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ORGANIZATIONAL AND ECONOMIC PRINCIPLES OF AGRICULTURAL MACHINERY USE

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Technical support of producers of agrarian products has always been and will remain a topical issue in realities of agrarian sector of Ukraine. In recent years, integrated forms of agricultural enterprises have become more widespread, which make it possible to increase and renew a machine-tractor park of their participants. In course of study four main technologies of soil cultivation and their impact were considered, an amount of necessary machinery and equipment, energy and labor costs, and impact on quality indicators of soil health. Also, main organizational forms of enterprises that provide equipment rental services or perform fieldwork were analyzed. Proposals were made regarding a merger of existing enterprises into agro technical centers, which would increase an efficiency of their functioning and cover functions of regional self-government. Also, the most common forms of machinery usage by agricultural enterprises were considered.

Keywords: agricultural producers; machinery; organizational forms; tillage systems

Introduction

An important component in process of agricultural products manufacture is a technical support of commodity producers. Only if necessary agricultural machinery is available, genetic potential of cultivated crops can be reached, since all technological operations are limited by time and require high quality of cultivation, sowing, fertilization, harvesting, etc. As world experience shows, progressive development of agriculture is only possible on a basis of innovation and technological modernization of production process.

One of the reasons of a low economic efficiency of most agricultural enterprises in Ukraine is a poor level of machinery. Basic equipment used by commodity producers has been worn out and needs to be replaced. Available equipment does not enable to produce competitive products and to increase an export potential.

There is a trend of agricultural enterprises consolidation in recent years and creation of integrated formations that actively use modern technology as well. Study of peculiarities of use of technical means in the conditions of inter-sectoral integration in the agrarian sphere of economy and analysis of impact of providing enterprises with fixed assets on economic indicators of economic activity is topical.

Analysis of recent research and publications. Problems of provision of agricultural enterprises by technical means and efficiency of their use are highlighted in scientific works of Belousko, Brewer, Kuksa, Burkovskii, Primak, Saiko, Voytyuk and others. Despite a wide range of issues studied by domestic and foreign scientist, some of them, in connection with deepening of market relations in countryside, need to be improved and further explored, especially in a context of inter-sectoral integration.

The purpose of the article is to study an efficiency of modern technology use in conditions of inter-sectoral integration in agrarian sector of economy.

Material and methods

Data from official statistics, annual and operational reports of agricultural enterprises were used. The main methods for processing economic information were the method of statistical groupings and correlation-regression analysis with the purpose of comprehensive study of factors that affect the level of technical supplies of agricultural production in Ukraine.

Results and discussion

Unlike other sectors of national economy, use of machinery has a number of distinctive features. This is primarily seasonal nature of production, which predetermines a non-rhythmic use of technology. In addition, agricultural production requires a variety of equipment: for cultivation of soil, for sowing, for crops care, for harvesting, forage harvesting, for processing of grain and other agricultural products. Field work is carried out in open air and on a large area. A need to perform certain technological operations clearly in certain agro technical terms has a great influence on the results.

In studies, for example, I.D. Burkovskii notes that in violation of the agronomic terms of sowing wheat, causes a yield reduction of 0.4 centners per hectare per day (Burkovskii, 2000). Natural and biological factors in agriculture have a greater influence than in industry, affect a turnover of fixed and current assets. In agriculture, they rotate more slowly, and a capital intensity of agricultural production is much higher than in the industry, because for agro technical requirements, means of mechanization are used for a short period of time. A narrow specialization of agricultural machines and tools, limited timeframes for works lead to a fact that they are involved from 15 to 110 days a year, that is, from 4 to 33% of calendar time. Therefore, agriculture should have a higher energy intensity than the industry. Use of equipment in agricultural sector not only dramatically reduces a level of labor costs, but also directly

affects the results of production, which ensures a renovation of enterprises machine-tractor park of corporate sector of the economy.

Currently, there is a gradual increase in efficiency of use of active part of fixed assets (machinery, equipment, vehicles) (Table 1).

A decline in efficiency of agricultural machinery in 2016 against 2000 is cause by a revaluation of fixed assets. During the investigated period, there is a gradual increase of efficiency of use of moving stock of agricultural enterprises fixed assets.

