Mechanized sowing of seeds of desert fodder plants

IOP Conf. Series: Materials Science and Engineering **883** (2020) 012096 doi:10.1088/1757-899X/883/1/012096

Mechanized sowing of seeds of desert fodder plants

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Abstract. In the paper, the authors addressed the fact that the continuous improvement of pastures by mechanized sowing and undersowing of local shrubs, sub-shrubs, and perennial grasses is one of the main conditions to maintain the fodder productivity and to combat pasture degradation. This will increase the pasture productivity up to 10 times, compared with natural fodder land. The seeders have been developed with new pick-up drums equipped with measuring grooves, which, during operation, significantly reduce the crushing of seeds, ensure uniform high-quality sowing, do not lead to a decrease in their natural germination. Sowing is carried out following agricultural requirements. The parameters of a pick-up drum with measuring grooves are determined.

1. Introduction

In Uzbekistan, about 21.4 million hectares of land are allocated to arid animal husbandry, which includes sheep breeding, astrakhan sheep breeding, camel husbandry, cattle, horse breeding. Animals are kept on the pasture of desert and semi-desert pastures almost all year round and represent a solid potential for solving problems of providing the population with livestock products. Farms located on desert pastures, thanks to natural pasture forage, receive cheap, high-quality, and environmentally friendly products: astrakhan skins, wool, meat, and milk, etc. [1].

In the Republic astrakhan sheep breeding is the second most important branch of agriculture. The basis for further development of the industry is a solid fodder base. Taking into account the almost year-round keeping of animals on natural pastures forage, the concept of "solid forage base" includes primarily the productivity (yield of fodder plants) of pastures.

Unfortunately, the state of arid pastures today does not meet the requirements of the industry. Almost 40.7 percent of desert pastures are degraded to varying degrees, and their productivity has declined by 21 percent. The area of degraded pastures in need of improvement is about 7.3 million hectares and continues to grow [2].

Scientists and specialists of the Uzbek Research Institute of Astrakhan Sheep Breeding and Desert Ecology, the Institute of Botany of the Academy of Sciences of the Republic of Uzbekistan and other scientific institutions have tested about 300 species of desert plants from the natural flora [4, 5, 6, 7, 8, 9, 10, 11, 12, 13] to restore the pasture. To combat the degradation of desert pastures and to increase forage productivity, from a variety of promising wild fodder plants characterized by high productivity and resistance to abiotic stress factors of the environment, they proposed several shrubs, half-shrubs, perennial and annual forage plants. Among them are black saxaul, solonchak or leafless saxaul [Haloxylonaphyllum (Minkw) Iljin], white saxaul [Haloxylonpersicum B ge.], Circassian Paletsky [Salsolapaletzki anaLitv.], Circassian Richter [Salsolarichteri Kyryujyguygandu, to [Calligonumçaput - medusa Schrenk.], Chogon (solyanka) [Aelleniasubaphylla (CAMey.) Aelle], borjock [Ephedra

Strobilaceae B ge.], Isen [Kochiaprostrota (L.) Schrad], Keireuk [Salsolaorientalis S G.], camphorosma [Camphorosmalessingii Litv.], teresken [Ceratoidesewersmanniana], wormwood effuse [Botsch. et Ikonn. Artemisiadiffusa Krasch.], wormwood salt-loving [Artemisia halophila Krasch.], Astamegalagamets [Astragalusagametigus Lipsky], bluegrass bluegrass - Congurbach [Poabulbosa L.], roofing carter (Yaldyrbash) [Bromustekterumil]) [Eremopyrumorientalis, Eremopyrumhirsutum], balykkuz - Wooly solyanka [Climacopteralanata (Pall.) Botsch.], Danashur-spine flower coniferous [Gamanthusgamocarpus (Moq.) B ge.], Haridandangolymnocenimamismemismollis.], eastern mortuk [Eremopryumorientales (L.) j.et sp.], roofing bonfire [Bromustectorum L.]

2. Methods

Continuous work to improve pasture by sowing and replanting local shrubs, half-shrubs, and perennial grasses is one of the main conditions for maintaining fodder productivity and combating pasture degradation.

Thus, the problem of developing arid animal husbandry in pastures requires large-scale work to combat degradation and increase forage productivity. Moreover, the forage productivity of pastures must be maintained systematically. This will increase the productivity up to 10 times, compared with natural forage land productivity [14].

Unfortunately, to date, the problems of mechanized seeds sowing of desert fodder plants have not been solved. Sowing is carried out using primitive methods, for example, manual seeds dissemination from a cart. Work on sowing mechanization was carried out mainly based on well-known agricultural machines that do not meet the specific requirements. These machines did not give positive results when sowing seeds of desert fodder plants. There is no certain complex of universally recognized machines for desert-pasture in livestock breeding.

