Innovative livestock production technology

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Abstract. The territory of the Republic of the North Caucasus has natural resources in the form of rich mixed grasslands located in mountainous areas. This natural resource is not fully used, especially for dairy farming. The technical means of the livestock production process produced by domestic manufacturers are not intended for milking in mountain conditions. In addition, due to the lack of infrastructure in the mountainous areas of pasture location, the organization of the production process is associated with difficulties in energy supply and transport. A developed technological process for the production of cow's milk in mountainous conditions of management by the distant method of keeping the herd in a closed cycle is proposed. The production line includes milking machines for mountain conditions, individual means of collecting manure, means of energy supply using non-traditional energy sources, utilization of production wastes in the form of methane and organic fertilizers introduced into the soil of pastures, agricultural land of the farm and the sale of surplus to third-party farms. The technical equipment passed state tests and confirmed the output results in the production process. The introduction of the proposed technology of dairy farming in mountainous farming conditions will significantly improve the profitability of farmers in the region.

On the territory of mountain pastures there is rich in forbs naturally growing forage land. Until the nineties of the last century, this natural resource was actively involved on an industrial scale in the animal husbandry of the region. Not unknown events in our country led to a critical decline in the production activity of the livestock industry as a whole. In the current situation, there is a positive trend towards the restoration of previous production capacities and with some improvement of technical means and technological operations.

The livestock keeping method in the studied region is based on the tethered method - the warm period of the year the animals are kept on pastureland territories located mainly in mountainous areas above 1,000 meters above sea level, and in the cold season the livestock are moved to the basic territories of farms in a stall with harvested forage base from nearby agricultural land for the next cold half-year.

Due to the remoteness of mountain pastures from settlements and the partial or complete absence of energy communications, possible ways to fill this gap are either bringing these communications to livestock facilities or developing and implementing non-traditional methods of energy supply for these facilities [1, 2, 3]. The supply and maintenance of energy communications is associated with significant capital investments and is often not lifted for small and medium-sized farms prevailing in the region.
An unconventional method of energy supply can be organized using renewable energy sources, including using a closed loop of production. Livestock production processes include the totality of a number of technical operations presented in figure 1.

**Figure 1. Technological processes of dairy farming.**

In the cold period of the year from October to April, the livestock is kept in a stall. All technological operations are tied to the premises for keeping animals [4, 5]. In the warm season, the herd is transferred to pasture land located near the herd of the milking center, where a shelter for night rest, a milking unit, a bioenergy plant for the disposal of manure, electricity generation, organic fertilizer, which is subsequently brought into the pasture, farmland and the sale of surpluses to others, are located farms.

The most common form of management in modern livestock breeding in the North Caucasus Federal District are farms up to 200 animals. The annual production process of distant livestock breeding, as noted above, is divided into two cycles: in the cold season, production is located on the territory of the immediate location of the farm with adjacent agricultural land, to feed the herd; during the warm period, the livestock is transferred to mountain pastures, where it is located with a mobile milking station and technical facilities adjoining it.

There are the following difficulties in organizing dairy production during the summer period of livestock on the territories of mountain pastures: remoteness of pasture milking centers, energy supply of milking centers, delivery of milk to a milk collection point, environmental pollution.
As a result of research work on the identified problem, technical means have been developed with adaptive and energy-saving qualities. New devices in the complex entered the technological line for the production of environmentally friendly drinking milk [6, 7, 8]. The developed technology of dairy farming in mining conditions includes the ADV-F-1A milking machines (patents No. 21161654, No. 2151498, No. 2216932, No. 2625658) possessing adaptive, gentle and energy-saving features in combination with energy- and resource-saving means of collecting manure, waste-free production of methane and organic fertilizer. Subsequent use of methane to drive the power plant. Organic fertilizer is used to enrich the soil of fodder land and to sell surplus to third parties [9].

The production process provides: environmental safety of territories from pollution by industrial waste; energy saving in milk removal and quality indicators of milk obtained (tables 1 and 3), collection and disposal of manure in an energy-saving mode (table 2); the possibility of using technical equipment both in stationary centers for the production of milk (cold period of stall keeping), and in mobile milking centers on mountain pastures (warm period of pasture maintenance). When servicing 100 dairy cows, the annual estimated energy savings will be about 3.0 thousand kWh per year; increasing the speed of milking (the process of machine milk removal of the whole herd is completed 18 minutes faster), the labor productivity of staff increases (in 1 hour of the main time by 8 goals more); there is an increase in cow productivity; bacterial contamination and mechanical contamination of milk are reduced; the number of cases of cow diseases by subclinical mastitis is reduced by 40%.