The main source of machine-tractor park formation is profit, which is aimed at its updating. However, according to the table, those with the highest level of profitability make up a small share in structure of acquisition of major types of machinery and equipment. This is states, first of all, the use of intensive agricultural production technologies. For the rest of agribusiness entities, an extensive nature of production is inherent, that is, an increase in gross output is ensured by growth of means of production.

Actual machinery provision of agriculture in Ukraine per unit area is significantly behind this indicator from a number of other countries. Thus, as of January 1, 2013, value of fixed assets per 100 hectares of agricultural land in Ukraine was 5.9 times lower than in Czech Republic, in Poland – by 6.1, in Hungary – by 7.8, in Slovakia – 6.8 times.

Acquisition of agricultural machinery by unprofitable and low-profit agricultural enterprises in large numbers is caused by a long-term prospect of profitable agribusiness and in case of its termination an opportunity to provide services of soil cultivation.

It deserves attention to use as an indicator for the analysis of financial situation of Polish farms their ability to reproduce capital, which demonstrates a possibility of expanding production by upgrading and modernizing main productive assets. In practice, this is the ratio of profits received to value of depreciation deductions, which refers to the costs of production of a particular agricultural product.

Of course, it should be at least 100%, which means unprofitable production, that is, zero profit. As you can see, for wheat it is more than 250%, and for barley it is 130%.

Table 2 compares this coefficient for conditions for winter wheat growing in Ukraine and Poland. Calculations of the main economic indicators give grounds to argue that even such a highly profitable culture as wheat does not allow to compete with possibility of acquiring basic productive assets compared to Polish farmers. Ability to reproduce capital in Ukraine is 100% lower than in Poland under equal conditions of depreciation.

A growth of mechanical impacts on soil leads to a number of negative consequences in agriculture. According to the "Institute of Agriculture", for the last 60 years content of humus in soil decreased by 25–30%, its density increased, erosion processes intensified. Over the past 20 years, mechanical action on soil increased almost 4 times, and yield of crops due to soil redevelopment decreased by 12–30%. Negative phenomena above determine an urgency of minimizing a cultivation of soil in modern agriculture (Saiko, 2010).

Table 2 Ability to reproduce fixed assets by example of growing 1 hectare of winter wheat at a yield of 60 centners, 2016

Index	Ukraine		Poland	
	UAH	%	UAH	%
Grain value	10,800	78.0	18,747	72.0
VAT	2,160	15.6	1,312	5.0
Grain value including VAT	12,960	93.5	20,059	77.0
In addition:				
– straw	900	6.5	1,493	5.7
– surcharge for seeds	0	0	447	1.7
– surcharge direct	0	0	4,072	15.6
Cost of production – total	13,860	100.0	26071	100.0
Price including VAT for 1 c grain	216.00	X	334.31	X
Cost of 1 c grain	184.76	X	255.86	X
Profit	1,874	X	4,707	X
Amortization*	3,104	X	3,104	X
Ability to reproduce capital (%)	160	X	252	X

Source: www.wip.org.pl and author's own calculations

*Depreciation is accepted for the calculation at the costing level of farmers in Poland

In process of production of agricultural products, a number of new technologies are introduced, which make it possible to significantly increase a productivity of agricultural production and ensure an efficient use of land and other resources.

Today, four basic tillage technologies are used: classic cultivating system, system of saving or reduced cultivation, system of fertility preservation and a technology of zero soil tillage.

Traditional crop cultivation technology based on plowing is a significant consumer of energy resources (which greatly affects a cost of production), it already exhausted itself as a result of continuous degradation of soils and too high energy intensity. It was found that such a system of soil cultivation accounts for 50% of energy and 25% of labor costs in total field work (Brewer, 2011).