For several years, research organizations and individual researchers [15, 16, 17, 18] carried out studies on the conversion of existing seeders and the design of special units for sowing seeds of desert fodder plants. The use of a seeder designed for sowing firm and loose seeds of agricultural crops, when sowing small, brittle, loose and unstable to mechanical effects seeds of desert fodder plants, led to the severe crushing of seeds due to repeated mechanical impacts and to clogging the seeder sections of the seed measuring devices; all this caused low-quality seed sowing and the loss of their biological germination. This indicates the absence of a seeder that meets the agrotechnical requirements for sowing seeds of desert fodder plants.

The current practice of sowing pasture forage plant seeds in seed nurseries also fails to meet modern requirements. Thus, the problems of protecting arid pastures from degradation, of increasing their productivity and seed production requires the development of a seeder that meets agrotechnical requirements in the sowing rate, in shallow depth of seeding.

The conditions of desert pastures differ significantly from the irrigated zone, which necessitates the creation of modernized, completely new, machines that meet the conditions of desert pastures.

The main disadvantages are due to the distinctive features of soil and climatic conditions of desert pastures and the specific physical and mechanical properties of seeds of desert fodder plants: low purity of seeds collected manually or mechanically (the proportion of seeds in the seed heap does not exceed 30 – 35%); small size; lightweight (the weight of 1000 pieces is 1.3-16.1 g); instability to mechanical influences; low flowability (seed wings). Seeding rates are low (3.0 – 10.0 kg/ha). These properties impose increased requirements on the technology of their sowing. The seed fragility and the presence of wings require a special technology of sowing.

3. Results and Discussion

Given the urgency of the problem of strengthening the fodder supplies and combating the degradation of the desert-pasture livestock sector, the Tashkent Institute of Irrigation and Agricultural Mechanization Engineers (TIIAME) conducts research on the development of universal seeders for mechanizing the process of sowing the seeds of desert fodder plants. Currently, environmental and

energy-saving technologies and a machine for their implementation have been developed and are being improved [20, 21, 22, 23].

A new pick-up drum with measuring grooves has been developed in the design of the seed section of a seeder. Since the bunker of the seed section of a seeder is mounted in a vertical position, the seeds pour out of it mainly due to gravity. Due to the inertia forces that appear when the tractor moves along an uneven field, the sowing section of a seeder is subject to small oscillations. This speeds up the seed motion down the bunker. In the process, the measuring grooves of the drum are filled with seeds pouring from the bunker. Since there is no mechanical effect on the seeds, the crushing and clogging of seeds in the bunker are excluded. Thus, the crushing of seeds is significantly reduced, uniform high-quality sowing is ensured, and natural germination is high. Sowing is carried out following agricultural requirements.

The design diagram and technological process of a seeder operation are presented in Figure 1.

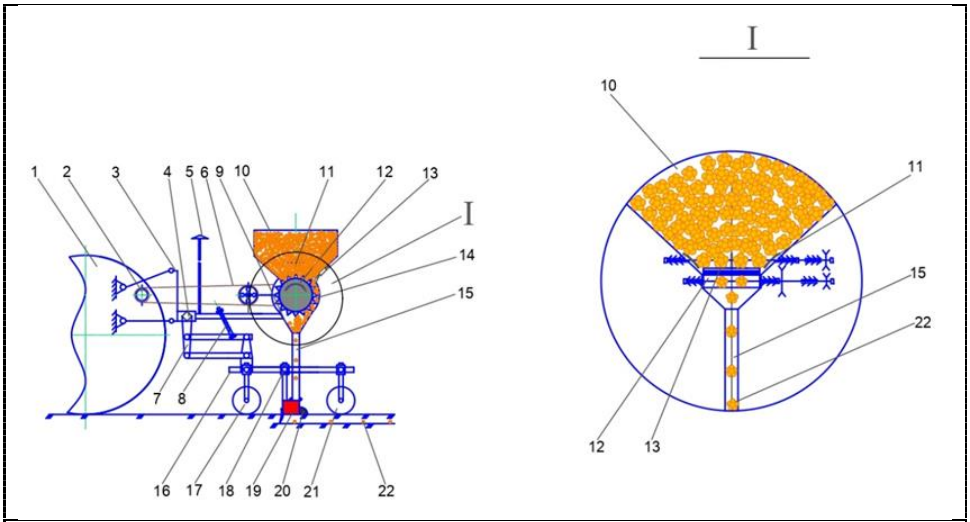

Figure 1. Structural diagram and technological process of a wide-cover universal seeder operation: 1is tractor running gear, 2 is sidepower take-off shaft(PTO) of a tractor with drive sprocket, 3 is seeder suspension mechanism, 4 is frame, 5 is markers, 6 is chain drive, 7 is parallelogram mechanism, 8 is thrust spring, 9 is sowing section, 10 is bunker, 11 is vault down-faller, 12 is pick-up drum, 13 is measuring groove, 14 is reflector, 15 is seed pipe, 16 is beam, 17 is track roller, 18 is lock, 19 is plowshare, 20 is coverer, 21 is compacting roller, 22 is sown seeds.

