecundity is greater than 2 AI/G, it is intervened (Ioan Hutu 2019).

Fisher's test analysis ( $p=0.340936$ ) shows that there are no significant differences between the two groups of cows ( $p \geq 0.05$ ). Even if from a statistical point of view no significant differences were found in the two batches of cows, from a percentage point of view differences in fecundity existed. Thus, during the second artificial insemination, the farmer spent 28.65% more conventional sperm, more gloves for the transrectal examination, more protective sequins and napkins in an attempt to achieve a pregnancy compared to HeiferPlus sperm. In the 3rd AI the expenses were 4.93% higher in the group of cows inseminated with conventional sperm compared to the group of cows inseminated with frozen semen HeiferPlus.



**Figure 1. Analysis of the service period for the two batches of cow**

From the graphic image above, it can be seen that the average time elapsed from calving to the first insemination, in cows inseminated with HeiferPlus semen, was approximately 66 days and in cows inseminated with conventional semen, it was approximately 74 days. This shows that there are no significant differences between the two groups. The duration of the estrous cycle between the first and the second IA was on average approximately 25 days, in both batches, which shows that some cows had longer or irregular cycles. This puts the insemination operator at a disadvantage, because he uses the reproduction calendar and based on this he must capture the optimal time window for artificial insemination. As the duration of the estrous cycle in cows has an average of 21 days, these long and irregular cycles have as a consequence, in most cases, the loss of the optimal period for artificial insemination, which leads to an increase in the duration of service period. Service period represents the mobile component of the calving interval. The average duration of service period in cows must be 80 days according to specialized literature. From the analyzed data, it can be seen that the duration of service period in the two groups was 89.7 days, in cows inseminated with HeiferPlus semen and 98.90 days in cows inseminated with conventional semen. This score leads to a decrease in income by increasing expenses. Moreover, the analysis of the service period shows that between the two batches there was a percentage difference of 10.25% in favor of the batch of cows artificially inseminated with HeiferPlus semen. This shows that productivity losses are much lower in cows artificially inseminated with HeiferPlus semen than in those artificially inseminated with conventional semen.

After performing the pregnancy diagnosis, 30 days after insemination, the cows are examined to perform the sex diagnosis. It is carried out with the help of the ultrasound machine between 55-90 days after insemination, respectively 25-60 days after the diagnosis of the pregnancy. Normally, in cows artificially inseminated with conventional sperm, 50% males and 50% females are born. New reproduction technologies have made it possible for this ratio to change in the desired direction. Thus, in farms that have herds specialized for milk production, the aim is to obtain females, and in feedlots and farms specialized in the sale of sperm, the obtaining of males. Today, according to specialized literature, up to 85% - 90% of cattle with the desired sex can be obtained.

The HeiferPlus technology, according to those who sell it, allows obtaining 60% - 70% of cattle of the desired sex with relatively low costs and with a better fecundity by approximately 5% - 15%. (<https://www.semtestcraiova.ro/#facilities>)

Table 2 shows the ratio between the sexes obtained in the two groups analysis

**Table 2 The analysis of the ratio between the sexes carried out in the two experimental groups**

n = 40 gestation semen HeiferPlus	Sex ratio semen HeiferPlus		Sex ratio with conventional semen	
	Males	Females	Males	Females
n= 30 gestation with conventional semen				
% sex ratio	42.5	57.5	53	47
Percentage difference between males and females	35.29		12.76	
Ftest sex ratio semen HeiferPlus ~ conventional semen	p=0.484476			
CHITEST sex ratio semen HeiferPlus 60% females	p=0,609834			

CHITEST sex ratio semen HeiferPlus 70% females	p=0,006377
CHITEST sex ratio conventional semen	0,548506

The sex diagnosis was carried out on the 70th day after insemination, respectively 40 days after the diagnosis of pregnancy and was carried out with the help of the ultrasound machine. The analysis of the gender ratio shows that in the group of cows inseminated with semen HeiferPlus, the percentage of females obtained was 57.5% and that of males was 42.5%. Similar results were obtained by Gaffari Turk and colleagues . The difference between the number of males and females was 35.29% higher in favor of females. This favors the farmer, breeder of milk cows, because in the next period the number of replacement females will increase, which will allow a better selection among the reformed cows. It is known that in dairy farms the biggest expenses are recorded with the purchase of the piggery material. Or in the context where the age of reformation of the cows is approximately 2.8 lactations, the farmer receives the insurance of the replacement female youth.