Today, resource-saving technologies of soil cultivation are becoming widespread. Best practices in agriculture show that annual deep plowing is a resource-intensive process that often causes significant damage to a soil microflora and enhances erosion processes. Therefore, a basis of resource-saving technologies in plant growing is a change in the way of soil cultivation. However, expected effect can be achieved by using a series of measures that will involve a use of strip-till and minimal soil cultivation. It should be noted that in Ukraine there are scientific preconditions for implementation,

Table 1 Dynamics of efficiency of use of machines and equipment at agricultural enterprises

Indicator	Year				2016 to 2000 (%)
	2000	2005	2010	2016	
Gross output in actual sales prices (UAH)	20.7	36.3	94.6	130.8	631.9
Cost of active part of fixed assets	15	14.5	34.4	82.1	547.3
Cost of machinery and equipment	11.5	11	28.1	67	582.6
Vehicles	3.5	3.5	6.3	15.1	431.4
Machine capacity	0.72	0.40	0.36	0.63	87.5
Machine deductible	1.38	2.5	2.8	1.6	115.9

Source: compiled and calculated according to the data of the State Statistics Service of Ukraine

accumulated experience of their use by advanced farms "Agroecology" and "Obriy", Shishatsky district of Poltava region, "Sokilcha", Popilnyansky district of Zhytomyr region, "Agro-Soyuz", Synelniki district of Dnipropetrovsk region.

The minimal understanding of scientifically grounded soil cultivation, which ensures a reduction of energy and labor costs by reducing the amount, depth and cultivated area of field, as well as a combination and implementation of several technological operations (loosening, consolidation of soil, fertilization, herbicides, seeding) in one work process. A necessity to minimize soil cultivation is determined by a reduction of energy and labor costs on its implementation. Intensification of agriculture involves increase of tractors power, width of capture of guns, but at the same time their weight and pressure on the soil increase. Application of intensive processing in rotation with the prevalence of annual plowing leads to the activation of microorganisms that accelerate the expansion of humus (Maksimchuk, 2001).

Minimum soil cultivation involves the preservation of plant residues and crushed straw in the upper layer, on the soil surface (without the use of a plow). Disadvantages of minimizing soil cultivation are a deterioration of its phytosanitary condition: increased infestation of crops, low resistance of crops to diseases and pests. This new farming system requires the implementation of a number of relevant agronomic measures (Shikula, 1990).

Particularly important is the use of minimal technology on fields subject to erosion. Plant residues are not collected from a surface of the soil and protect the upper layer from water and wind, and formed mulch from drying and direct sunlight. In this case, the top layer of soil is retained, and amount of evaporated moisture is reduced. For the fourth year of application of minimal technology weeds are virtually disappearing. There is no other alternative, except for minimal technology, for a risky farming area and arid zones.

According to the information agency "Agro-Soyuz", characteristic of the main costs of growing winter wheat after maize on silage in the traditional and two variants of soil protection technology, using medium and wide-haul technique – suggests that in comparison with traditional technology, soil protection requires 2.9 times less moto-hours when using the mid-range equipment and five times less for wide-reaching. Accordingly, a consumption of fuel decreased – 2.3 and 3.2 times. Here, both the depth of cultivation and the width of grabbing of cultivating machines are important – respectively, 1.7 and 2.5 times. But the biggest changes are found in the cost of growing winter wheat. Compared to traditional soil protection technologies medium-grazed technology cultivation costs are reduced by 6.3 times.

In order to determine the effectiveness of various methods of strip-till compared to traditional technology, staff of the Ukrainian Research Institute for prediction and testing of techniques and technologies of agricultural production named after Leonid Pogorilly conducted a classification of basic tillage technologies, divided into four groups : conventional, based on use of guns with a complete turning over of the treated layer of soil and high quality wrapping plant residues; strip-till cultivation, that is, without turning the treated layer, cutting underground and preserving aboveground plant residues on the surface of the field; surface treatment, which provides weeding, crunching, loosening, leveling the soil of the treated layer to a depth of 8 cm; direct sowing technology, which involves carrying it out without preliminary soil cultivation (Kuksa, 2011).

The technologies above can be done through a set of various brands of agricultural implements and working bodies, which according to a principle of work belong to a certain technology.

According to the results of research, the technology of strip-till, mulching of soil by plant residues and seed compared with traditional technology provides a reduction of labor costs by 5% for the first option and 64% for the second; fuel consumption decreases respectively by 13% and 57%, direct operating costs by 31% and 40%.