The use of energy-saving individual means of collecting manure (patent No. 2226050) allows you to free the vast majority of equipment involved in the preparation of bedding material and the removal of bedding manure from the premises during the stall period and during the night period of the pasture term of the livestock. In the stall maintenance period (from October to April), the savings are: in energy consumption - about 22.0 thousand kW hour; fuel and lubricants consumption - about 1.0 t; to reduce the metal consumption of the equipment used - more than 32.0 tons.

Table 1. Production comparative tests of milking machines in the mountains from 100 heads of dairy herds of cows.

| Indicator                                      | Values of indicators |
|------------------------------------------------|----------------------|
| The quality of milk obtained:                  |                      |
| - degree of purity, group                      | not lower than 2     | 1 | 2 |
| - bacterial contamination, thousand            | no more than 500 ... 4000 | 280.7 | 1280.7 |
| microbes in 1 ml. milk                        |                      |
| The incidence of cows subclinical mastitis, % |                      |
|                                               | -                    | 6.4 | 46.7 |
| The average daily milk yield per cow, kg       | 10.0                 | 12.5 | 10.5 |
| The average fat content of milk, %             | 3.6                  | 3.65 | 3.3 |

Table 2. Operational results of comparative tests of milking machines in mountain conditions from 100 heads of cows.

| Indicator                                      | Value of indicators |
|------------------------------------------------|---------------------|
|                                                | according to the specifications for the UDS-3B milking unit | According to experiment results |
|                                                | Tested | COMPARED |
| Number of devices                              | 8      | 8        | 8 |
| Number of milkers                              | 2      | 2        | 2 |
| Milking cows serviced by the plant in 1 hour of regular time | not fewer than 55 | 56 | 48 |
Milking cows served by a milker in 1 hour of regular time

28  28  24

The total mass of all machines and equipment used for litter preparation, preparation and application of litter manure [10] to the soil reaches more than 40.0 tons of metal and other valuable materials (table 2). The costs for all production processes and operations are: fuels and lubricants - about 4.0 tons; energy consumption - more than 11.0 thousand kW. h; labor costs of machine operators and cattlemen - about 1770.0 people hours (table 3).

Table 3. Technical and economic indicators of the collection of manure from 100 cows according to the existing technology (the method of keeping animals is tethered-distant).

| Production process, machinery and construction, brand of equipment, number of equipment and workers | Metal consumption, kg | Material consumption, kg | Consumption of fuels and lubricants | Energy consumption, kWh | Labor costs, hour |
|-------------------------------------------------|-----------------------|--------------------------|-----------------------------------|------------------------|------------------|
| Harvesting straw:                                |                       |                          |                                   |                        |                  |
| - drag pushing cable VNK-11, 1 pc.               | 1800                  | -                        | -                                 | 198                    | 7 5days 2people 7hours =70hours |
| - tractor K-701, 1pc, 1mech, 2 workers           | 12400                 | - 358                    | -                                 | 198                    | - 70h          |
| Loading and storing of straw: 5 days 6 people 7 hours = 210 people · hour + |                       |                          |                                   |                        |                  |
| - loader PF-0.5; 1pc, 2 workers                 | 950                   | -                        | -                                 | -                      | 5days 2people 7hours =70hours |
| - MTZ-82 tractor; 1pc, 1 mech.                  | 3370                  | - 97.2                   | 55.16                              | -                      | 63               |
| Loading from stacks of straw:                    |                       |                          |                                   |                        |                  |
| - forager FN-1.4; 1 pc                          | 1270                  | -                        | -                                 | -                      | -               |
| - MTZ-82 tractor; 1pc, №1, 1mech.               | 3370                  | - 97.2                   | 8687.7                             | - 157.5                | -               |
| - trailer 2PTS-4 (transportation to the barn), 1 worker tractor MTZ-82; 1pc, №2, 1mech. | 1890                  | -                        | -                                 | -                      | 6days 1person 4hours =42 people hours |
| Manual loading of straw into TU-150 hand trucks, 4 pcs., 4 milkers | 800                   | -                        | -                                 | -                      | 180 days x 1 hour=720 |
| Manually transporting straw from the landfill site to the barn and manually spreading straw through the stalls | 800                   | -                        | -                                 | -                      | 180 days x 1 hour=720 |
Manually raking manure with choppers in a manure channel, 1 worker

Manure is loaded into a bioenergy plant producing methane and organic fertilizer, which have proven themselves in the enrichment of pasture crops, as well as in high yield of vegetable crops [9]. The methane produced is used to drive the power unit of the vacuum pump of the UDS-3B milking unit.

It is possible to use wind and hydrogenerators to generate additional energy resources, if there are appropriate environmental conditions in a separate location of the milking center on the mountain pastures of the North-Caucasian Federal District. As a result, the proposed technology is non-waste and has a closed production cycle, taking into account the use of its own resources of the economy and the climatic features of the location of the production process [10, 11].

