UNIVERSAL SEEDING DEVICE FOR SOWING SEEDS OF DESERT FORAGE PLANTS

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Abstract. The development and implementation of resource-saving technologies and technical equipment for agriculture are among the important priorities of modern agricultural engineering. This is particularly relevant for desert and semi-desert regions, where unfavorable climatic conditions, limited soil moisture, low precipitation, and degradation of natural pastures significantly restrict the productivity of forage lands. This paper presents the results of research conducted within the framework of the scientific topic "Justification of the parameters of a metering device for sowing seeds of desert forage plants (izen)". As a result of the research, a universal seeding device for sowing seeds of desert forage plants was developed. The proposed device is designed to simplify and improve the efficiency of the sowing process and can be adapted to seeds of different sizes and shapes. Its mechanical metering system provides controlled placement of seeds at a specified depth and spacing, thereby creating favorable conditions for subsequent plant establishment and development. The universal design allows the device to be used under desert and semi-desert conditions and provides an opportunity to improve the efficiency of field operations.

Keywords: desert forage plants, Izen, seed, seeding device, seed metering unit, seeding machine, sowing technology, resource-saving technology, sowing depth, seed spacing, desert agriculture.

Introduction

The rational use of natural resources, restoration of degraded pastures, and development of sustainable forage production systems are important challenges facing modern agriculture (Shamsutdinov et al., 2021). These issues are particularly significant in desert and semi-desert regions, where agricultural production is affected by low and irregular precipitation, high evaporation rates, limited soil moisture, poor soil fertility, and the intensive use of natural pasture resources (Chlachula & Zhagloskaya, 2017). The development of forage vegetation in such areas is essential for strengthening the feed base of livestock production and improving the productivity of degraded and low-yielding pasturelands (Vehrs, 2016). Among the most important technological operations in the establishment of forage crops is the sowing of seeds (Kokwaro, 2013). The quality of sowing directly affects seed germination, plant establishment, and subsequent crop development (Ahmad et al., 2021). Uniform seed distribution, appropriate sowing depth, and adequate spacing between seeds are particularly important in arid and desert environments, where available soil moisture is limited (Karimova et al., 2012). Seeds of desert forage plants have specific physical and mechanical properties (Farmonov E et al., 2023). Some species produce relatively small, lightweight, and irregularly shaped seeds, which can create difficulties when conventional seed-metering devices are used (Arshad et al., 2022). Non-uniform seed flow may result in excessive seed consumption, uneven plant density, and reduced effectiveness of sowing

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operation. Therefore, the development of specialized and universal seeding equipment capable of providing stable and controlled seed distribution is an important scientific and practical task.

Purpose and Objectives of the Research

The main purpose of this research is to develop a universal seeding device capable of sowing seeds of desert forage plants in accordance with established agrotechnical requirements while ensuring simplicity of construction, operational convenience, and adaptability to different types of seeds. To achieve this objective, the following research tasks were established: to study the physical and mechanical properties of seeds of desert forage plants; to analyze the factors affecting the seed-sowing process; to study existing seed-metering devices and their structural solutions; to develop a seed-metering mechanism capable of providing controlled seed placement; to develop a universal design suitable for seeds of different sizes and shapes; to provide the required sowing depth and seed spacing; to assess the applicability of the developed device under desert and semi-desert conditions; to determine the technological and operational efficiency of the developed equipment.

Materials and Methods

The research object is the technological process of sowing seeds of desert forage plants and the technical means used to implement this process. The research has been conducted since 2023 within the scientific research topic "Justification of the parameters of a metering device for sowing seeds of desert forage plants (izen)". The research methodology included theoretical analysis, study of existing seeding technologies, engineering design, development of the experimental device, and experimental evaluation of the proposed technical solution. Particular attention was paid to the following parameters: uniformity of seed distribution; seed-metering rate; sowing depth; distance between seeds; stability of seed flow; adaptability of the metering mechanism to different seed characteristics; operational suitability under desert conditions. The developed design was based on the principle of controlled mechanical metering of seeds from a seed hopper into the sowing zone.