According to the research materials conducted by the laboratory of systems of economic norms for a new equipment, norms of productivity and fuel consumption for grain crop sowing were developed by Solitair-12/1200K row drill in unit with a tractor John Deere-8520 with the seeding rate of 120–180 kg/ha without implementation of mineral fertilizers by traditional technology and technology with minimal soil treatment. For the first group of fields (the length of the race – 1,000 m or more), rate of productivity is 61.8 hectares for a seven-hour working shift with traditional technology and 66.7 hectares with zero, which is more than 4.9 hectares, or 7.93%. The research also showed that fuel consumption under traditional cultivation technology was 3.3 liters/ha, while under minimum cultivation – 2.8 liters/ha, which is less by 0.5 liter, or 15.2%, excluding costs for traditional technology on previous technological tillage operations of the soil.

According to the traditional technology for basic soil cultivation, following operations were carried out: peeling of a stubble with a disk harrow BDV-7, plowing with a plow PNO-4+1 "Veles", pre-sowing cultivation with a KPN-8 cultivator in a unit with a tractor KhTZ-17221 and sowing with a Solitair-12/1200K in unit with a tractor John Deere-8520. Under the technology of minimal soil tillage: peeling of a stubble by a harrow disk BDT-7 in a unit with a tractor KhTZ-17221 and a sowing with a direct drill Solitair-12/1200K in unit with a tractor John Deere-8520 was carried out. Analysis of the research results shows that, in terms of economic efficiency, the technology of minimal tillage has advantages over traditional ones, namely: direct operating costs are reduced by 71.83%, and the amount of reduced costs 55.2%. At the same time, the annual economic effect is UAH 300,470.

Area of agricultural land in use has a significant impact on a purchase of agricultural machinery. Agricultural farms with agricultural land in use over 20,000 hectares are oriented to the use of agricultural machinery and services of other organizations, because of lack of financial resources their activity in powerful agricultural machinery purchase is quite low.

According to the results of the study, regardless of the amount of land in use entities of corporate sector buy tractors with a capacity of 60–100 W.

The largest share in structure of acquisition for this category of tractors falls on agricultural enterprises with an area of land use up to 500 hectares.

Table 3 Dynamics of number of tractors and combine harvesters in Hungary, Poland, Slovakia and Czech Republic (thousand units)

Index	Tractors			Combine harvesters		
	2005	2014	2014 in % to 2005	2005	2014	2014 in % to 2005
Hungary	120	118	98.33	12.1	10.8	89.26
Poland	1,437	1,436	99.93	147	–	–
Slovakia	21.8	27.24	124.95	3.6	3.6	100
Czech Republic	87.0	77.3	88.85	11.6	10.4	89.66

Source: www.wip.org.pl and author's own calculations

Also, in our opinion, the high share of energy-intensive tractors (over 100 watts) purchase by this category of agricultural producers indicates the ineffective use of them, provided that they will not be involved in a provision of paid services to other entities. A similar situation occurred on farms with an area of land use from 1,001 to 10,000 hectares.

Agriculture of leading countries in the world is characterized by a high level of energy supply and integrated mechanization of all technological processes. So, for 100 hectares of land, the power of tractor engines is: US 200 hp; Germany 540; United Kingdom 178; France 277; Denmark 293; Ukraine about 100 hp (Primak, 2010).

Thus, in Hungary, Poland, and Czech Republic there is a gradual decrease in the number of tractors and combine harvesters (Table 3).

This circumstance is caused by an increase in capacity of engines of technical equipment and development of cooperative forms of agricultural machinery use.

High technical level, quality and reliability of foreign machinery are supplemented by a variety of new models, a greater degree of unification, and compliance with various natural conditions and sizes of farms. For example, in the US, there are 345 models of tractors, 42 models of grain harvesters and 49 forage harvesters (Belousko, 2008).

Increase of acquisition cost, maintenance and operation of equipment convinces us of a need to develop new organizational forms for its joint use, in particular, co-operation.

Cooperatives are rivals to enterprises providing mechanized services. And in this struggle they have a certain advantage, because they do not pay a professional tax and enjoy other benefits.