The technological process of universal seeder operation for sowing seeds of desert fodder plants is as follows. Sowing seeds of desert fodder plants is done in the fields of gray-brown soils and sand deserts prepared for sowing. Before sowing, the seed bunker 10 of the seed section 9 is filled with seeds.

During the seeder operation in the field, from the side power take-off shaft (PTO) of the tractor 1, the sprocket 2 through the chain 6 transmits the movement to the vault down-faller 11 and the pick-up drum 12. When the pick-up drum 12 rotates, the seeds from the bunker slowly pour into the measuring grooves 13. The volume and the number of measuring grooves 13 are determined depending on the size and the given seeding rate. The vault down-faller11 loosens the seeds inside the bunker 10. This allows more complete filling of the measuring grooves 13. The rotating drum 12 alternately brings the measuring grooves 13 to the seed discharge zone into the seed pipe 15. The selected seeds through the seed pipe enter the plowshare 19. The teeth of the plowshare cut shallow (up to 3 cm) grooves where seeds from the measuring grooves 13 enter. At the bottom of the bunker 10, a reflector 14 is installed above the pick-up drum 12. It removes with its brushes an excess layer from the surfaces of the measuring grooves 13 of the pick-up drum 12 and directs to the side of a suitable next measuring

groove 13. The embedding of removable brushes in the measuring grooves to 1.0-1.5 mm is done by the screw of the seed reflector 14. This eliminates the waste of expensive seeds. The use of such a new technical solution makes the seeder a resource-saving unit.

The plowshare 19, on both sides, is covered by a protective wall which shields the seeds of high windage from the wind characteristic of the arid zone during the sowing season. This ensures accurate seeding at a given shallow depth.

The setting of seeding depth (0.5-2.0 cm) is regulated by changing the plowshare 19 height relative to the soil surface. The change in the depth of seeding is achieved by raising or lowering the plowshare19 with locks 18 relatives to the beam 16. The seeds are covered with soil using coverer 20 which is compacted by rollers 21.

The stability of the running depth of the plowshare19 is provided by the track rollers 17 and the compacting rollers 21.

As already noted, the seeds of desert fodder plants are low-flowing, and their seed heap is not loose. This significantly affects the technological process of the seeder. To ensure a stable supply of seed heap to the pick-up drum12, the side walls of the bunker are installed taking into account the natural angle of seed sliding over the metal. In turn, the vault down-faller 11is installed in the lower parts of the bunker 10 above the pick-up drum 12; it rotates constantly and eliminates vault formation. The rotation speed of the pick-up drum is 2–3 times higher than that of the vault down-faller11. This contributes to the smooth flow of seeds into the measuring grooves 13. New technical solutions of a seeder exclude crushing, clogging of seeds, and maintain the quality of seed, which leads to an increase in seed germination. The parameters of the measuring grooves 13 mounted on the seeder pick-up drum allow high-quality sowing of seeds of desert fodder plants of various sizes.

The developed seeder meets the requirements of agricultural technology when sowing seeds of desert fodder plants.

The parameters of the pick-up drum of the seed section of a seeder are determined by the technique presented in [24].

The parameters of the developed sowing section of a seeder are shown in Table 1.

Table 1. Parameters of the seed section of a seeder

Parameters	Units of measure-ment	Value
Pick-up drum radius	mm	50
Pick-up drum length	mm	60
Frequency of rotation of the pick-up drum	s^{-1}	0.25
Width of a measuring groove	mm	33
Depth of a measuring groove	mm	10
Length of a measuring groove	mm	60
Coefficient of a measuring groove filling with seeds	%	70
Number of measuring grooves	pieces	8
Tractor speed	m/s	2.0
Seeding rate	kg/ha	2.5-10
Depth of seeding	cm	0.5-2.0

4. Conclusions

Mechanization conditions of work in desert pastures are significantly different from the conditions in the irrigated zone, which necessitates the creation of modernized and completely new machines that meet the conditions of arid pastures. The absence of a specialized seeder leads to low-quality sowing of seeds and a decrease in the biological germination of seeds of desert fodder plants. Specialists develop and improve environmental and energy-saving technologies. A specialized seeder has been created for sowing seeds of desert fodder plants, the physical and mechanical properties of which

differ greatly from the seeds of other crops. The design of a seed section with a pick-up drum has been developed. Measuring grooves are installed on the drum, which selects the seeds in a sweeping mode, excluding crushing and clogging of seeds. The parameters of a pick-up drum providing continuous sowing are determined. The proposed seeder, on a whole, provides the sowing of seeds of desert fodder plants following agricultural requirements. The loss of expensive seeds is reduced by 50% and the consumption of fuels and lubricants – by 2 times.

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