Current state and development prospects of domestic equipment for sheep and goat breeding

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Abstract. The article presents an analysis of the machinery equipment of Russian sheep and goat breeding. The absence of Russian-made equipment for the main processes, such as keeping, drinking, distributing feed, and milking sheep and goats, has been revealed. The existing domestic projects for the mechanization of processes in sheep breeding exist in the form of prototypes, however, there are no projects in goat breeding. Therefore, proposals have been formulated to solve the problems of the provision of sheep and goat farms with Russian equipment. The essence of these proposals is the need for state support for the equipment development and production. The engineering and manufacture of process equipment for sheep and goat breeding should be based on the experience of effective use of foreign equipment in the conditions of domestic enterprises.

1. Introduction

The crisis state of domestic sheep and goat breeding caused by the migration of the rural population to cities and the fall in demand for the products of these industries has become the reason for the continued redistribution of the livestock among farms of various categories: the share of sheep decreased to 16.5% of their total livestock in agricultural organizations, and increased to 42.8% and 40.7% in households and peasant farms, respectively; the share of goats decreased to 7% of their total livestock in agricultural organizations and increased to 78.1% in households and 14.9 % in peasant (farm) households [1].

Increase in the share of sheep and goats in private homesteads and farms in 1990-2019 negatively affected the process and machinery equipment of these subsectors. The current situation is the basis for revising the priority areas for the development of technology and technical means used in keeping sheep and goats. In this regard, the study of technological and technical factors in the development of these sub-sectors acquire special scientific relevance and practical significance.

The purpose of the research is to study the technical equipment and development trends of Russian-made equipment for sheep and goat breeding.

2. Research materials and methods

The object of the research was technical means for performing the main processes in sheep and goat breeding. Methods of comparative analysis and expert assessments, as well as experience of using the current equipment at Russian and foreign enterprises were used.
3. Research results and discussion
Mechanization of processes in sheep and goat breeding allows using technical means obtained from other branches of animal husbandry (e.g. the KT-F / KTU type mobile feed dispensers; linear and bunker feeders combined for feeding sheep in heap cages; mobile [VUO type] and fixed [GAO / APO type] drinkers). Despite this, the level of comprehensive mechanization of processes in Russian sheep breeding was the lowest of all livestock subsectors and amounted to 12% in 1990. The most mechanized processes were sheep shearing (the level of mechanization reached 97%) and primary wool processing [2]. For milking sheep, the UDO-F-24 / UDOP-F-16 fixed and mobile milking installations, respectively, were developed and produced. The main livestock of goats was concentrated in personal subsidiary plots, where all work on their keeping and maintenance was carried out manually.

The system of sheep breeding machines created in the USSR was focused towards large farms having a large livestock. The mechanization of the main production processes was based on the use of high-performance fixed equipment, the efficiency of which depended on the level of concentration of the sheep population. The manufacture of the most of the previously used equipment has now been discontinued.

The lesser demand for high-performance fixed equipment due to the ongoing redistribution of the sheep population among farms of various categories has now served as the basis for revising the priorities in the development of technical means for sheep breeding towards self-contained mobile and multifunctional equipment. The Institute for Animal Husbandry Mechanization, a branch of the Federal Scientific Agroengineering Center VIM, All-Russian Scientific Research Institute of Sheep and Goat Breeding, a branch of the North Caucasian Federal Scientific Agrarian Center, Orenburg State Agrarian University, Kostroma State Agricultural Academy, Azov-Black Sea State Agrarian Academy, Vyatka State Agricultural Academy, and Yaroslavl State Agricultural Academy perform the main work in this area (table 1).

Despite the availability of domestic production of individual components of microclimate systems (e.g. the VKR-4 type roof fans and VTs-4 centrifugal fans made by Roven Group, etc.), most of the range of microclimate equipment used in agricultural organizations is produced abroad (e.g. the BIG-ASS-FAN mixing fans, USA, DA-40A / DA-50 supply fans, Denmark, WKT series heat exchangers, Germany, lifting windows, etc.) [3-7].