In Ukraine, a similar function is performed by agricultural service cooperatives (ASC), which are oriented on providing services for joint cultivation of soil mainly to its members – owners of personal and small farms. Thus, during 2008–2016 their number almost doubled. However, most of them act as business entities for provision of services of land cultivation. This situation is caused by inconsistency of current legislative acts regarding a provision of non-profit organization status to agricultural service cooperatives.

According to the results of a survey of machine-tractor park of operating ASCs, most of them have technical means only for carrying out a limited list of technological operations on plant production (plowing, cultivation) and provision of transport services.

Advanced set of machinery owned by machine pools unification of farmers for common use of machinery. Large machine pools (50–100 members) employ specialists to manage and maintain equipment.

In Western Europe, there is a large number of independent enterprises that provide mechanized services (basic soil cultivation, fertilization, harvesting, etc.). For example, an approximate cost of individual mechanized work in the UK is (in pounds sterling/ha): plowing 21–30; sowing 10–24; chemical cultivation 5–9; fertilizer application 5–8; harvesting 30–50.

According to the analysis of creation and operation of many machine-technology stations, their return on investment is provided in 2–3 years.

Primary task of ensuring a successful functioning of machine-tractor station (MTS) is a segmentation of a consumer market of their services. Today, there are 17 groups of farms that can be divided into several categories according to a potential of technical equipment (Table 4).

The category of farms with agricultural area of over 500 hectares is owned by 8.1 thousand agricultural enterprises. They produce more than 44% of gross agricultural products, have a strong material and technical base, which ensures a possibility of independent performance of basic technological operations.

Agricultural producers with a sown area of 1–500 hectares, which in Ukraine are more than 4 million and which produce about 56% of gross output, must receive technical and technological services for crop and livestock production, material and technical services, trade and exhibition activities, etc.

Basic enterprises that are able to provide such services and are located in area of influence of the Ministry of Agrarian Policy and Food of Ukraine for 2016 are repair-transport companies (RTC), of which 140 are engaged in repair of agricultural machinery and equipment, 63 in providing mechanized services for crops and livestock, 85 provide transport services, 34 specialize in advisory services.

However, activity of these companies is not system, they currently are unable to provide comprehensive assistance to farmers, which significantly reduces the efficiency of their services. Hence comes a challenge: to determine how to support their activities, improve efficiency and quality of services.

A need to find innovative organizational methods to solve the problems of mechanization of the main technological processes, a state and prospects of implementation of modern technical and technological solutions, high energy costs and low efficiency of agricultural production require a development of scientifically grounded conditions for a creation (taking into account a world experience) of multi profile organizations, which provide services to agricultural producers.

In our opinion, it is advisable to combine existing enterprises into agro technological centers in a form of regional engineering and technical unions (multidisciplinary agro technological centers – ATC), guided by a current legislative framework, including the Law of Ukraine "On Public Associations". On behalf of the Ministry of Agrarian Policy and Food of Ukraine and regional state administrations, association of such organizations could be delegated functions of a formation of market infrastructure, information-statistical, inspection and organizational, as well as, which is now extremely important, functions of coordinating a development of regional agricultural machinery production.

In Institute of. L. Pohorilyi according to a domestic and foreign experience, principles of construction and functioning of regional engineering and technical unions based on the main provisions of the Law of Ukraine "On Public Associations" have been developed.

Table 4 Grouping of agro enterprises of Ukraine by a technical potential, 2016

Farm categories by area (ha)	Quantity (thousand tons)	Sown area (thousand hectares)	Volume of gross product (UAH million)	Need for technological and technical services						
				trade and exhibition activity	informational support	technical service	material and technical support	technological services in crop production	technological services in animal husbandry	other services
0.1–5.0	4,545.6	8,194.8	112,754.6	–	+	+	+	+	+	+
5.01–20	8.9	107	673.4	+	+	+	+	+	+	+
20.1–500.0	25.6	2,425.1	15,263.6	+	+	+	+	+	+	–
over 500	8.1	16,943.6	104,904.6	+	+	+	+	+	+	–
–	4,588.2	27,670.5	233,696.3							

Source: compiled and calculated according to the data of the State Statistics Service of Ukraine

The main distinctive feature of such public associations will be systematic and comprehensive provision of various services to economic actors of agro-industrial complex, which will have a positive effect on efficiency of agricultural production.