In the batch of cows AI with conventionally sperm, the percentage of males obtained was 53%, (G. Turk1 2015), 12.76% higher than the number of registered females. The large number of males obtained has the advantage that, in the short term, the farm will benefit from immediate financial resources by selling them, but it has the disadvantage that in the medium and long term, the rigor of the selection will decrease in order not to make the existing herd vulnerable. As the change of generations in cows is high, for 4.8 years, it is preferable that the percentage of females born over a period of time is at least 50% of the products so that this change can be carried out in optimal conditions.

Fisher's test analysis ( $p = 0.484476$ ) shows that there are no significant differences ( $p > 0.05$ ) between the two groups regarding the gender ratio obtained. Even if from a statistical point of view these differences are insignificant, percentage-wise there are differences between the two batches which admit that the use of HeiferPlus semen is a viable solution for obtaining a larger number of cattle of the desired sex.

The analysis of the CHITEST indicator was carried out to highlight the differences between the number of cattle with the desired sex obtained and the expected one. Thus, in the group that used conventional sperm, the gender ratio was 53% male - 47% female. As from this sperm it was expected that the gender ratio would be 50% male - 50% female (J.R.Roche 2006), the CHITEST indicator showed that in this batch there were no significant differences ( $p = 0.548506$ ) between the gender ratio obtained and the expected one ( $p > 0.05$ ). Even if from a statistical point of view it is found that there are no significant differences between the two sexes obtained, from a percentage point of view they exist and were in favor of males. This, in the long term, does not favor the farmer. In small and medium farms, up to 50 heads, where the profit margin is smaller, these percentage differences can tip the balance decisively between stagnation and progress. In the batch of cows artificially inseminated with HeiferPlus semen, it was found that the percentage of females obtained was 57.5% and that of males 42.5%.

From this batch, according to the estimates provided by the producer, the percentage of cattle obtained varies between 60% and 70%. From the analysis of the CHITEST indicator, it is found that if we compare the values obtained by us to the minimum value of cattle estimated by the producer (60%), there are no significant differences ( $p = 0.609834$ ); ( $p > 0.05$ ).

However, if we report the results obtained by us to the maximum value (70% cattle) estimated by the producer, the CHITEST analysis shows that there are significant differences between the obtained and estimated values ( $p=0.006377$ ); ( $p\leq 0.001$ ). By reporting the result obtained by us to the normal one of 50% male - 50% female, it is found that there are no significant differences between the two results ( $p=0.133614$ ); ( $p>0.05$ ).

If we compare the performances obtained by the two batches, namely: cows inseminated with conventional sperm 47% females and 53% males and cows inseminated with semen HeiferPlus 57.5% females and 42.5% males, it is found that between the two batches there are significant differences in terms of the ratio between the sexes of the products of conception obtained ( $p=0.035397$ ); ( $p<0.05$ ).

In order to be able to establish the economic efficiency of the use of HeiferPlus semen, the costs were calculated and the cost price was established. The cost price included: the purchase price of the dose with frozen semen and the price of the gloves for examination/artificial insemination. The price of the sequins for the insemination torch was not included because they come in the package with the frozen semen. In order to be able to make a comparison with the expenses recorded for performing the artificial insemination procedure with the conventional semen, the same costs were taken into account as with the semen HeiferPlus.

In table number 3, the economic analysis of the use of HeiferPlus semen is presented.

<b>Table 3. Economic efficiency of using semen HeiferPlus compared to conventional semen</b>						
Bulls	n=	Sperm dose price	No. AI/G	Gloves ETR (lei)	Sex diagnosis 70 days of gestation	
Amadeo HeiferPlus	40	21 Lei	1,8	3.9	17♂	23♀
Amadeo conventional	30	16 Lei	2	4.32	16♂	14♀
The cost of calves obtained from semen HeiferPlus	Females		41.7 Lei		41.7/23*21=38.07 Lei	
	Males				41.7/17*21=51.51 Lei	
The cost of calves obtained from conventional semen	Females		36.32 Lei		36.32/14*16=41.50lei	
	Males				36.32/16*16=36.32lei	
Percentage difference in yield between females obtained with heifer plus and those with conventional semen						9
Percentage difference in yield between males obtained with heifer plus and those with conventional semen						41.82
Percentage difference in yield between calves obtained with heifer plus and those with conventional semen						15.11
Ftest semen HeiferPlus ~ conventional semen						$p=0,298049$
Correl price semen HeiferPlus/calves						0.546479
Correl price conventional semen/calves						0.612965

