



Influence of the age of first insemination and first calving in Holstein - Friesian heifers on farm economic efficiency

K. Stankov*

Department of Management, Faculty of Economics, Trakia University, 6000 Stara Zagora, Bulgaria

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Abstract. *The present study aims to assess the influence of the age of first insemination and first calving in Holstein-Friesian heifers on the cost of breeding and the cost of their marketing as breeding animals. For this purpose, a study was conducted on 7 farms (A, B, C, D, E, F, G) situated in Central and Southern Bulgaria in which Holstein-Friesian cattle are bred. The results of the study indicated that the age of first insemination in the controlled farms was 17.2 months on average, and the age of first calving (AFC) was 26.6 months, which was within the established norms for the Holstein-Friesian breed raised in the country. The heifers from farm A, which entered breeding age the earliest (at 16 months), as well as the age of first calving (25.3 months) had the longest utilisation period – 4.9 lactations. However, they did not develop the highest milk yield either and the economic performance from their raising was low. The heifers on farm F, with age of first insemination of 17.3 months, and first calving age of 26.8 months, and the ones from farm G, with ages 17.4 and 26.6 months, respectively, developed maximum milk yield per lactation. The expenses for raising a heifer of the Holstein-Friesian breed varied from BGN 1922 up to BGN 2389, with an average sum of cost for the studied farms amounting to BGN 2123. This indicated that the raising of heifers from a high-yield breed was an expensive undertaking, but when taking the necessary care for their breeding at a younger age during the period of use they developed higher milk productivity.*

Keywords: costs, expenses, investment, lactation, milk yield, performance

Introduction

The economic efficiency of dairy cattle farming depends on the timely and proper utilisation of the biological long-term assets (cows). In this regard, proper feeding and raising the young animals is of exceptional importance, for the sake of achieving optimal live weight, at which the biological potential for high milk yield can be successfully reached. According to Panayotova et al. (1997) and Popova (2003), the optimal age of first insemination of the heifers is 16-18 months, at the point they reach 65-70% of an adult cow's live weight, which is 360-400 kg for Holstein dairy cows. Premature insemination (before 14 months or under 60% of the live weight) of the heifers hampers normal growth, deteriorates their further sexual function, and has a negative effect on the quality of the offspring and the amount of the achieved milk yield (especially at 1st lactation). The popular practice in Bulgaria is for heifers to be inseminated at the age of 20-22 months, which is counterproductive, as it leads to difficult conception and culling due to infertility. Todorov (2009) considers that lower milk yields are achieved with animals inseminated at a later age, thus leading to an increase of the produce's production cost, delays in reproduction, and a decrease of economic cost-efficiency.

Le Cozler et al. (2008) underlined that in order to rear heifers

as efficiently as possible, from both a technical and economical point of view, it is necessary to improve the management of the farm. In most cases, the aim is to rear heifers at the lowest cost possible without any deleterious effects on future performances. According to the authors, rapid rearing lowers the age of sexual maturity and consequently may be an efficient way to reduce the non-producing period prior to conception.

It is accepted in the world cattle breeding practice that the optimal economically profitable model is for heifers' first insemination to take place between the ages of 15 and 18 months, and first calving – between 24.5 and 27.5 months (Wangler, 2011). Cooke et al. (2013) established optimum performance in UK Holstein-Friesian cows with an age of first calving of 23-25 months, as these animals performed well in terms of both milk production and fertility and had longer life in the herd. The authors noted that improving reproductive efficiency of heifers also increases profitability by lower rearing cost with no adverse effect on milk productivity after calving. Zavadilová and Štípková (2013) reported that the Czech Holstein cows with high AFC (33-46 months) had worse fertility at the first lactation and lower length of productive life compared to the cows with low (16-24 months) and average (25-30 months) AFC. According to Pirlo et al. (2000), reduction of AFC below 26 months consistently produced a positive effect

*e-mail: kocestankov@gmail.com; kocestankov@abv.bg

on the difference between milk yield and returns of the raising costs. The reduction of AFC to 23-24 months is more profitable than reducing AFC to 22 months, but possible biological limitations should be considered. Ettema and Santos (2004) found that Holstein heifers reared in 3 commercial dairy farms in California, USA, had the highest economic return when calving between 23 and 24.5 months of age. A study of Do et al. (2013) showed that maximum lifetime profit by Korean Holstein cows is obtained when AFC is between 22.5 and 23.5 months. Similar economic studies on the insemination terms, age of first calving and the duration of cows' utilisation for milk production, were conducted by a number of other authors as well (Tozer and Heinrichs, 2001; De Vries, 2008; USDA, 2013; Heinrichs and Jones, 2013; Penev et al., 2014; Shindarska et al., 2016; Krpálkova et al., 2014, 2017; Valchev et al., 2020).

