Scientific technologies and their technical support - main factors of efficiency of plant products production

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Abstract: *The modern trends of development of agricultural technologies and their technical support and methodical approach to the formation of an effective technical and technological base of agrarian enterprises. It is established that the main factors influencing the efficiency and environmental friendliness of agricultural production are technologies and technical means for their implementation. In economically developed countries, technological innovations provide 70-90% growth in gross domestic product. The methodical approach to formation of effective technical and technological base of the agricultural enterprises on the basis of innovative technologies and the newest technical means with the technical and operational parameters coordinated with volumes of mechanized works and rational terms of their performance is offered. The main paradigm of the latest technologies for crop production is greening, which is based on the harmonization of the relationship between technology and soils, which will reduce the physical degradation of soils and preserve their fertility. To ensure efficient production of crop products in the agricultural enterprise should be formed technical and technological base on the basis of science-intensive technologies and the latest technical means with technical and operational parameters consistent with the scope of work and rational agro-technical terms of their implementation.*

KEY WORDS: *TECHNOLOGIES, TECHNICAL AND TECHNOLOGICAL BASE, VOLUMES OF MECHANIZED WORKS, TECHNICAL MEANS, TECHNICAL AND OPERATIONAL PARAMETERS.*

1. Introduction

Ukraine's natural resources are favorable for the production of all types of agricultural products. They are characterized by a variety of soils and climatic conditions, which led to a large number of technologies for growing crops and requirements for technical support for their implementation.

Concentrating in their development the achievements of scientific and technological progress, machinery and technology have become the most important factors in the efficiency of agricultural production. They determine the level of land productivity, efficiency and comfort of work, cost and quality of products, form the social and economic factors of development of the agricultural sector of Ukraine's economy.

The main paradigm of new technologies is their greening, which is achieved through strict compliance with the requirements of agricultural technology to the timing and quality of technological operations, the use of new working bodies and structural and functional schemes of technical means created taking into account soil and climatic conditions and plant requirements.

Greening of technical and technological policy in agriculture is a search for new ways to harmonize the relationship between technology and soil, which will reduce the physical degradation of soils, preserving their natural fertility.

The set of technologies and machines for their implementation form the technical and technological base of the agricultural enterprise, which is the determining system that affects the volume, quality and economic efficiency of agricultural production.

Therefore, the problem of forming the technical and technological base of agricultural enterprises is relevant, taking into account the structure of sown areas, innovative technologies and production volumes of agricultural products and the latest technical means, the use of which will minimize production costs and anthropogenic soil load.

2. Preconditions and means for resolving the problem

Analysis of recent research and publications. The results of research on the development of technologies for growing crops and trends in their development are covered in the works [1 - 5] and other authors.

Technical and economic bases of formation and effective use of material and technical base of agro-industrial production are considered in works [6-12].

The complex of production technologies and material and technical base for their implementation form the technical and technological base of agricultural enterprises.

Taking into account the impact of technical and technological base of agricultural enterprises on the efficiency of agricultural production and participation in production activities of a wide range of technical means of various functional purposes and terms of their use, the authors found the need for a systematic approach to the formation of technical and technological base of agricultural enterprises and its use in production processes.

The purpose of the research. To identify promising areas for improving the efficiency and environmental friendliness of crop production in agricultural enterprises.

Methods of the research. Monographic, economic-mathematical, analytical, systems analysis, systems engineering.

Research by agricultural scientists in Western Europe is focused on developing a new generation of machine technologies that will preserve the biological and ecological balance in nature. Ecologization and resource saving in the production of agricultural products with the minimum contamination of anthropogenic means of intensive impact on agrocenosis provide for the reasonable use and regulation of the systems of cultivation and fertilization of soil, plant protection and other agrotechnical methods that ensure the minimum cost of material and technical resources and environmental safety.

3. Results and discussion

Among the numerous factors that affect the efficiency of production and resource intensity of agricultural products, the determinants are the technologies of its production and technical means used for their implementation. Therefore, the main task of agricultural science at the present stage is to develop the latest machine technologies for agricultural production, which will preserve biological and ecological balance in nature, reduce costs of all types of resources per unit of output, improve its quality and safety.

Crop technologies have come a long way in evolution. Along the way of their development, man was faced with the problem of reducing production costs, increasing the profitability of production.

