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# REVIEW AND ANALYSIS OF EXISTING DESIGNS OF SEEDING MACHINES

# ЕГІСТІК МАШИНАЛАРЫНЫҢ ҚОЛДАНЫСТАҒЫ КОНСТРУКЦИЯЛАРЫНА ШОЛУ ЖАСАУ ЖӘНЕ ТАЛДАУ

# ОБЗОР И АНАЛИЗ СУЩЕСТВУЮЩИХ КОНСТРУКЦИЙ ПОСЕВНЫХ МАШИН

***Abstract.*** *In modern agro-industrial production, a high level of mechanization of ongoing processes prevails. At present, a huge number of machines with various operating principles and devices are used in agriculture. Seeders are distinguished by a variety of principles of action, structures, and working bodies; therefore, identifying the advantages and features of structures, directions of development, as well as principles of action, is an urgent task. The materials of the article show the relevance of work to improve the designs and increase the efficiency of seeding machines. An overview of existing seeding complexes is given, as well as a classification of seeding machines is presented, and an analysis of the merits of the presented designs is carried out.*
***Keywords:*** *seeding complex, seeder, technological process, design, working process.*

***Аңдатпа.*** *Қазіргі агроөнеркәсіптік өндірісте орындалатын үдерістерді механикаландырудың жоғары деңгейі басым. Қазіргі уақытта ауыл шаруашылығында әртүрлі жұмыс принциптері мен құрылғылары бар көптеген машиналар қолданылады. Сепкіштер әртүрлі іс-қимыл принциптерімен, конструкцияларымен, жұмыс органдарымен ерекшеленеді, сондықтан құрылымдардың артықшылықтары мен ерекшеліктерін, даму бағыттарын, сондай-ақ іс-қимыл принциптерін анықтау өзекті мәселе болып табылады. Мақала материалдары егіс машиналарының конструкцияларын жетілдіру және тиімділігін арттыру бойынша жұмыстардың өзектілігін көрсетеді. Қолданыстағы егіс кешендеріне шолу жасалды, сонымен қатар егіс машиналарының жіктелуі ұсынылды, ұсынылған құрылымдардың артықшылықтары талданды.*
***Кілтті сөздер:*** *себу кешені, сепкіш, технологиялық процесс, конструкция, жұмыс процесі.*

***Аннотация.*** *В современном агропромышленном производстве преобладает высокий уровень механизации выполняемых процессов. В настоящее время в сельском хозяйстве применяют огромное количество машин с различными принципами действия и устройства. Сеялки отличаются разнообразием принципов действия, конструкций, рабочих органов, поэтому выявление достоинств и особенностей конструкций, направлений развития, а также принципов действия, является актуальной задачей. Материалы статьи показывают актуальность работ по совершенствованию конструкций и повышению эффективности посевных машин. Приведен*

*обзор существующих посевных комплексов, а также представлена классификация посевных машин, проведен анализ достоинств представленных конструкций.*

***Ключевые слова:*** *посевной комплекс, сеялка, технологический процесс, конструкция, рабочий процесс.*

*Introduction.* Agriculture is one of the key sectors of the economy of the Republic of Kazakhstan (RK), and the degree of its equipment with modern multifunctional machines and equipment is directly related to the cost and quality of the products obtained.

In Kazakhstan, various technologies are used for growing crops: traditional, minimal, "zero" and intensive, the choice of which is often determined by the technical equipment of farms, and the transition from one technology to another entails high costs for the purchase of various types of equipment, for example, for providing seeding with fertilizers and plant protection products [1-6].

As the agrarian potential of Kazakhstan develops, much attention is paid by the state to the issues of improving the quality of technical equipment of the agro-industrial complex (AIC). Factors that determine the demand for modern machinery and means of agricultural mechanization are the requirements for cultivation technology, the progressive specialization, and concentration of production in developing farms, and the quantitative and qualitative state of equipment of agricultural implements and equipment.

Sustainable production of crop products depends primarily on the technologies used and mobile agricultural complexes, the main means of production. Due to the difficult political situation in the world, technologies for the technical modernization of seeding complexes (hereinafter referred to as SC), combining the functions of several units, began to develop more.