Todorov (2009) indicates that female calves go in heat for the first time as they reach 40% of an adult animal's weight. Considering the adult cows' weight, this means reaching the weight of 240-260 kg, which usually occurs at the age of 9-11 months. Insemination should be performed at reaching 65% of the adult live weight, which is about 360 kg for the Holstein-Friesian breed.

The aim of the present study is to evaluate the influence of the age of first insemination and the age of the first calving in Holstein-Friesian heifers on the costs of breeding and the costs of heifers selling as breeding animals.

Material and methods

The objects of study were heifers of the high-yielding Holstein-Friesian breed. Seven farms were included in the study, all under selection control (for which we had all the necessary accounting primary data) and which had all the necessary accounting primary data for milk productivity, costs incurred for raising heifers and duration of use. The studied farms, situated on the territory of Central and South-eastern Bulgaria were with different capacity as follows: farm A (with the capacity of 88 cows), farm B (62 cows), farm C (60 cows), farm D (346 cows), farm E (137 cows), farm F (53 cows) and farm G (72 cows) with the total number of 818 cows. The study was conducted in 2013. Female calves are reared in individual cages on open sites until weaning. Calves are weaned after reaching the age of three months. Weaned calves and heifers intended for breeding are reared in groups formed by age and live weight in semi-open buildings.

The cows from the studied farms were free-stalls reared (freely in groups) with full mechanization of the production processes and observance of the requirements for animal welfare.

While conducting the investigation we used the analytical-consultative method, comparative analysis method, monographic study and mathematical methods for data processing. Supporting methods used in the formation of the information base for determination and analysis of the farms' efficiency was the survey method, as well as interviews.

The analysis used mostly data from the farms' primary accounting statements, statistical information from Stara Zagora territorial statistics office, data from the district directorates

of agriculture and forestry in Stara Zagora, Plovdiv, Sliven, Yambol and Burgas, as well as Agricultural Market Information System – AMIS (2020).

Results and discussion

The data in Figure 1 show that the milk yield of cows from the studied farms for the lifetime period of use averaged for one lactation varies widely - from 4207 kg for farm E up to 10227 kg for farm D. The milk yield of the cows from the respective farms for a lactation period of 350 days is 6058 kg, and for a period of 305 days lactation is 5166 kg on average, which is significantly higher than the average for Bulgaria, which is 3678 kg, but is also quite lower than the average for the EU countries, which for the same period is 7280 kg (Georgieva, 2020). Heifers from farms F and D, which were bred at the age of 17.3 and 17.4 months, developed the highest average milk yield per lactation.

According to data of the EASRAB (Yordanov et al., 2017), the average milk yield of Black-and-white breed (Holstein type) cows in Bulgaria is 5300-5600 kg, with 3.6 - 3.8% fat and 3.2 - 3.3% protein in milk.

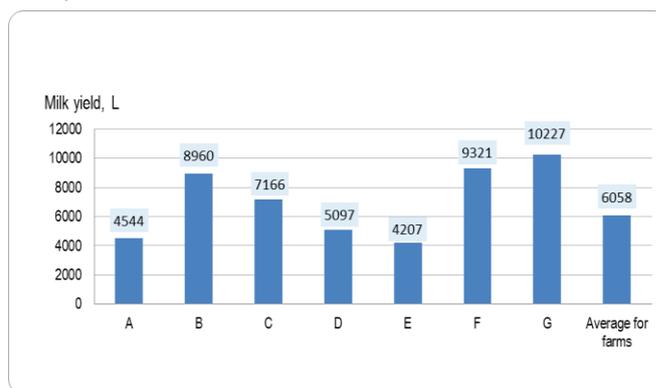


Figure 1. Average milk yield for lactation during the period of lifelong use of cows

The results in Table 1 show that heifer's age of first insemination was within 16 months for Farm A, and up to 18.9 months for Farm B. For the other farms, except Farm C, insemination age was within the established world norms. The farms are ranked in a similar way in terms of first calving age – between 25.3 (Farm A) and 28.1 (Farm B) months, average of 26.6 months. Only Farm B, where first calving occurred at the age of 28.1 months, was outside the established norm. The data obtained were close to the results reported by Marinov (2016) and a little higher than the average age at first calving in the USA for all dairy herds in 2007 - 25.2 months (USDA, 2007).

The data also indicated that Farm A had the largest average number of lactations of all farms – 4.9, and the longest lifelong cow's utilisation. The farm also had the lowest number of inseminations of the heifers - 2.1 times per production cycle on average. The data were quite indicative for the influence of the optimal term for first insemination on the further productive utilisation of the cows. For all other farms, the average number of lactations was comparatively low – from 3.0 for Farm F to 3.8 for Farm E.