The introduction of the proposed closed-milk dairy farming technology will make it possible to obtain high-quality milk and meat, using energy-saving technologies, preserving the ecology of the

| Description                                                                 | Quantity | Hours | Remarks |
|----------------------------------------------------------------------------|----------|-------|---------|
| Manually raking manure with choppers in a manure channel, 1 worker         |          |       |         |
| Removing manure from the premises with a TSN-3.0 conveyor, 1 pc.           | 2020     | 1040  | gear lubrication 3960  |
| Transportation of manure from the barn to the storage:                     | 1900     | -     | -       |
| - 2PTS-4 trailer (converted), 1 pc.                                        |          |       |         |
| tractor MTZ-82; 1 pc., 1 mech.                                            | 3370     | -     | 2500   | 69501.6  | 180  | - |

Manure Processing:

| Description                                                                 | Quantity | Hours | Remarks |
|----------------------------------------------------------------------------|----------|-------|---------|
| - in bulk                                                                   |          | +     | -       |
| - to bioenergy installation                                                 |          | +     | -       |
| - separation into fractions - methane; organic disinfected fertilizer      |          | +     | +       |
| - methane is supplied to the internal combustion engine to drive the vacuum pump |          | +     | +       |

Fertilizer Shipment:

| Description                                                                 | Quantity | Hours | Remarks         |
|----------------------------------------------------------------------------|----------|-------|-----------------|
| loader PF-0.5; 1 pc                                                         | 950      | -     | 209             |
| MTZ-82 tractor; 1 pc., 1 mech.                                              | 3370     | -     | 13878.3         | 15.1  |

Loading and spreading organic fertilizers:

| Description                                                                 | Quantity | Hours | Remarks |
|----------------------------------------------------------------------------|----------|-------|---------|
| organic fertilizer spreader MZHHT-F-6; 1 pc.                               | 3100     | -     | -       |
| MTZ-82 tractor; No. 2, 1 mech.                                              | 3370     | -     | 418     | 2756.6  | 30.2  |
| Manual cow cleaning, 4 people                                               |          | metal brushes | 10hous x 6 months = 600 people hours |

Total                                                                 | 44730    | 1040  | 3776.6 | 103765  | 3960  | 610  | 2950  |

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The introduction of the proposed closed-milk dairy farming technology will make it possible to obtain high-quality milk and meat, using energy-saving technologies, preserving the ecology of the
environment and in addition high-quality organic fertilizers, with an attractive economic effect of production.

References

[1] Miroshnikova V V and Krasnov I N 2016 Improving the technology for the production of livestock products on a dairy farm of a modular type of closed cycle Bulletin of the Gorsky State Agrarian University 53(4) 92-8

[2] Apazhev A K et al. Innovative technology and technical means for the disposal of manure and litter Bulletin of Agricultural Counseling Special Issue No 2 Best Innovations in the Agricultural Sector 4 42-8

[3] Bruchanov A Yu, Vasiliev E V, Shalavina E V and Uvarov R A 2019 Methods for solving environmental problems in animal husbandry and poultry farming Agricultural machines and technologies 13(4) 32-7

[4] Krasnov I N et al. 2018 The roles of milking motives in cows’ milk discharging Eurasia J Biosci 12 83-7

[5] Krasnov I N et al. 2018 Energy saving in milk pasteurization processes hydrodynamic heaters use PlantArchives 18(2) 2593-9

[6] Fiapshev A G and Khamokov M M 2009 Development and testing of a bio-gas-humus plant for farming Materials of the International scientific-practical conference "Provision and rational use of energy and water resources in the agricultural sector" (Moscow: RGAZU) pp 77-83

[7] Baragunov B Ya and Baragunov A B 2004 Energy-saving means of mechanizing the collection of excrement of cows Proceedings of the 4th International Scientific and Technical Conference, GNU VIESH part 3 (Moscow) pp 159-62

[8] Baragunov A B and Krasnova A Yu 2017 The mechanization of milking and primary milk processing in mining conditions (Nalchik: KBGAU) p 232

[9] Fiapshev A, Kilchukova O, Shekikhachev Y, Khamokov M and Khazhmetov L 2018 Mathematical model of thermal processes in a biogas plant MATEC Web of Conferences 212 010032

[10] Apazhev A K, Fiapshev A G, Shekikhachev Y A, Hazhmetov L M and Shekikhacheva L Zl 2019 Modeling the operation process of the unit for processing rowspacements of fruit plantings IOP Conference Series: Earth and Environmental Science 315 052023

[11] Druzyanova V P, Petrova S A, Okhlopkova M K, Spiridonova A V and Bondarenko A M 2017 Approbation of a new biogas technology: experiments and results Journal of Industrial Pollution Control 33(1) 1066