



# Age of Productive Insemination of Heifers as an Important Factor of the Livestock Industry

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**Abstract** | This study was conducted at the breeding farms in the Udmurt Republic, Russia depending on heifers and cows of the Russian black pied breed. Five groups were used, depending on the age of productive insemination: the first group was up to 14 months, the second group was 14.1-16 months, the third group was 16.1-18 months, the fourth group was 18.1-20 months and the fifth group was 20.1-22 months. The best indicators, taking into account regional characteristics, in terms of milk productivity and reproduction rates were obtained from heifers, the age of fruitful insemination of which was at the level of 14 to 16 months. The milk yield for 305 days of lactation was 6,921 kg, the duration of the service period was 158.8 days, the safety of cows for three lactations in relation to the 1st lactation was 47.3%, and the culling of cows after calving was not observed. Heifers, fruitfully inseminated at a later date of 18 months and later, had longer service period of 174.1 days and a low survival rate for three lactations - 35.8%.

**Keywords** | Cows of the Russian black pied breed, Age of the first productive insemination, Live weight, Cow livability, Service period

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## INTRODUCTION

Due to the high production intensity, high requirements are imposed on the conditions of feeding and management, aimed to increase the realization of animals' genetic potential (Batanov and Starostina, 2017; Vasileva and Safronov, 2018; Sudarev et al., 2018; Kopaneva and Babailova, 2016; Korepanova and Berezkina, 2018; Levina et al., 2019; Pavlova, 2016). For breeding a productive cow, a heifer will be needed that can reach its full potential at a particular farm (Batanov and Shaidullina, 2019; Batanov and Starostina, 2017; Batanov et al., 2011). At the same time, the costs that go through its management start to pay off only after the second lactation and it is very important for cows to retain past two lactations (Leshchuk, 2011).

Multiple studies provide data on the feasibility of early insemination while other studies reject this suggestion (Fedoseeva et al., 2016; Shevkhuzhev and Tumov, 2018; Kudrin et al., 2019). When breeding replacement heifer,

it is necessary to consider the physiological characteristics of its body, especially its puberty begins at the age of 7 or 8 months and ends by the age of 10 to 12 months with the use of intensive growing technology (Levina et al., 2019). The problem of replacement breeding heifers is also relevant because a new population of dairy cattle with a high genetic potential, which was bred using the Holstein breed, has been widely created in Russia (Shevkhuzhev and Tumov, 2018; Nekrasov et al., 2017). The purpose of this study is to identify the effect of the age of productive insemination on milk productivity and reproduction rates.

## MATERIALS AND METHODS

This study was conducted at breeding farms in the Udmurt Republic, Russia, Agricultural production cooperative "Koloz", Agricultural production cooperative (Kolkhoz) "Udmurtia", Agricultural production cooperative named after Michurin of the Vavozhsky district. Heifers of the Russian black pied breed born in 2013 and 2014 were used

as the object of the study, 2,300 cows were analyzed. We divided the groups based on the age of the first productive insemination, where the first group included cows with the age of the first productive insemination up to 14 months, the second group 14.1-16 months, the third group 16.1-18 months, the fourth group 18.1-20 months, and the fifth 20.1-22 months.

In groups of heifers, the change in live weight was studied at the age of 12 months, at the first fruitful insemination and at the first calving.

The milk productivity of cows was assessed on the basis of control milking, which was carried out on farms once a month. To determine fat and protein in milk, average samples were taken in accordance with GOST 26809.1-2014 Milk and dairy products. Acceptance rules, sampling methods and preparation of samples for analysis. The quality indicators of milk were determined using a Klever-2M device.

The reproductive ability of cows was studied according to the criteria that determined fertility: age at the first fruitful insemination and first calving, live weight, duration of the service period.

Data for the assessment of life-long productivity, as well as for the assessment of reproductive indicators, such as culling of cows (causes), postpartum complications were taken from the SELEX-Dairy cattle program.

The loose-box housing for dairy cattle was used at all the studied farms and Calving took place in the maternity ward in 3×3-m boxes, where newborn calves were kept with cows for 24 hours. After that, they were transferred to a dispensary, where they were kept for 10-12 days in individual cages. Up to 6 months of age, the heifers were kept in group cages with five to six animals in one cage and after that, they were kept in group cells with 17 to 18 animals in one cage up to the breeding age. After insemination, the heifers were transferred to a loose-box housing system on a deep litter.