Table 1. Heifers' age of first insemination and first calving

Farms	n	Age of first insemination		Age of first calving		Average number of lactations	Average number of inseminations
		months	days	months	days		
A	88	16.0	480	25.3	760	4.9	2.1
B	62	18.9	567	28.1	844	3.1	3.7
C	60	18.2	545	27.3	820	3.2	3.2
D	346	17.1	506	26.7	782	3.3	3.0
E	137	17.1	514	26.3	787	3.8	2.7
F	53	17.3	521	26.8	796	3.0	3.7
G	72	17.4	521	26.6	797	3.5	2.8
Average for all farms	818	17.2	514	26.6	790	3.5	3.0

Of interest are the data in Table 2 regarding the accrued expenses for raising a heifer from her birth to the time of first calving. In this regard, there is considerable variety among the studied farms. The expenses varied from BGN 1927 for Farm A to BG 2375 for Farm B. The other farms registered intermediate values, with the average expenses for raising a heifer from all

farms being BGN 2117. It is important for the cattle breeding industry to know that the cost of a heifer from farms with medium-high to high milk yield is over BGN 2000, and with a profit of 15-16%, its real value on the market reaches no less than BGN 2500. It is evident from the data that raising a heifer is a costly undertaking.

Table 2. Expenses for heifer raised for breeding (BGN)

Age in months	Farms							Average for all farms
	A	B	C	D	E	F	G	
0-3 months								
1. Milk up to the 10 th day	40	40	40	40	40	40	40	40
2. Milk up to the 80 th day	136	146	144	138	142	140	142	141
3. Concentrated mix (muesli)	86	102	106	88	96	88	92	94
4. Hay	10	10	10	10	10	10	10	10
5. Remuneration fund	30	30	30	30	30	30	30	30
6. Electricity	12	17	15	12	15	14	14	14
Everything from 0-3 months	314	345	346	318	333	322	328	329
3-6 months								
1. Fodder	140	156	155	144	150	142	145	147
2. Remuneration fund	30	30	30	30	30	30	30	30
3. Electricity	10	15	15	10	10	12	12	12
4. Fuel	20	36	32	22	20	21	20	24
Everything from 3-6 months	200	237	232	206	210	205	207	213
7-14 months								
1. Fodder	360	420	400	380	410	390	408	395
2. Remuneration fund	60	70	70	60	70	60	70	66
3. Electricity	23	30	28	23	25	23	28	26
4. Fuel	41	60	53	42	44	44	42	47
Everything from 7-14 month	484	584	551	505	549	517	548	534
15-24 months								
1. Semen	25	44	38	36	32	44	34	36
2. Fodder	688	870	850	711	783	700	748	767
3. Remuneration fund	80	110	105	80	90	84	92	92
4. Fuel	66	100	92	60	66	60	71	76
5. Electricity	26	45	31	28	30	26	32	32
6. Hay	20	20	20	20	20	20	20	20
Everything from 15-24 months	905	1189	1136	935	1021	934	997	1023
Vaccines and medications	24	24	24	24	24	24	24	24
Total:	1927	2375	2288	1988	2137	2002	2104	2117

The results from our study indicated that relatively fewer expenses were accumulated for raising a breeding heifer at Farms A, D, and F. For Farms A and D this was due to the earlier inclusion of heifers into breeding, which affected their further dairy yield. Regardless of the later inclusion of heifers from Farm B into breeding and the increased expenses for their raising, the achieved high milk yield and good economic efficiency justified this delay and the increased investment.

The results obtained regarding the age of insemination and first calving were close to what was reported by Panayotova et al. (1997) and Gaydarska (2012). The study by Wangler (2011) regarding the age of first calving and the cost of a heifer of the Holstein-Friesian breed established data different from our own. The author indicated that, in Germany, the age of first calving was 29.4 months and the expenses for raising a heifer up to the time of first calving were BGN 1500 on average, whereas, in our study, the average age of first calving for the studied farms was 26.6 months, and the expenses amounted to BGN 2117, or € 1060.

Conclusion

The results obtained give grounds to draw the following conclusions: 1) The age of first insemination of the Holstein-Friesian heifers from the investigated 7 farms in Central and Southeast Bulgaria was 17.2 months on average, and the age of first calving – 26.6 months, which is within the established norms for the Holstein-Friesian breed in our country. 2) The heifers on Farm A, which entered into breeding age the earliest – at 16 months of age, with first calving at 25.3 months, had the longest utilisation term – 4.9 lactations. However, they have not achieved the highest average milk yield. The highest average milk yield for lactation had the cows from farms F and D, reached at 17.3 and 17.4 months, respectively. 3) The expenses for raising a heifer of the Holstein-Friesian breed varied from BGN 1927 to BGN 2375, with an average sum of costs for all studied farms BGN 2117. This indicated that raising a heifer from high milk productivity breed was a costly undertaking for the dairy farms included in the study.

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