Multi-profile organizations which provide services to agricultural producers are created in each region of Ukraine in a form of agro-technology centers and are, in essence, public non-profit associations regional engineering and technical unions.

The purpose of ATC creation is to structure an existing system of technical and engineering services in agriculture, particularly for small and medium-sized agricultural enterprises, increase productivity, agricultural production, ease working conditions, improve profitability and ensure comprehensiveness and consistency in service delivery to farmers.

Ways of achieving this goal: association with a regional management of agro-industrial development of existing enterprises (organizations) into a multifunctional agro technological center on a basis of the Law of Ukraine "On Public Associations"; delegation to ATC by state executive entities functions of development of regional agricultural machinery production, as well as inspection, informational, statistical and organizational functions in accordance with directions of activity of each member of the association.

ATC consists of companies, organizations, firms and enterprises that provide services to agricultural producers. Agro technological centers closely cooperate with the Main Departments of Agro-Industrial Development, which determine a technical policy of agricultural production in each region, as well as the ways of regional agricultural machinery development. Members of public councils of regional engineering and technical alliances are executives (representatives) of companies that provide services to agricultural producers in regions.

A concentration of harvesting and transport equipment in one unit, accurate maintenance and operational repair contribute to an increase in annual equipment loads, reduce downtime, significantly increase production, improve a quality of work, organization of work of machine operators. Such a method is already being used in some regions of Ukraine, increasing efficiency of machinery use 3 times.

Domestic agricultural producers are already buying foreign grain, feed and beetroot harvesters. Under basic parameters, many of purchased combine harvesters are similar to the combine DON-1500, but they have better technical and operational performance, higher technical readiness.

According to calculations of "Institute of Mechanization and Electrification of Agriculture", a form of joint acquisition and use of equipment has prospects where several farms are located nearby and have approximately the same volume of work and their total volume of work does not exceed a normative annual load of equipment (Voytyuk, 2004).

An amount of invested funds to a purchase of equipment for each farm in co-operation is determined by an amount of work on farm for this machinery or by a planned time of its use. A priority and a period of use of jointly purchased equipment, as well as the conditions for its storage, are stipulated in a contract concluded by members. Typically, the machinery is stored and serviced at the farm, where it performs work. For long-term storage, it can be located at the farm which has the most favorable conditions for this purpose (Afanasyev, 2006).

Providing machines and equipment for hire (lease) a kind of rental of more complex and expensive equipment. This form of co-operation is usually expensive. Rental cars are common in many European countries. There is a short-term (up to a year) and a long-term (over a year) lease. Often, landlords are farmers (neighboring leases) or farmers' cooperatives.

When concluding an agreement, a lessee is obliged to use equipment in accordance with a stipulated rate of its loading, and to invite specialists for repair and maintenance. All costs of operation, maintenance and ongoing repairs for a period of a contract are reimbursed by the tenant. He is also responsible for damage that exceeds normal wear and tear and is not provided by manufacturer's guarantee, as well as an insurance program.

Conclusions

It should be emphasized that in a whole variety of the mentioned forms of agricultural machinery use in terms of organizational and legal relations, there are two fundamentally different options for service provision: economically independent of service users entities (private dealers, enterprises, firms) and on a basis of commodity producers cooperation.

Variants of commodity producers cooperation for a purpose of organization of effective use of machinery differ on following grounds: who owns means of production; who manages them (uses them); who organizes a sharing of machines; by forms of payment for services; by sources of funds for a purchase of equipment; by organizational and legal status.

By a first condition, there are two variants of co-operation: in possession of means of production and their use; in use of means of production owned by each participant of a cooperative.

Technological operations (machinery management) can be carried out by owners of means of production, consumers of services, hired workers.

Depending on a number of cooperated producers, an organization of joint use of means of production is carried out on a basis of direct agreement between neighbors, or through specially hired agents for this purpose (dispatchers), or through a management apparatus of cooperative.

Payments for services are provided in a form of mutual assistance, payment on a basis of bilateral, multilateral and common to cooperative agreements.

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