Feeding was carried out according to the following scheme: whole milk from the 3<sup>rd</sup> day to the 21<sup>st</sup> day of age; hay from the 8<sup>th</sup> week; substitute for whole milk from the 22<sup>nd</sup> day to the 9<sup>th</sup> week; pre-starter from the 3<sup>rd</sup> day to the 21<sup>st</sup> day; starter compound feed from the 22<sup>nd</sup> day to the 9<sup>th</sup> week (40% of the total need for concentrated feeds); grain mixture (50% oats + 50% corn) from the 3<sup>rd</sup> day to the 9<sup>th</sup> week (60% of the total need for concentrated feed); water (freely available).

Live body weight gain during the first three months of life was at the level of 1,000 g/day and higher, from 3

to 12 months of age was 950-800 g/day, and from 13 to 21 months of age was 750-800 g/day. Heifers, dairy and dry cows were fed with the same type of complete feed mixture, which consisted of cereal-bean hay, mixed-grass silage, grain mix, sunflower meal, beet molasses; salt, monocalcium phosphate, and premix were also added.

## RESULTS AND DISCUSSION

We analyzed 2,300 cows in this study and out of these, 285 or 12.4% (the first group) were productively inseminated at the age up to 14 months (13.5 months on average), 838 or 36.4% (the second group) were productively inseminated at the age from 14.1 to 16 months (15.1 months on average), 821 or 35.7% (the third group) were productively inseminated at the age from 16.1 to 18 months (17.3 months on average), 280 or 12.2% (the fourth group) were productively inseminated at the age from 18.1 to 20 months (19.6 months on average), and 76 or 3.3% (the fifth group) were productively inseminated at the average age of 21.1 months. Physiological puberty in heifers begins at 7 - 8 months of age and ends by the age of 10-12 months with intensive growing management. The effect of live weight at the age of 12 months on the level of milk productivity of first-calf cows, milk quality, and the duration of the service period are presented in Table 1. The live weight of heifers at the age of 12 months was the highest in the first group (average age of productive insemination was 13.5 months, 344.1 kg), which was significantly higher than in the heifers of the fifth group by 21.0 kg or 6.5% ( $P \geq 0.95$ ) and the fourth group by 21.8 kg or 6.8% ( $P \geq 0.99$ ). The live weight of heifers at the age of 12 months in all groups was in the range from 322.3 to 344.1 kg. Moreover, the highest live weight at the age of 12 months was reported in the first group; 344.1 kg, which was 21.8 kg or 6.8% ( $p \geq 0.99$ ) higher than the fourth group and 21 kg or 6.5% ( $p \geq 0.95$ ) higher than the fifth group (average age of productive insemination was 21.1 months). At the time of the first productive insemination, the live weight in the first group was significantly lower compared to heifers that were productively inseminated at a later date. In the first group, the live weight during the first productive insemination was 395.1 kg, which was significantly lower compared to the second, third, and fourth groups by 4.6% ( $p \geq 0.95$ ), 8.5% ( $p \geq 0.99$ ), and 14.6% ( $p \geq 0.999$ ), respectively. The milk yield during the 305 days of lactation was the highest in the third and fourth groups; 6,871 and 7,003 kg, respectively and the service period in these groups was the longest, 174.1 and 170.6 days, respectively, which determined the high milk yield in the groups.

The most important parameter is the amount of milk received over three lactations because four calves can be obtained from a cow during this period. In our study, the total milk yield for the first three lactations was in the

**Table 1:** Live weight and productivity of first-calf heifers, depending on the age of productive insemination.

Group	n	Live weight, kg			Milk yield during 305 days of lactation	Content of fat by mass, %	Content of protein by mass, %	Service period, days
		12 months	at the time of the first productive insemination	at the time of the first calving				
up to 14	285	344.1±4.3	395.1±6.1	564.4±7.1	6547±61.3	3.81±0.01	3.12±0.02	143.1±3.8
14.1-16	838	336.4±5.1	413.9±5.5*	563.9±6.4	6,921±54.4***	3.71±0.01***	3.19±0.01**	158.8±4.1**
16.1-18	821	326.6±4.9*	428.8±6.6**	564.1±5.8	6,853±71.1**	3.82±0.02	3.14±0.01	163.3±2.9***
18.1-20	280	322.3±5.0**	439.1±4.8***	569.1±6.6	6,871±68.1**	3.77±0.01**	3.08±0.02	174.1±5.1***
20.1-22	76	323.1±6.1*	452.6±5.1***	571.2±5.6	7,003±61.1***	3.63±0.01***	3.03±0.02**	170.6±6.7**