From table number 3, it can be seen that the price with which the HeiferPlus was purchased was 21 lei/dose (approximately 4.3 euros). Since 1.8 doses of frozen sperm were used to obtain a pregnancy and 3 ETR shoulder gloves were consumed (0.72 lei/glove), we realize that the price for obtaining a fertilization was 41.7 lei (approximately 8.51 euros). Gloves were used as follows: first for artificial insemination; the second at the pregnancy test and the third at the gender diagnosis. From the data obtained, it was found that the distribution of costs was different between the two sexes registered and this was influenced by the number of products of the same sex obtained. Because of the 40 gestations obtained, 23 were female, resulting in a cost of 38.07 lei (approximately 7.76 euros) for obtaining a cow. From the analysis of the expenses for obtaining a male, it was found that the price was higher, approximately 51.51 lei (approximately 10.51 euros). The percentage cost difference between obtaining females and males in the batch artificially inseminated with semen HeiferPlus was 35.30% in favor of the females. The low cost of obtaining a cow compensates to a small extent the maintenance costs that the farmer has with the cow until it becomes primiparous. The higher cost of obtaining a male will negatively influence its selling price.

From the analysis of the costs of the batch inseminated with conventional semen, it was found that the price for obtaining a female was 38.21 lei and for obtaining a male it was 33.44 lei. The percentage difference in cost between females and males obtained with conventional semen was 14.26% in favor of males.

From the comparative analysis of the costs between heifers bred with HeiferPlus sperm and heifers obtained with conventional sperm, it is found that 9% more was spent to obtain a heifer with conventional material. From the comparative analysis of the costs for obtaining a male, it was found that in the lot inseminated with HeiferPlus the costs were 42% higher. From the analysis of the costs for obtaining a calf, it is found that in the group of cows where HeiferPlus sperm was used, the costs were 15.11% higher compared to the group inseminated with conventional material. As the farm of the Research and Development Institute for the Breeding Cattle of Balotesti owns specialized cows for milk production, so it is concerned with raising replacement female youth, it is found that the use of semen HeiferPlus is more profitable from an economic point of view than the use of conventional frozen semen .

The cost analysis using the Fisher test shows that there are no significant differences between the two batches ( $p=0.298049$ ); ( $p>0.05$ ). Even if from a statistical point of view these differences do not exist, percentage differences were found that can decisively influence the farmer's decision to use, in the future, the desired type of sperm for the artificial insemination of the cows in the herd.

The analysis of the correlation between the cost price and the cattle obtained in the lot artificially inseminated with semen HeiferPlus shows that there is a positive correlation between the two (0.546479). Similar results were also obtained from the analysis of the correlation coefficient in the group of cows where the conventional sperm was used (0.612965). This shows that if the costs will be higher, the number of cattle obtained will be higher. For a cow farm, this type of correlation is undesirable. In general, farmers prefer obtaining negative correlations in order to reduce their production costs and increase their benefits.

## CONCLUSIONS

- Fecundity in the group of cows artificially inseminated with semen HeiferPlus was higher by 4.03% than in the group of cows artificially inseminated with conventional semen.

- Fecundity at I AI was 28.65% higher in favor of HeiferPlus. This favors the increase of income by decreasing expenses.

- The sex ratio in the group artificially inseminated with semen HeiferPlus was 1.15 in favor of females compared to the group artificially inseminated with conventional semen where the ratio between sexes was 1.06 in favor of males.

- Reproduction indicator no. AI/G shows that in the batch of cows artificially inseminated with semen HeiferPlus, the efficiency was better.

The costs for obtaining a cow were 9% lower in the batch of cows inseminated with semen HeiferPlus, even though the cost of purchasing a dose of frozen semen was +31.25% higher.

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