Evaluation of the feasibility of using technical means for sheep machine shearing showed the promise of widespread use of mobile devices (mobile shearing stations and mobile shearing units), which can be delivered directly to the location of animals. The Institute for Animal Husbandry Mechanization, a branch of the Federal Scientific Agroengineering Center VIM is now developing them. Mobile shearing stations are created based on a cargo-passenger cross-country vehicle and a mobile electric shearing unit is developed based on a motorcycle. The advantages of such technical solutions are as follows:

- Ability to shear sheep directly at their locations regardless of the number of animals (from a dozen and several hundred to several thousand heads);
- Simultaneous delivery of process equipment and service personnel to the cutting site;
- Rational use of vehicles (their attraction for the shearing season and using them for their intended purpose for the rest of the time) [5].

While evaluating technical projects for sheep breeding, it can be argued that work is being performed in Russia both to create new machines and to make design changes to existing ones. However, all this work is limited to the creation of prototypes. There are no enterprises producing special process equipment for industrial sheep breeding.
Table 1. Domestic projects for sheep breeding.

| Description | Features | Developer |
|-------------|----------|-----------|
| Sheep shearing and dipping unit (SSDU) based on a production line | The solution brings the special sheep breeding processes to a higher level, close to robotic systems with continuous transport and handling operations. The SSDU development was brought to a draft design, the operability of the unit for removing sheep from the lower branch due to their sliding off the valve and ‘falling’ on the front inclined section onto the inclined belt conveyor was verified by full-scale tests, during which a unique solution was found, for which an application for patent is being executed. | Institute for Animal Husbandry Mechanization |
| Hanging feeders | They have an adjustable installation height | Institute for Animal Husbandry Mechanization in cooperation with Kostroma State Agricultural Academy |
| Automatic drinking line with heated water in winter | It includes an electric pump, a tank fitted with a water level sensor, electric heating elements and a thermostat, a control unit, pressure and return water mains, flexible hoses to group drinkers fitted with shut-off valves, and taps. It allows obtaining (according to All-Russian Scientific Research Institute of Sheep and Goat Breeding) additional weight gain for the stall period of up to 3 kg per sheep and more rational use of feed | Institute for Animal Husbandry Mechanization in cooperation with Kostroma State Agricultural Academy |
| Shearing units | It has a fundamentally new push mechanism with reduced dimensions and weight | Federal Scientific Agroengineering Center VIM |
| Shearing machine | It has an improved push mechanism | Institute for Animal Husbandry Mechanization in cooperation with Kostroma State Agricultural Academy |
| Shearing machine | It has a modernized push mechanism and cutting device | Orenburg State Agrarian University |
| Process equipment for keeping sheep and raising lambs | A carousel machine for veterinary treatment of sheep; self-feeders for feeding lambs with concentrated feed on pastures; mobile cages for lambing queens in pastures; animal care tools; conveyors for feeding fixed sheep for veterinary treatment; versatile metal portable hedges; standard size range of electric fences for grazing sheep. | All-Russian Scientific Research Institute of Sheep and Goat Breeding |

Source: compiled by the author based on [3-5].

Russia also not only does not produce, but also does not develop equipment for the mechanization and automation of the main processes on goat farms (apart from the development by the All-Russian Scientific Research Institute of Sheep and Goat Breeding, a branch of the North Caucasian Federal Scientific Agrarian Center, of a set of engineering and design documentation for panel equipment with hinged feeders for keeping animals [8]). Newly created industrial farms for the production of goat milk are equipped with imported equipment. So, some foreign companies, such as SAC (Denmark), Sylco Hellas (Greece), DeLaval (Sweden), GEA Farm Technologies and Westfalia Surge (Germany),
etc., offer mobile and fixed stations for drinking kids. The situation is similar with milking equipment: there are mainly milking parlors of European and American manufacturers (such as ‘carousel’ or ‘parallel’ ones), as well as mobile milking machines from various foreign manufacturers, on the Russian market.

Domestic experience in operating foreign milking equipment has shown its effectiveness: equipping the PZ Prinevskoye goat farm (the Leningrad region) with a 2x36 parallel milking parlor made by SAC, a Danish company, and designed for a livestock of 2,000 goats, and PZ Krasnoozernoe goat farm (the Leningrad region) with a 2x32 parlor designed for 1,500 goats, made it possible to obtain 838 and 846 liters of milk from each goat, respectively, in 2019 [9].