In the conditions of aggravation of ecological, economic, energy, social, demographic and other factors the question of search of rational, effective, ecologically safe ways of agricultural production becomes more and more urgent. Prospective options should embody the foundations of the strategic development of the agro-industrial complex of the country, ensuring food independence, to comprehensively address other equally pressing

issues for society - the preservation of the village as the primary source of the nation. There is no simple solution to these issues. That is why today it is important not just to optimize the process of production, which in many cases is artificially simplified, limited by a small number of factors, but to maximize the use of all components of the impact on the efficiency of production and environmental friendliness, which as a result can significantly minimize the negative consequences of the development of agro-industrial complex.

Energy-efficient food production is one of the most pressing issues today and agricultural production, as one of the largest consumers of fuel in the country, cannot and should not stand aside from modern scientific advances in the development of technologies and equipment for energy-efficient agricultural production.

Crop growing technologies are characterized by a significant duration of harvesting processes and depend on a number of controlled and uncontrolled factors.

In implicit form, this can be written as:

$$T = f(A,S,G,K,O,L,D,U,Z,C,M), \quad (1)$$

where A – agricultural techniques for growing crops; S – variety potential; G – soil fertility potential; K – climate conditions; O – soil treatment system; L – seeding method; D – crop care system; U – fertilizer system; Z – plant protection system; C – level of staffing; M – logistics level.

One of the main basic elements of various technologies, which further defines its type, is the soil tillage system. It is the system of soil tillage and the complex of technical means for its implementation that largely determine the level of energy saving of a particular technology, its ecological and economic orientation.

The value of mechanical tillage is due to the action of the working bodies of machines on all soil properties, because it is tillage that creates the appropriate conditions for plant growth and development.

The results of research in agricultural science found that depending on the mechanical composition of the soil, its density should be in the range of 1.1-1.3 g/cm^3 for medium and 1.3-1.4 g/cm^3 for light soils, and the content of agronomically valuable structural units (size 0.25-10 mm) not less than 70%, air capacity - not less than 15% of soil volume, total density - 50-55%, water permeability - not less than 30 mm/h .

Tillage helps to create a favorable agrochemical environment in the root layer: for plants whose root system is located in the upper soil layers (cereals, ears, legumes, flax) the best condition of this environment will be one in which the main mineral fertilizers will be in the upper soil layer at depth 5-15 cm below the depth of sowing seeds.

The economic efficiency of tillage is also relevant for agriculture, as tillage is one of the most energy- and labor-intensive technological operations. Depending on the technology and technical support in the structure of direct operating costs in crop production for tillage operations account for up to 40%. Of these, up to 41% - energy consumption and up to 25% - labor costs. Different methods of tillage differ significantly in energy consumption, so their choice should be aimed at achieving their goals and payback for their implementation.

Equally important is the environmental efficiency of tillage systems, as among them there are those that have a mobilizing effect on soil fertility (shelf), and others more economically affect the use of energy resources and labor costs (shelfless and surface).

Systematic intensive use of soil plowing in the conditions of Ukraine in the 60-80s of the XX century led to soil degradation, reduction of their fertility, significant reduction of the amount of humus in them. The average humus content in soils over these 20 years decreased from 3.5% to 3.2%, which is 1-2% less than the optimum [2,14].

About 50% of arable land is affected by water and wind erosion. The intensity of erosion processes now exceeds the natural soil formation by 2-10 times. Soils are also negatively affected by physical erosion, which is manifested in their compaction under the action of the running systems of tractors and agricultural machinery. With intensive technologies, the number of passes of single-operation units on one track reached 8-16, and soil compaction was extended to a depth of 1000 mm [14].

A large number of different technical means can be used for technical support of tillage systems, which differ both in the method of impact on the soil and in technical and operational parameters, but all of them must, with appropriate preparation for work, ensure the implementation of technological techniques according to agronomic requirements. both in quality and in terms of their implementation.

The main task of agrarian production at the present stage is the application of new generation machine technologies, which allow to preserve biological and ecological balance in nature, provide reduction of expenses of all kinds of resources per unit of production, increase of its quality and safety. Production of competitive ecologically safe agricultural products does not require simplification of technologies, but a reasonable effective use of natural conditions, rational application of systems of cultivation and fertilization of soil, protection of plants and other measures ensuring production of products with minimum costs of material and technical resources and labor. The basis of such technologies is optimization of placement of crops in the crop rotation and performance of the whole complex of works in optimal terms with observance of requirements of agrotechnics concerning their quality. Therefore, machinery for such technologies should be equipped with means of automation of control and management of technological processes.

Currently, the following basic technologies are practiced in Ukraine for soil preparation for agricultural crops: technology of differentiated cultivation in the crop rotation system; surface tillage technology; canning treatment technology; zero tillage technology and strip tillage technology. Each technology has its advantages and disadvantages, which are manifested in different ways in different soil and climatic conditions of Ukraine.

