Cow productivity index depending on their linearity

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Abstract. The studies were carried out in "Tubinsk" JSC, Krasnoturansky district of the Krasnoyarsk Territory. Red-and-white cows of Reflection Sovereign 198998, Vis Back Ideal 1013415, Pabst Governor 882993, Siling Trijun Rokit 252803 lines were taken as the object of the study. Milk productivity was taken into account and productivity index was calculated. It was identified that the cow index of productivity on the farm should be 1.200 and higher. However, the desired result was not achieved. According to the first lactation, the indicators of bulls’ daughters of lines R. Sovereign and P. Governor were most consistent with this value - 1.007 and 1.033, respectively. By the third lactation, the daughters of lines R. Sovereign and V.B. Ideal approached the desired value - 1.008 and 1.077, respectively. Cows of different lines with high milk production more often left the herd, which may indicate a low adaptive ability to technologies. The daughters of line R. Sovereign showed the highest milk productivity (P≥0.95), the mass fraction of fat in milk was higher in the daughters of the P. Governor line (P≥0.999), the mass fraction of protein was higher in the daughters of R. Sition (P≥0.999). Dairy cattle breeding at "Tubinsk" JSC appears to be profitable. The level of profitability depends on milk productivity and makes 61.9% in the daughters of R. Sovereign and 65.3% in P. Governors, respectively. To improve milk productivity and its quality indicators off-springs of bulls-producers of R. Sovereign and P. Governors lines should be used, as well as breeding to increase the adaptability to technology.

1. Introduction

Milk productivity of cows is one of the most valuable breeding characteristics. The most important indicators are milk yield, mass fraction and the amount of milk fat and protein. An increase in the productivity of dairy cows is closely related to change in the gene pool, the enrichment of which occurs due to the import of gametes, embryos, and producers. At present, in breeding much attention is paid to the belonging of bulls-producers and their daughters used in herds to the lines that have their own valuable qualities [1; 2; 3; 4]. The rate of increase in the genetic potential of a herd depends on the breeding value of the bulls used [5; 6].

On the Krasnoyarsk Territory the main dairy breed is the red-and-white, which was bred through reproductive crossbreeding. Red-and-white Holstein bulls were used in brood herds of Simmental animals. The resulting animals are characterized by early maturity, strong body composition, adaptability to breeding with intensive technologies, high content of milk protein and fat [7; 8; 9]. The development of informative and accessible methods for assessing animal productivity increases the ability to assess the genotype as a whole. One of such practically critical indicators is the productivity index, the use of which helps to increase the selection efficiency of cows. In this regard, the purpose of the work is to study milk production and productivity index of cows depending on their linearity.
2. Material and research methods

The object of the study was the red-and-white cows of the "Tubinsk" JSC of the Krasnoturansk district, Krasnoyarsk territory. Belonging to the Reflection Soverign lines 198998 (R. Sovereign), Vis Back Ideal 1013415 (V.B. Ideal) Pabst Governor 882993 (P. Governor) Rosafe Sition 267150 (R.s. Sition), Siling Trijun Rotik 252803(S.T. Rokit). The data was taken from the primary zoo technical records. Among the indicators studied were 305 days milk yield, kg; mass fraction of fat, %; the amount of milk fat, kg; mass fraction of protein, %; the amount of milk protein, kg; productivity index. The productivity of cows was provided with complete feed at the rate of 67-70 feed units per head. Economic efficiency was calculated on the basis of accounting reports.

To determine the quality of milk, the productivity index was used, which is based on the total amount of milk fat and protein [10]:

\[ PI = \frac{(MF_f + MP_f)}{(MF_a + MP_a)} \]  

where \( PI \) is the productivity index;

\( MF_f \) - actual amount of milk fat per 305 days of lactation, kg;

\( MP_f \) is the actual amount of milk protein per 305 days of lactation, kg;

\( MF_a \) - amount of milk fat per 305 days of lactation on average for the herd, kg;

\( MP_a \) - the amount of milk protein per 305 days of lactation on average for the herd, kg.

The calculation of economic efficiency of the animals with various origins usability was carried out in accordance with the "Methodology for determining the economic efficiency of the use of agricultural results, research and development work, new technology, inventions and innovation proposals using economic and mathematical modeling methods" [11].

The obtained results were processed on the basis of generally accepted statistical methods of E.K. Merkurieva (1970) applying the MS Excel software package, reliability of indicators was assessed with Student’s t-test [12].