Development of the Universal Seeding Device

As a result of the research, a universal seeding device for sowing seeds of desert forage plants was developed. The main purpose of the device is to provide controlled and uniform sowing of forage plant seeds in desert and semi-desert areas while meeting the required agrotechnical parameters. The proposed device is designed to work with seeds having different physical and mechanical characteristics, including differences in size and shape. The construction makes it possible to adjust the sowing process depending on the characteristics of the seed material. The device can be used for sowing several types of seeds either simultaneously or separately, depending on the technological requirements of the cultivation process. This feature increases the versatility of the equipment and expands its potential application in the establishment and restoration of forage vegetation. The general view of the developed universal seeding device is presented in Figure 1.

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Figure 1. General view of the universal seeding device for sowing seeds of desert forage plants

The operating principle of the device is based on the controlled transfer of seeds from the seed hopper to the metering mechanism and subsequent placement of the seeds into the prepared sowing furrow. The mechanical metering system regulates the movement of seeds and allows them to be placed at a predetermined depth and spacing. After seed placement, the soil covers the seeds, creating conditions necessary for germination and subsequent plant establishment. The design provides the possibility of adjusting the main technological parameters depending on the type and physical characteristics of the seed material.

Structural and Technological Features. One of the principal features of the developed device is its universal design. Conventional sowing machines are often designed for seeds with relatively stable and standardized physical characteristics. In contrast, desert forage plant seeds may vary considerably in size, shape, mass, and flowability. The developed device is intended to overcome these limitations by providing an adaptable seed-metering mechanism. The main structural and technological advantages of the device include: adaptability to different types of desert forage plant seeds; controlled seed metering; the possibility of adjusting the sowing depth; the possibility of regulating seed spacing; improved uniformity of seed distribution; suitability for different seed sizes and shapes; mechanical operation of the sowing process; reduced dependence on manual labor; potential reduction of excessive seed consumption; suitability for desert and semi-desert field conditions. The universal design also makes it possible to modify the operating parameters of the device according to specific agronomic requirements.

Application in Desert and Semi-Desert Areas. The developed universal seeding device is primarily intended for use in desert and semi-desert regions for the establishment and improvement of forage vegetation (E. T. Farmonov et al., 2022). One of the important target crops of the research is Izen, a desert forage plant adapted to arid environmental conditions (E. Farmonov et al., 2020). The establishment of such vegetation can contribute to improving the forage potential of degraded and low-productivity pasturelands. The proposed equipment can be used for: establishment of forage plant stands in desert areas; restoration of degraded pasturelands; improvement of natural grazing areas; establishment of forage plots; mechanized sowing of desert-adapted forage plants; implementation of resource-saving agricultural technologies. The use of a specialized seeding device can facilitate the timely completion of sowing operations and improve the organization of field activities in areas where environmental conditions impose significant limitations on agricultural production.

Scientific and Practical Significance. The scientific significance of the research lies in the development and substantiation of a technical solution for controlled sowing of desert forage plant seeds

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with different physical and mechanical properties. The practical significance of the developed device is associated with the possibility of mechanizing the sowing process and improving the technological conditions required for successful establishment of forage plants. Uniform seed placement is particularly important in arid environments because soil moisture is a critical limiting factor. Properly controlled sowing depth and seed spacing can contribute to more favorable conditions for seed germination and plant establishment. The developed device therefore represents a practical technical solution within the broader framework of resource-saving agricultural technologies and machinery for arid-zone agriculture.

Expected Technological Benefits. The introduction of the developed universal seeding device may provide several technological benefits (Farmonov E et al., 2023). First, the device enables the sowing process to be adapted to the specific characteristics of different seed materials. Second, controlled seed metering can improve the uniformity of seed distribution across the field. Third, the possibility of adjusting sowing depth and spacing allows the equipment to be adapted to different agronomic requirements. The mechanization of sowing operations can also reduce the amount of manual labor required and increase the operational efficiency of field activities. The device is therefore particularly relevant for large-scale establishment and restoration of forage vegetation in desert and semi-desert areas.