Differentiated tillage system is based on the use of plows, disc implements and cultivators to prepare the soil for sowing in the crop rotation system. This technology is economically feasible with sufficient rainfall, time, technical and operational resources for its implementation, as well as the need to earn into the soil a large number of plant residues, organic fertilizers and green manures, reducing the pesticide load on the soil.

The technology of surface tillage is common in preparing the soil for winter sowing. It is based on the use of wide-reaching tools with paddle or disc working bodies and rollers of various constructions that loosen the soil to a depth of 16 cm. It is moisture-saving, highly productive, energy-saving per unit area. This technology provides loosening of the surface layer of the soil with the preservation of 60-80% of plant residues on the surface, as mulch.

Preservation technology of tillage to a depth of 25-40 cm is performed by heavy cultivators, deep cultivators, chisels or combined tools. Moisture-accumulating, energy-saving technology per unit of output can be used mainly in the treatment of soils for chills in all soil-climatic zones of Ukraine.

This technology provides loosening of the compacted core (plow sole) and intensive loosening of the surface layer with preservation on the surface of up to 40% of plant remains.

The technology of sowing into untreated preliminary soil (No-till) is based on the application of special units for direct sowing of crops and chemical means of weed and pest control. It is highly productive, minimizes direct energy costs for soil tillage and sowing, is damp-saving, all plant residues remain in the field, which protects the soil from deflation.

According to strip treatment technology (Strip -til) the soil is loosened to a depth of 30-35 cm only in the area of seeds sowing with simultaneous layer-by-layer introduction of nutrients into the loosened zone. In this case, plant residues available on the surface from the strip zone are moved into the row spacing and act as mulch and partially inhibit the growth of weeds.

According to foreign economists in economically developed countries technological innovations provide an increase of 70-80% of gross domestic product. In the USA, the growth of national gross income per capita due to technological innovations reaches 90% [13]. The underestimation of the leading role of technology significantly reduces the competitiveness of production.

But no matter how perfect the technology in the farming system is, it will remain a pipe dream unless it is provided with the same perfect technology. Therefore, the search for ways to improve the economy of agrarian enterprises should be focused on creating conditions for optimal provision of them with modern equipment, as the main prerequisite for the innovative development of the industry.

In today's conditions the agriculture needs not just new equipment, but such material and technical basis, which will allow increasing labor productivity several times. Its formation is possible only on the basis of technical means of new generation, parameters of which should be indicative on achievement of high levels of productivity with minimum expenses of live and vegetable labor per unit of production.

The analysis of domestic and world experience in the development of agrarian technologies shows that climatic anomalies negatively affect the efficiency of agricultural production. However, agricultural enterprises, which produce products using knowledge-intensive technologies, suffer less from them. In farms with a high level of technical and technological base development the negative influence of natural and climatic factors is significantly reduced. Modern trends in the development of technical and technological base of Western European countries consist in the renewal of its machines of high technical level, ensuring the performance of technological operations in accordance with the requirements of agricultural machinery with the minimum cost of energy resources.

Researches of scientists of agrarians in the countries of Western Europe are focused on development of machine technologies of new generation which will allow to keep biological and ecological balance in the nature. Biologization and resource saving in agricultural production with minimum application of anthropogenic means of intensive influence on agrocenoses provide reasonable use and regulation of systems of soil tillage and fertilization, plant protection and other agrotechnical methods ensuring minimum expenses of material and technical resources and ecological safety.

Modern intensive technologies require the involvement of large doses of mineral fertilizers and plant protection products in the process of crop production, which leads to an increase in production costs. That is why the technology of targeted fertilizer application to the zone of root system development of agricultural crops under the programmed yields, and the need for them is determined by the results of diagnostics and satellite mapping of fields.

Important factors of modern agro-technologies are protection of plants from harmful organisms, carrying out technological operations in clearly defined terms. When using pesticides, the advantages are provided by selective agents and ultra low volume spraying, which allows reducing the rates of consumption of working solutions by 80-90% and reducing environmental pollution.

The development of agricultural production technologies in Ukraine and their technical support is under constant influence of achievements of scientific and technical progress in leading countries of the world, where industrial methods in agricultural production are combined with highly effective agrotechnologies, the introduction of which accelerates the technical progress in agricultural engineering.

In modern conditions all firms-manufacturers of agricultural machinery conduct rigid competitive struggle for the right to provide agricultural production with machinery. For this purpose, they are trying to best meet the needs of consumers, constantly improving the consumer properties of machines in accordance with the requirements of the latest production technology and service support.