3. Research results

At the first stage the studied indicators for the entire herd of "Tubinsk" JSC were analyzed. On average, the herd milk yield per 305 days of lactation was 6441 kg (table 1). Cows of the first and third lactation were isolated from the total herd. The largest mass fraction of fat was determined in milk obtained from cows during the first lactation - 4.2%, the lowest - from the third 4.16%. The standard deviation of the mass fraction of fat in the milk of cows averaged 0.19% for the herd, 0.2% for the first lactation, and 0.17% for the third. The amount of milk fat was the highest in the third lactation cows - 283 kg, the standard deviation was 87.5 kg. The mass fraction of protein in the milk of cows on average for the herd and first lactation was 3.15%, for the third lactation - 3.14%. At the same time, the amount of milk protein is the largest in the third lactation - 214 kg.

| Index                     | Heard average | 1 lactation | 3 lactation |
|---------------------------|---------------|-------------|-------------|
|                           | M±m   σ       | M±m   σ     | M±m   σ     |
| Yield per 305 days, kg    | 6441±57.8    | 1294    | 6354±57.7   | 1125   | 6814±312   | 2113   |
| Mass fraction of fat, %   | 4.19±0.1     | 0.19     | 4.20±0.01   | 0.2    | 4.16±0.02  | 0.17   |
| Amount of milk fat, kg    | 269±2.39     | 53.4     | 266±2.39    | 46.6   | 283±12.9   | 87.5   |
| Mass fraction of protein, %| 3.15±0.001  | 0.08     | 3.15±0.004  | 0.9    | 3.14±0.006 | 0.04   |
| Amount of milk protein, kg| 200±2.20     | 49.1     | 196±2.48    | 47.3   | 214±9.81   | 66.5   |
| Productivity index        | 1.000±0.01   | 0.212    | 0.985±0.01  | 0.191  | 1.060±0.05 | 0.328  |

The study of productivity index showed that for the first lactation it equalled 0.985, for the third - 1.060. The mean square deviation of the productivity index on average for the herd amounted to 0.212. In this regard, we propose to carry out breeding work to increase fat and protein milk content with...
animals which indicators exceed the herd average by 20%. Therefore, the desired cow productivity index should be 1,200 and above.

At the next stage, the first lactation cows were selected and their linearity was established (table 2).

| Line          | Cow number | Productivity index | Milk yield per 305 days, kg | Mass fraction of fat, % | Mass fraction of protein, % |
|---------------|------------|--------------------|----------------------------|-------------------------|-----------------------------|
| Average per lines | 364        | 1.010              | 6352±75.8                  | 4.20±0.01               | 3.16±0.001                  |
| R. Sovereign  | 183        | 1.007              | 6547±80.5 *               | 4.17±0.01 a             | 3.13±0.001 c                |
| V. B. Ideal   | 86         | 0.983              | 6259±114                  | 4.14±0.02 b             | 3.15±0.01 c                |
| P. Governor   | 81         | 1.033              | 6415±128                  | 4.35±0.02 c             | 3.21±0.06                  |
| Ros. Sition   | 11         | 0.797              | 5053±142 c               | 4.17±0.06               | 3.23±0.01 c                |
| S.T. Rocket   | 3          | 0.938              | 6051±325                 | 4.20±0.16               | 3.09±0.05                  |

* P≥0.95 relative to the average per lines.
* b P≥0.99 relative to the average per lines.
* c P≥0.999 relative to the average per lines.

The productivity index of the first lactation cows averaged 1.010. Cows of the line Sovereign and P. Governor had the highest productivity index - 1.007 and 1.033, respectively. The lowest value of the productivity index was observed in cows from the lines of V. B. Ideal - 0.983, S.T. Rocket - 0.938 and RF. Sovereign - 0.797, which is 2.6%, 7.12% and 21.1% less than the average, respectively. Thus, at the end of the first lactation, the cows of lines R. Sovereign and P. Governor had the best milk quality.

First-calf cows of R. Sovereign had the highest milk yield per 305 days of lactation of 6574 kg, which is 195 kg (3%) more than the herd average (P> 0.95). Milk of cows lines V. B. Ideal and P. Governor were close to the average and herd amounting to 6259 and 6418, respectively. Milk yield below average was shown by cows of S.T. Rocket by 4.5% (P> 0.95) and R. Situation by 21% (P> 0.999).

The mass fraction of fat in milk was the highest in P. Governor cows - 4.35% with an average value for the herd of 4.20%, in other lines it varied from 4.14% to 4.20%.

On average per lines, the mass fraction of protein in milk was 3.16%. Animal line R. Sition was distinguished by the highest milk-protein content. R. Sition and P. Governor accounted for 3.23% and 3.21% respectively.

Cows of different lines varied in adaptability to technology. Low livestock viability was established among the bulls’ off-springs of R. Sovereign (36.1%) and V. B. Ideal (70.9%). It can be assumed that the daughters from these lines do not have sufficient adaptive resources. In this regard, the number of daughters in the lines decreased by the third lactation.