The analysis of the modern scientific study of the mechanization of the seeding process was carried out by such scientists as: Abbasov Z.M., Zhazykbaeva Zh.M., A.I. Belyaev, V.A. Vorobyov, V.V. Kalinnikov, M.M. Mezentsev, Gusakov F.A., Rudenko V.N., Kulaev E.V., Solntsev V.N., Tarasenko A.P., Orobinsky V.I., Polivaev O.I., Vorokhobin A.V., Dyachkov A.P., Arinov K.K., Shestakova N.A. Musynov K.M., Karipov R.Kh., Zhumagulov I.I., Ivannikov A.V., Shramko N.V., Mukazhanov K.M. and many others [1-9].

The leading companies in the field of world production and improvement of seeding equipment are John Deere (USA); Amazone, FranzKleine, Kverneland-Accord (Germany); Kongskilde (Denmark); Crucianelli (Argentina); MaterMacc, AgricolaItaliana, MascarS.p.a., MashioGaspardo (Italy); Monosem, Kuhn (France), etc.

Despite the variety of seeding machines used in the Republic of Kazakhstan (and in the world), according to the layout of the working bodies, they can be divided into monoblock, separate-aggregate, and sectional. The first group includes seeders manufactured in the CIS countries - such as SZ-3.6, SZS-2.1, SZS-6, SZS-12, etc., and foreign samples - AMAZONE D9-60, D9-120, GASPARDO MOD M. The disadvantages of this group of seeders are high material consumption, high seeding irregularity at low rates, and high traction resistance. The second group includes seeders manufactured by the CIS - SZS-8, SZS-14, PPA-7.2, SPN-8 units, and units of foreign manufacturers - GASPARDO PE, VENTA TI, FLEXICOIL, JOHN DEERE 750A, RABE WERK TURBODRILL, etc. [10, 11]. The disadvantages include - high uneven seeding at a low rate, a high degree of seed damage during transportation by airflow, as well as the removal of moisture from the soil by airflow.

The layout of the third group is typical for special seeders.

Along with the listed machines, soil-cultivating and seeding units are the most widespread in the Republic of Kazakhstan, which are used for seeding seeds of grain and leguminous crops

when cultivating them using "minimal" or "zero" tillage technologies.

The main modern directions for improving the PC are: increasing the speed of agricultural operations, reducing the time for refueling seeding units with seeds and fertilizers; increasing the dosing accuracy of the sown materials and the uniformity of the depth of their incorporation into the soil; the use of rollers to level the surface of the field after seeding; technological universalization and modularity of PC design [10-14]. In addition, increasing productivity, reducing metal consumption, increasing energy efficiency, reliability and other operational characteristics remain relevant.

A problematic issue for the agricultural enterprises of the East Kazakhstan region and the Republic of Kazakhstan (as a whole) is their equipment with universal equipment for seeding and tillage, increasing the technical resource reliability of seeding complexes. So, for example, "Pilot farm of oilseed crops" LLP, using the equipment of one of the leading foreign manufacturers, the CRUCIANELLI company, which is widely used in the Republic of Kazakhstan due to its low and reasonable cost, faced the problem of natural wear of coulters (almost during one season) in difficult soil conditions of the East Kazakhstan region, which leads to a significant increase in production costs. Also, in some cases, the problem is the design itself and the kinematics of the seeding device, which limits the microspace for the achene/grain. Another problem is the lack of research on the adaptation of some disk elements of the seeder to the conditions of the East Kazakhstan region (quick clogging, etc.). These examples give an idea that even in modern equipment from a well-known manufacturer, there is a significant potential for agricultural engineering in the direction of modernization, which will ensure more effective functioning of the PC in the specific conditions of various regions.

Further development of the agro-industrial complex of the Republic of Kazakhstan, aimed at increasing the productivity and profitability of its industries, requires the adoption of a set of measures for the qualitative growth of technical equipment, the observance of scientifically based agricultural technologies, the strengthening of scientific support and the introduction of innovative developments in the field of agricultural engineering in accordance with the needs of the real sector. Therefore, the scientific and technical problem of ensuring the efficient and resource-saving operation of mobile and universal agricultural units in a variety of conditions for growing crop products is very relevant for the Republic of Kazakhstan.