Conclusions

As a result of the research carried out since 2023 within the scientific topic "Justification of the parameters of a metering device for sowing seeds of desert forage plants (izen)", a universal seeding device for sowing seeds of desert forage plants has been developed. The proposed technical solution is designed to provide controlled sowing of seeds with different sizes and shapes and to place them at a specified depth and spacing. The universal design allows the equipment to be adapted to various desert forage plants and provides opportunities for its use under desert and semi-desert conditions. The developed device can contribute to the mechanization of sowing operations, improvement of seed distribution, reduction of manual labor, and implementation of resource-saving technologies in arid-zone agriculture. Further research should focus on experimental determination and optimization of the main structural and technological parameters of the seed-metering mechanism, including seed-metering rate, sowing depth, seed spacing, working speed, and distribution uniformity. Field trials under different soil and climatic conditions should also be conducted to determine the technological and economic efficiency of the developed equipment. The results obtained provide a basis for further improvement of the universal seeding device and its adaptation for practical application in desert pasture development and forage production.

References

1. Ahmad, S., Singh, J. P., Dev, I., Radotra, S., Bhat, S. S., Mir, N. H., & Chaurasia, R. S. (2021). Diversity and matrix scoring of fodder plants in Ladakh Himalaya, India: Implications for exploration, conservation and evaluation. In Range Management and Agroforestry (Vol. 42, Issue 2, pp. 191–197). Range Management Society of India.
2. Arshad, F., Waheed, M., Harun, N., Fatima, K., Khan, B. A., Fatima, K., Abbas, Z., Jabeen, S., & Majeed, M. (2022). Indigenous farmer's perception about fodder and foraging species of Semi-arid lowlands of Pakistan: A case study of District Kasur, Pakistan. In Taiwania (Vol. 67, Issue 4, pp. 510–523). College of Life Science. https://doi.org/10.6165/tai.2022.67.510.

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3. Chlachula, J., & Zhagloskaya, A. A. (2017). Environmental aspects of the black saxaul forests' distribution in the cold semi-deserts of central asia. In International Multidisciplinary Scientific GeoConference Surveying Geology and Mining Ecology Management, SGEM (Vol. 17, Issue 32, pp. 821–828). International Multidisciplinary Scientific Geoconference. https://doi.org/10.5593/sgem2017/32/S13.106.
4. Farmonov, E., Ismailova, Z., Abdilaev, T., & Farmonova, F. (2020). Mechanized sowing of seeds of desert fodder plants. In R. A.I, U. U.P, A. A.I, J.-P. B, & B. D.R (Eds), IOP Conference Series: Materials Science and Engineering (Vol. 883, Issue 1). IOP Publishing Ltd. https://doi.org/10.1088/1757-899X/883/1/012096.
5. Farmonov, E. T., Arifjanov, A. M., & Farmonova, F. E. (2022). Experimental seeders for sowing unseeded seeds. In Journal of Physics: Conference Series (Vol. 2176, Issue 1). Institute of Physics. https://doi.org/10.1088/1742-6596/2176/1/012057.
6. Karimova, T. Yu., Lushchekina, A. A., Narantuya, N., Neronov, V. M., Safronova, I. N., & Uchrakhbayar, T. (2012). Changes in state of mongolian gazelle (Procarpa gutturosa Pallas 1777) population of Eastern Mongolia: Long-term data analysis. In Arid Ecosystems (Vol. 2, Issue 3, pp. 150–155). Pleiades Publishing. https://doi.org/10.1134/S2079096112030079.
7. Kokwaro, J. O. (2013). Classification of East African Crops: Second edition. In Classification of East African Crops: Second Edition. African Books Collective. https://www.scopus.com/inward/record.uri?eid=2-s2.0-85022059611&partnerID=40&md5=7b10d1b89f2c481839a1d1f153c77ddc.
8. Shamsutdinov, N. Z., Sanzeev, V. V., & Sh Shamsutdinov, Z. (2021). Ecological restoration of fodder productivity of degraded pastures in the foothill desert zone of Central Asia. In IOP Conference Series: Earth and Environmental Science (Vol. 901, Issue 1). IOP Publishing Ltd. https://doi.org/10.1088/1755-1315/901/1/012033.
9. Vehrs, H.-P. (2016). Changes in landscape vegetation, forage plant composition and herding structure in the pastoralist livelihoods of East Pokot, Kenya. In Journal of Eastern African Studies (Vol. 10, Issue 1, pp. 88–110). Routledge. https://doi.org/10.1080/17531055.2015.1134401.

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