In cows of the third lactation, the productivity index varied from 0.887 (S.T. Rokit line) to 1.077 (V. B. Ideal line) (table 3).

| Line          | Cow number | Productivity index | Milk yield per 305 days, kg | Mass fraction of fat, % | Mass fraction of protein, % |
|---------------|------------|--------------------|----------------------------|-------------------------|-----------------------------|
| Average per lines | 222        | 1.011              | 6552±112                  | 4.09±0.01               | 3.12±0.01                  |
| R. Sovereign  | 66         | 1.008              | 6520±199                  | 4.09±0.02               | 3.11±0.01                  |
| V. B. Ideal   | 61         | 1.077              | 6972±218                  | 4.10±0.03               | 3.16±0.01 b               |
| P. Governor   | 81         | 0.978              | 6413±194                  | 4.06±0.02               | 3.09±0.01 a                |
| R. Sition     | 11         | 0.975              | 6192±380                  | 4.16±0.05               | 3.23±0.02 c               |
| S.T. Rocket   | 3          | 0.887              | 5706±483                  | 4.09±0.08               | 3.21±0.07                 |

* P≥0.95 relative to the average per lines.
* b P≥0.99 relative to the average per lines.
* c P≥0.999 relative to the average per lines.
The highest milk productivity in the third lactation was in the daughters of V.B. Ideal - 6972 kg, which is 420 kg more than the herd average. Off-springs of R. Sovereign and P. Governor yielded 6520 kg and 6413 kg respectively. Milk yield was below average in cows from R.Sition by 3.6% and S.T. Rocket by 12.3%. The mass fraction of fat in milk varied from 4.06% for daughters from the P. Governor line to 4.16% of daughters from the R. Sovereign. The daughters from the lines R. Sition were distinguished by the highest milk-protein content. R. Sition and S.T. Rocket with 3.23% and 3.21% respectively.

The calculation of economic efficiency from the use of daughters from different lines in the herd of "Tubinsk" JSC was carried out according to the first lactation (table 4).

| Index                        | Lines              |
|------------------------------|--------------------|
|                              | R. Sovereign | V.B. Ideal | P. Governor | R. Sition |
| Yield per 305 days, kg       | 6547         | 6259       | 6415        | 5053      |
| Yield per 305 days in reference fat content, kg | 8030         | 7621       | 8207        | 6197      |
| Cost of milk production, rub. | 128760      | 128760     | 128760      | 128760    |
| Net cost of 1                  | 1967         | 2057       | 2007        | 2548      |
| Sale price of 1 centner milk, rub. | 3250       | 3250       | 3250        | 3250      |
| Profit, thau.rub              | 103          | 90.9       | 102         | 43.5      |
| Profitability, %              | 65.3         | 58.0       | 61.9        | 27.5      |

Further production activities on the farm depend on the level of production profitability. Effective selection work with lines makes it possible to increase cow milk production and ultimately improve the level of profitability. The study found that the daughters of lines R. Sovereign and P. Governor have a higher milk productivity in comparison with the offspring of other lines (table 3).

Thus, the index of cow productivity on the farm should be 1,200 and higher. The desired result for the studied number was not achieved either in the first or third lactations. The closest to it, according to the first lactation, were the daughters R. Sovereign and P. Governor - 1,007 and 1,033, respectively. By the third lactation, the daughters of the following lines approached the desired value – R. Sovereign - 1,008 and V.B. Ideal - 1,077, respectively.

It was found that cows of different lines varied in adaptability to technology. Cows with high milk production are more vulnerable to technology, and more often leave the herd.

The daughters of R. Sovereign line showed the highest milk productivity in the first lactation with 6547 (P≥0.95), the mass fraction of fat in milk was higher in daughters of the P. Governor line 4.35 (P≥0.999), the mass fraction of protein in the daughters R. Sition amounted to 3.23 (P≥0.999).

According to the results of the third lactation, there were no significant differences with the average indicators for the herd. However, the daughters of V.B. Ideal showed the highest results of 6972 kg. Differences in milk fat content of the daughters from different lines were not significant. The mass fraction of protein in milk similarly with the first lactation, was higher in the daughters of R. Sition amounting to 3.23 (P≥0.999).

Dairy cattle breeding at "Tubinsk" JSC appears to be profitable. The level of profitability depends on milk productivity and makes 61.9% and 65.3% in the daughters of R. Sovereign and P. Governor, respectively.

To increase milk productivity, improve the quality indicators of milk, bulls-producers of the R. Sovereign and P. Governor lines which off-springs demonstrated an increased productivity index and milk yield per 305 days of lactation should be used; as well breeding should be done to increase adaptability to technology.

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