*Review and analysis of structures.* In recent years, pneumatic centralized seeding systems (PCSS) have been increasingly used in agriculture. The use of PCSS dictates increased requirements for reducing the metal consumption of units and increasing their productivity. Of the pneumatic seeders for centralized seeding, the grain-fertilizer universal pneumatic seeder S-6PM.1 deserves great attention (Figure 1) [15, 22].

The grain fertilizer seeder is designed for row seeding of grain, medium and small-seeded leguminous crops, herbs and their mixtures, and vegetables with the simultaneous application of granular fertilizers. The seeding process is carried out through a central dosing system. The seed flows from the hopper onto the metering shaft.

The seed flow rate can be increased or decreased by adjusting the screw on the metering roller. The edges of the coil are equipped with rubber seals and a nylon brush, which eliminates the spillage of seeds and their mechanical damage. Seeds that have passed the metering shaft fall into the ejector. In the same way, from the fertilizer compartment of the hopper, fertilizers enter the injector. Under the action of the airflow entering the ejector from the fan, seeds and fertilizers rise and mix in a vertical corrugated pipe. The resulting mixture is fed into the distributor.

The seeds and fats are then conveyed from the distributor through flexible tubes directly to the coulters. The seeding system for distributing seeds from the seeder C - 6PM.1MP is a single-stage type with a vertical corrugated pipe, the disadvantage of which is the relatively high resistance of the ejector device, as well as air leaks through the coil into the atmosphere [22].

**Figure 1.** Universal pneumatic seeder grain-fertilizer C – 6PM.1

The representative of the group of vacuum pneumatic tilled seeders with devices installed above the coulters is the mounted eight-row seeder MS-8 manufactured by OJSC Millerovoselmash (Russia). It is designed for precise (dotted or dotted-nested) seeding of corn, sunflower, sorghum, soybeans, and gourds with simultaneous application of mineral fertilizers to the soil with appropriate devices (Figure 2).

**Figure 2. Eight-row seeder MS-8**

The MS-8 seeder is a mounted machine, consisting of a frame, 8 seeding sections symmetrically relative to the hitch, 4 fertilizer meters, and marker devices also symmetrically located. The drive of seed and fertilizer seeders is carried out from the supporting wheels through the transmission, chain drives, and gearboxes. Advantages of this planter design:

– convenient layout of the loading bins, which allows for different types of loading (manual, mechanized);

– the presence of a transport device that allows the use of public roads when transporting over long distances;

– the skid-shaped coulter evenly distributes the seeds in depth;

– the low height of seeds falling to the bottom of the furrow to maintain their distribution in the seeding row.

Disadvantages in the design of the seeder:

– the use of a skid-shaped coulter does not allow seeding on wet soils and at operating speeds of more than 8 km/h;

– the vacuum seeding unit does not provide high-quality dosing at speeds above 8 km/h.

The seeding complex "AGROMASTER 4800" (Figure 3) of Russian production performs the entire range of seeding operations. In one pass, it produces the main and pre-seeding cultivation, destroys weeds, simultaneously sows seeds and fertilizers, and harrows, and rolls the soil. The seeding complex is designed for direct seeding and minimal resource-saving technology for growing grain crops [16-18, 22].

**Figure 3**. The seeding complex "AGROMASTER 4800"

The seeding complex consists of the following main components, mechanisms, and systems: a rigid frame, a hopper for seeds and fertilizers, lancet coulters, a three-row harrow, a two-balanced support compacter, front support wheels, a drive wheel, a pneumatic system for seeding seeds and fertilizers, a loading auger, a computer workflow management. The fan is driven by an independent engine or hydraulic motor [22].

The disadvantage of a stand-alone engine is a limited service life in the field, where the operation of the engine is adversely affected by dust. Seeding complexes "AGROMASTER" have a wide range of modifications - anchor, disc, wide-cut, combined seeders, in which the distribution of seeds and fertilizers occurs in a two-stage line under air pressure through a vertical pipeline. This seeding system has the disadvantage that the seeds are transported simultaneously with fertilizer along the same line [22].