The experience gained by the world's leading firms in creating the structures of agricultural machinery deserves attention and use in agricultural engineering of Ukraine.

In order to ensure the effective conduct of agrarian business in each agrarian enterprise should be formed technical and technological base, which includes a system of innovative production technologies and machinery and tractor park for technical support of their implementation.

The system of technologies is formed under the appropriate farm structure of cultivated areas and production volumes ... For this purpose the specialists of the farm should develop technological regulations of cultivation of each crop by innovative technologies taking into account the place of the crop in the crop rotation and planned yield, calculate the norms of fertilization under the planned yield, indicate the expected calendar terms of execution of all technological operations and their duration recommended by agrotechnics, requirements to quality parameters of execution of technological operations.

Then on the basis of technological regulations the plan of mechanized works is developed. In accordance with the requirements of agricultural machinery in terms of quality of work are formed machine and tractor units. All factors affecting the conditions of production and operation of machine and tractor units are random. Therefore, the machine and tractor fleet of an agrarian enterprise should provide the possibility of completing the machine and tractor aggregates, adaptive to the changing conditions of production and counteract their negative influence on the results of work. Its functional description for crop production can be conventionally represented by an expression:

$$MTP = \{ K, N, U, t, F\}, \quad (2)$$

where K – many crops grown on the farm; N – many technological operations that must be performed in the production of all types of agricultural products on the farm; U – a set of calendar periods in which it is necessary to perform appropriate technological operations in the production of a particular type of product; t – is the set of rational agrotechnical terms of performance of each technological operation; F – the amount of work that must be performed for each technological operation in the time recommended by agricultural technology in the cultivation of crops on the farm. This description of the MTP is quite general, and its practical application is complex.

Since the MTP of an agricultural enterprise is an important component of its production potential and significantly affects the results of economic activity, one of the main tasks of enterprise management is the formation of MTP, which will ensure the production of competitive products using innovative technologies and rational use of production and financial resources. and its solution is complex.

During the planned economy, the problem of developing a mathematical model and software to justify the optimal structure of the MTP was given considerable attention by scientists. Since in the process of agricultural production interacts a large number of factors that are probabilistic in nature, and their interaction is unknown, the results of the calculations did not give a global optimum, but also had a probabilistic nature. However, they provided a guide for the formation of plans for the production of agricultural machinery.

With the transition to a market economy and market saturation with a wide variety of technical and operational indicators created conditions for the MTP of agricultural enterprises with technical means with technical and operational parameters that best meet the technology, structure and volume of agricultural production in the enterprise.

In these conditions, it is expedient to solve the problem of acquisition of rational composition of machine and tractor park by means of decomposition for a number of tasks on selection of technical means for performance of concrete technological operations with set quality indicators in recommended agrotechnical terms, using for this purpose known dependences of technical-

operational indicators of MTA on parameters of technical means and their influence on economy of production.

To ensure efficient and effective product production, technical parameters for completing machine and tractor units need to be selected according to performance criteria and technical indicators.

According to the criterion of quality the machines are selected on the basis of indicators of their purpose for the compliance of indicators of quality of their work with the requirements of agricultural machinery to perform a certain technological operation:

Necessary technical-operational indicators of technical means are determined by the corresponding algorithm from the condition of performing technological operations in terms recommended by agrotechnics with the given quality. These requirements are best met by universal multi-operational automated technical means, provides a high coefficient of their employment in the production cycle and a corresponding reduction in operating costs for production.

According to the requirements of agricultural machinery, the working time fund for certain technological operations is limited to the number of days, along which it is advisable to perform this or that technological operation. Deviation from the optimal terms of technological operations leads to shortage / loss of yield. The greatest losses occur when sowing, plant protection and harvesting are not met. Therefore, the daily output of the machine-tractor unit (Wq) should ensure the implementation of the entire volume of the same type of work, coinciding in calendar periods, in the optimal agro-technical terms and can be defined as a fraction of the division of the total volume of work recommended by the agricultural machinery duration of these works (working time fund):

$$W_q = \frac{\sum F_{pi}}{T_a}, \quad (3)$$

where $\sum F_{pi}$ – the sum of the same types of work, the timing of which for different crops in different fields coincide, in a certain calendar period, ha; T_a – the fund of working hours recommended by agrotechnics for performance of certain technological operations coinciding in calendar periods, calendar days.