Abroad, for the automation of production processes, robotic technology is increasingly used in the form of robotic feed dispensers, feed stations, suspended feed dispensers and other units [10]. Mixers-feed dispensers of domestic production (made by Kolnag LLC under the license from Trioliet Mullos BV, the Netherlands, Slobodskoy Machine Building Plant) and of foreign production (JF-STOLL, Denmark, Trioliet Mullos BV, Netherlands Kuhn, Germany, Zapagromash, Republic of Belarus) and others are offered on the Russian market from this product line [11]. Components of precision animal husbandry are being introduced, e.g. sensors to alert livestock breeders about the state of animals [12]. At the same time, the introduction of innovations in sheep breeding is preceded by a detailed study that determines their priority and the need to allocate resources for their implementation [13].

Sheep and goat breeding in this country has suffered the most from economic transformations, which have led to a complete loss of production of equipment for these subsectors. State financial support for the development and production of equipment for sheep and goat breeding is of paramount importance for changing this situation. However, the Strategy for the Development of Agricultural Engineering in Russia for the period up to 2030 does not mention these subsectors [14].

The development of new equipment for sheep and goat breeding should be based on the assessment and best practical experience of using foreign equipment in Russian conditions.

4. Conclusions
Given the lack of domestic equipment for the mechanization and automation of basic processes at sheep and goat farms, we consider it necessary to provide state financial support for organizing its development and production at Russian enterprises.

It is advisable to create mobile equipment for sheep breeding, with the help of which it is possible to serve several small enterprises.

Dedicated process equipment for performing production processes, which does not have domestic prototypes, should be developed by analogy with foreign ones, which have confirmed their effectiveness in the conditions of domestic enterprises.

References
[1] National Report on the Progress and Results of the Implementation in 2019 of the State Program for the Development of Agriculture and Regulation of Markets for Agricultural Products, Raw Materials and Food 2020 (Moscow: Rosinformagrotekh) 194
[2] Kormanovskiy L P, Morozov N M and Tsoi L M 1999 Justification of the System of Processes and Machines for Animal Husbandry (Moscow: IK Rodnik) 228
[3] Mirzoyants Yu A and Firichenkov V E 2019 Robotic means in the mechanization of special processes in sheep breeding. Bulletin of the All-Russian Research Institute of Livestock Mechanization 1(33) 147-152
[4] Mirzoyants Yu A and Firichenkov V E 2018 Areas of modernization of the technical base of sheep farms and facilities. Bulletin of the All-Russian Research Institute of Livestock Mechanization 2(30) 45-52
[5] Mirzoyants Yu A and Firichenkov V E 2016 Innovative technologies for the production of sheep products. Bulletin of the All-Russian Research Institute of Livestock Mechanization 3(23) 51-56
[6] Mirzoyants Yu A and Firichenkov V E 2017 The state of sheep breeding in Russia, maintenance technology and provision of technical means. *Proc. 68th Int. Scientific and Practical Conf. on Actual Problems of Science in the Agribusiness* 187-193

[7] Lachuga Y F et al. 2012 *System of Machines and Technologies for Integrated Mechanization and Automation of Agricultural Production for the Period up to 2020* vol 2 *Livestock* (Moscow: All-Russian Scientific Research Institute of Agricultural Mechanization) 212

[8] Sannikov M Yu and Novopashina S I 2018 *Dairy Goat Keeping Technology* (Stavropol: All-Russian Scientific Research Institute of Sheep and Goat Breeding, a branch of the North Caucasian Federal Scientific Agrarian Center) 176

[9] 2019 *Yearbook on Breeding Work in Sheep and Goat Breeding at the Farms of the Russian Federation* 2020 (Moscow: VNIIplem Publishing House) 342

[10] Kharitonova D 2010 Goat breeding: a successful business. *Machinery and equipment for rural area* 8 29-33

[11] Yuldashbaev Yu A et al. 2020 *Innovative Technologies for the Maintenance of Small Cattle: An Analytical Review* (Moscow: Rosinformagrotekh) 80

[12] Halachmi I., Guarino M, Bewley J and Pastell M 2019 Smart Animal Agriculture: Application of Real-Time Sensors to Improve Animal Well-Being and Production. *Annual Review of Animal Biosciences* 7 403-425

[13] Espinosa-García J A et al. 2015 Technological prospection and strategies for innovation in production of sheep in Tabasco, Mexico. *Revista Científica de la Facultad de Ciencias Veterinarias de la Universidad del Zulia* 25 (2) 107-115

[14] Order of the Government of the Russian Federation No. 1455-r dated July 7, 2017 On Approval of the Strategy for the Development of Agricultural Engineering in Russia for the Period until 2030. *2017 Collected Legislation of the Russian Federation* 29 4413