A representative of vacuum pneumatic row seeders with devices mounted on sections with coulters or disc coulters is the mounted eight-row seeder MAGICSEM model 4100 manufactured by MaterMacc (Italy).

The machine is designed for precise seeding of seeds of row crops and their incorporation into the soil using coulters of two types: double-disk or keeled, depending on the quality of soil preparation before seeding and its condition (Figure 4).

A seeder is a mounted unit, consisting of the main frame, seeding units, support wheels, a fan driven by the tractor PTO to create a vacuum in the pneumatic system of the mounted unit, hydraulic markers, a seeding unit drive transmission, and supports for storing seed.

Advantages of this planter design:

– the use of polymeric materials facilitates the design of the seeder;

– a convenient hatch for unloading the seeding machine;

– the possibility of using a keeled and disc coulter.

Disadvantages in the design of the seeder:

– lack of a receiver, which increases the pulsation in the pneumatic system;

– lack of fertilizer seeders for fertilization;
– high seed fall height, which worsens the distribution of seeds in the seeding row;
– lack of a plume leveling the soil surface after the coulter has passed.

The seeding complex (SC) "Kuzbass" (Figure 4) refers to machines of zero seeding technology.

**Figure 4.** The seeding complex (SC) "Kuzbass"

The seeder performs the entire range of spring field-work in one pass through the field: pre-seeding treatment, seeding, fertilizing, rolling and leveling the soil, and seed dressing [19-21].

The technological scheme of the pneumatic system is designed in such a way that first the air-grain flow is divided into 4 parts with centralized two-stage distribution, and then through vertically located distributors to the coulters. Two compartments of the hopper are equipped with autonomous seeding mechanisms, so both seeds and fertilizers can be poured into the hopper at the same time. A hydraulic motor drives a fan that forces air into the seed tube system.

The advantage of this seeding complex:

- high quality of seeding works; no additional devices needed;
- small required power; maneuverability; reduction of labor costs by several times. However, some shortcomings were also identified:
- the low resource of the durability of coulters;
- uneven seeding of seeds with an uneven field surface;
- clogging of the seeding pneumatic system, which forces a long and thorough preparation of the seed for loading into the hopper.

A representative of overpressure pneumatic row seeders with devices mounted on sections with disc coulters with track rollers is the trailed twelve-row seeder Great Plains YP-625A made in the USA. It is intended for seeding sunflower, corn, and other tilled crops with the function of double seeding (Figure 5) [22].

**Figure 5**. Twelve-row planter Great Plains YP-625A

The planter consists of a frame, support wheels, four fertilizer boxes, a hydraulically driven overpressure fan, disc openers, coulters, and furrow cleaners. The drive wheels are equipped with a special tread that has a minimum slip coefficient. AIR-PRO openers allow you to set row spacings up to 20 cm. Coulters are necessary to facilitate the penetration of openers into the soil [8, 22].

Advantages of this planter design:

– the possibility of using it for stubble seeding;

– wavy coulters installed in front of the coulter facilitate its passage through unprepared soil;

– double-disk opener, allowing to increase the working speed;

– the seeding device of excessive pressure provides uniform distribution of seeds;

– two-row seeding allows you to increase the number of plants per hectare when cultivating a crop for silage.

Disadvantages in the design of the seeder:

– trailer type of machine reduces the use of shift time;

– cumbersome design;

– small width of capture.

*Conclusion.* Scientific study and calculation of the resistance of swept coulters with various plant materials of developed arable lands are necessary. The conducted patent analysis of the materials of this review article shows the patentability of the material in question and recommends it as analogs in the preparation of applications for titles of protection. The following directions for the development of seeding machines have been established: improving the quality of seed dosing by reducing the height of the fall of seeds; improving the quality of seed dosing through the use of overpressure seeders in dosing devices; use of airflow to transport seeds to the soil; centralization of fertilizer; use of disc coulters; the use of polymeric materials; development of designs of machines operating on stubble backgrounds.

These directions in the development of seeding machines provide an increase in the quality of seeding seeds, the reliability and durability of seeding machines, and their productivity, for which purpose high-speed working bodies have been introduced into their design in order to increase operating speeds up to 15 km/h.

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