\*: P ≥ 0.95; \*\*: P ≥ 0.99; \*\*\*: P ≥ 0.999

**Table 2:** The effect of the age of productive insemination on milk yield and livability after three lactations.

Group	n	Milk yield during three lactations, kg		livability of cows after three lactations compared to the first lactation
		$\bar{x} \pm m$	C <sub>v</sub>	
up to 14	285	23,233±117.1	6.4	43.2±0.4
14.1-16	838	23,764±112.3*	8.6	47.4±0.7**
16.1-18	821	22,559±97.8**	9.1	48.1±0.7**
18.1-20	280	22,613±105.4**	11.2	35.8±0.5**
20.1-22	76	23,241±121.4	13.9	40.1±0.3**

**Table 3:** The effect of the age of the first productive insemination on the frequency of postpartum complications.

Group	n	Difficult calvings, %	Retention of the placenta, %	Culling after calving	Livability of the livestock before the end of the first lactation
up to 14	285	25.3	12.7	9.1	89.0
14.1-16	838	8.6	10.1	-	98.9
16.1-18	821	5.4	10.0	6.7	92.4
18.1-20	280	6.9	7.6	6.1	88.1
20.1-22	76	16.1	12.1	5.2	82.6

range from 23,241 kg in the fourth group and 25,764 kg in the second group. It was noticed that heifers of the first, second, and third groups provided higher milk yield than the heifers of the fourth and fifth groups with a high degree of certainty ( $p \geq 0.999$ ) as shown in Table 2. Not all cows introduced into a herd remain for three lactations. The livability of cows after three lactations compared to the first lactation was in the range between 35.8 - 48.4% and age average of cows in the herd was 2.6-2.8 lactations. While, the highest percentage of cow livability (48.4% and 47.1%) was noticed in the second and third groups with average productive insemination ages of 15.1 and 17.3 months.

The effects of the age of the first productive insemination on postpartum complications was summarized in Table 3. The proportion of difficult calving and retention of the placenta was significantly higher in animals with the youngest (up to 14 months -25.3%) and eldest age (20.1-22 months) of productive insemination. Therefore, it can be

concluded that productive insemination at the age between 14-16 months is optimal for the highest livability of the livestock and culling for animals frequency of these groups are less. Likewise, the livability of the livestock before the end of the first lactation was 98.9%.

As a result of the comparative analysis of the effect of the age of the first productive insemination of cows on milk productivity, reproductive qualities, and safety, we can conclude that with a decrease in the age of the first productive insemination, the frequency of cases of difficult calving and retention of the placenta increased (25.3% and 12.7%, respectively) so, the percentage of culling after calving was higher. Meanwhile, the milk yield during the first three lactations, in turn, was higher in the second group (average age of productive insemination 14.1-16 months) and milk yield during the first lactation was the highest in the group with the highest return of productive insemination (an average of 21.1 months).

Thus, we have found that the age of fruitful insemination has significant impact on the level of milk production, reproductive performance, as well as on safety and postpartum complications.

To obtain more milk for three lactations (23,764 kg), the age of fruitful insemination should be in the period from 14 to 16 months with an average live weight of 413.9 kg.

With early periods of fruitful insemination, up to 14 months, in the conditions of the republic, heifers do not reach the required level of live weight, which leads to complications after calving retention of placenta (12.7%), difficult calving (25.3%) and culling after calving (9.1 %).

Heifers fruitfully inseminated at the age of 18-22 months are subsequently inseminated poorly, the duration of the service period averages 174.1 days and the safety of cows for three lactations in relation to the 1<sup>st</sup> lactation is only 35.8%.

The obtained data will allow the farms of the republic to work more effectively in the cattle breeding industry.

## AUTHORS CONTRIBUTION

All authors contributed equally.

## CONFLICT OF INTEREST

The authors have declared no conflict of interest.

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