To establish the daily output of the machine-tractor unit on a certain type of work determine the width of the relevant technical means (B_p, *m)*, which will ensure high-quality and timely execution of technological operations:

$$B_p = \frac{W_q}{0.1 \cdot t \cdot V \cdot \tau \cdot \alpha \cdot k_z \cdot k_v}, \quad (4)$$

where t – normative duration of change, 7 hours; V – working speed of MTA during performance of a certain type of works, km / h; τ – utilization rate of working time of change during the day; k_z – coefficient of variability; k_v – the utilization factor of the working width of the working machine; α – the coefficient of weather conditions of the relevant period and region.

$$k_z = \frac{T_f}{t}, \quad (5)$$

where T_f – the actual duration of the unit during the day, h.

The values of the relevant coefficients are taken as normative or those that have developed in the economy in recent years.

The duration of the unit during the day depends on a number of factors, the main of which are the type of work, the duration of the light time, the technical level of the machine-tractor unit, the level of work organization. When choosing technical means for innovative technologies, preference should be given to universal multi-operating machines equipped with means of automation of control and management of the operating mode.

In farms with a large amount of work for their timely implementation may require several units. The required number of units (n_a) determined by the dependence:

$$n_a = \frac{B_p}{B_f}, \quad (6)$$

where B_p – the required estimated width of the MTA for timely execution of works, m; B_f – the actual width of the capture available in the farm technical means to perform a certain type of work, m.

Required tractor power (N_e) for each type of work is determined by indicators of resistivity of tools or specific energy consumption of technological operations by expression:

$$N_e = B_f \cdot q, \quad (7)$$

where q – engine power required per 1 m of working machine width, kW (hp).

In the absence of tractors with engines of the required power, determine the appropriate width of the machine for aggregation with tractors available on the farm, or decide on the feasibility of purchasing a tractor of the required power:

$$B_q = \frac{N_k}{q}, \quad (8)$$

where B_q – reasonable working width of the implement for the attachment to the tractor on the farm.

For the production of various types of products, the parameters of technical means in the technological complexes of machines are coordinated in terms of working width (in-line), productivity and load factor, allows to increase the efficiency of their use. Parameters of auxiliary machines are coordinated with the productivity of machines that perform the main technological operation.

An indicator of the efficiency of the use of each technical means in the farm to perform technological operations is the coefficient of its employment in the production process. It is determined by the dependence:

$$\eta_i = \frac{t_f}{t_q}, \quad (9)$$

where t_f – actually worked hours on this type of work, or when growing a particular crop; t_q – duration of the cycle of field work on the farm, hours (permitted annual fund of relevant field work).

The coefficient of use of the technological complex of machines (hik) for growing a certain crop is defined as the average value of employment rates in the production process of technical means or all machine-tractor units used in the technological cycle of growing crops:

$$\eta_{ik} = \frac{1}{N}\sum_{i=1}^{n}\frac{t_f}{t_{qi}}, \quad (10)$$

where $N = n_1 + n_2 + \ldots + n_i$ – the number of MTAs used in the technological cycle during the cultivation and harvesting of crops;i = 1, 2, 3 ,…, n – number of MTA technical means of the same type of units used to perform technological operations during the cultivation of crops.

Technical means with a low employment rate in the production process must be checked for the feasibility of having their own technical means or perform this amount of work under the lease (services).

The minimum amount of work for which it is advisable to have their own technical means is determined by the expression:

$$Q_{\min} = \frac{C_n}{C_o - C_v}, \quad (11)$$

where Q_{min} – the minimum amount of work for which it is advisable to have your own equipment; Cn – the value of fixed costs of ownership of equipment, which includes the annual amount of accrued depreciation, the cost of storage of a particular technical device, interest payments on credit, if the equipment was purchased on credit, USD.; Cv – the value of variable costs for the performance of certain types of work with their own equipment, which includes the cost of labor, fuel and lubricants and maintenance and repair, USD / ha; Co – the amount of costs for a certain type of work under the lease agreement, USD / ha.

The amount of fixed and variable costs is determined in accordance with applicable regulations [16]

The machine-tractor park formed on such methodical bases will provide ecologically safe effective production of crop production.

4. Conclusions

1. The main paradigm of the latest technologies for crop production is greening, which is based on the harmonization of the relationship between technology and soils, which leads to a reduction in physical degradation of soils and preserve their fertility.

2. To ensure efficient production of crop products in the agricultural enterprise should be formed technical and technological base on the basis of science-intensive technologies and the latest technical means with technical and operational parameters consistent with the scope of work and rational agro-technical terms of their implementation.

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