FRI-ONLINE-1-AMT&ASVM-02

AGRO-ENGINEERING: WAYS TO SOLVE ENVIRONMENTAL AND ENERGY PROBLEMS IN AGRICULTURE

Kravchuk Volodymyr Ivanovych, PhD
Member of the Academy of Sciences of Ukraine
Leading Researcher of the SSI "L. Pogorilyy UkrNDIPVT", Ukraine
ORCID: 0000-0003-2196-4960

Targonya Vasyliy Serhiyovych, Doctor of Agricultural Sciences
Leading Researcher of the SSI "L. Pogorilyy UkrNDIPVT", Ukraine
ORCID: 0000-0002-1353-9182

Assoc. Prof. Ludmil Mihaylov, PhD
"Angel Kanchev" University of Ruse, Bulgaria
E-mail: lmihaylov@uni-ruse.bg

Gaidai Tatiana Viktorivna
Leading Researcher of the SSI "L. Pogorilyy UkrNDIPVT", Ukraine
ORCID: 0000-0001-9141-4820

Abstract: *In this study is proposed a methodology for environmental and economic management of agricultural technologies. It not only complies with the dominant concept in different countries to minimize the intensification of production processes, but also provides a forecast for multifactor development to increase productivity and further improve the environmental characteristics of products. The approach integrates several components: information and forecast systems for remote aerospace sensing; advanced information ergatic-resolving systems of precise farming; biotechnological alternatives; methodologies for selection of scientifically based rational agricultural technologies.*

Keywords: *Biosphere, Agrotechnology, Agricultural engineering, Ecological and economic management systems.*

INTRODUCTION

In modern conditions for agricultural production, the tasks of ensuring "food and food safety" based on post-industrial information technologies become the most relevant. "Feed the world and save the planet" is a predictive motto of the most famous international experts of the agricultural engineering industry - members of the Bologna Club, which represent institutions and organizations from more than 100 countries, including from research institutions (69%), industry (15%) and international organizations (17%).

Management of agriculture, taking into account the requirements of the environmental management system, puts forward new conditions: the ability to plan (program), execute, evaluate and continuously work on creating improved agricultural technologies based on the laws of historical development of the planet's nature (biosphere laws).

EXPOSITION

Studies conducted at the State Scientific Institution "Leonid Pogorilyy Ukrainian Research Institute for Forecasting and Testing of Technics and Technologies for Agricultural Production" over the years have shown that the CGMS forecast system, adapted to the conditions of Ukraine, by 15-20 % exceeds the accuracy of forecasts made by other methods, and the resulting agricultural and weather indicators can be used to make optimal environmental and economic decisions in specific dynamic conditions of vegetating crops (Micale; Kravchuk, 2009).

The ergatic component is realized through defragmentation of the available technology elements (varieties, hybrids, crop rotation, fertilizer and plant protection systems, selection and use of machines, etc.) in order to obtain the rational use of the agroclimatic potential of the territories, the biological potential of plants and the capabilities of machine technologies.

Over the past three years, the institute has been conducting experiments to select the rational composition of the machine-tractor fleet for growing grain under different soil cultivation and sowing systems - the AgroOlimp project (Kushnaryov, 2010). Each soil treatment system contains a specific technological operation for it: the traditional system - plowing; preserving - deep loosening (chiseling); mulching - fine processing and a system with Mini-Till elements - chemical weed removal.

Studies have shown that in the case of the use of preserving, mulching technologies or with Mini-Till elements, compared with the traditional one, fuel consumption is reduced from 47.6 to 45.3; 37.1; 29.2 l / ha or 5, 22, 39 percent, respectively in Kravchuk (2000). The implementation (implementation) of such tillage systems and other programmed operations (yield mapping, monitoring of nutrient reserves, shift norms technological materials application for locally determined part of the field, etc.) is achieved by conducting guaranteed adaptive management of the latest generation agricultural machines, which work according to electronic cards of agricultural technologies using information management systems. The work of the mechanisms and working bodies of agricultural machines is associated with the transfer of the agricultural environment or agricultural object by performing a number of technological operations from a state that does not correspond to agricultural requirements to a new state that satisfies the agricultural requirements of formalizing this process, which will associate with the spatio-temporal transformation of the initial state S * (ti- 1) to the final state S * (T) (predicted and calculated), as shown in Kravchuk (2005). Step-by-step Δt = ti - ti-1 = ti + 1-ti change and obtaining intermediate rational environmental and economic results optimizes the achievement of the final goal – obtaining the yield.

The efficiency of the agricultural machines is determined by the optimal transformation function $S*(ti-1) \rightarrow S*(ti) \rightarrow \ldots \rightarrow S*(T)$ and characterizes the dynamic system, which has the form:

$$S(x, y, z, ti, u, v) = F(x, y, z, ti-1, \Delta t, u, v), \qquad (1)$$

where x, y, z, respectively, the coordinates of the locally determined part of the field with many specific features of the physicochemical parameters of soils, biosphere and the environment; (ti-1), Δt, ti - time discretization of processes relative to cause-and-effect phenomena; ν - relevant environmental and pollution factors applied to the agricultural machines; u - control in the form of state values of the regulated parameters of the mechanisms.

Studies by Kravchuk (2009) and Pogoriliy (2003) showed that the proposed system implements a hierarchical multi-circuit technology, including: agricultural machines with on-board multifunctional complexes, working bodies with information control batchers for introducing rational norms of expensive materials (fertilizers, pesticides, plant development regulators). Regional management of the functioning of divisions of the agro-industrial complex makes it possible to achieve the following results:

- increase by 10-15% the actual yield due to the accurate and dosed application of pesticides and mineral fertilizers;
- increase the efficiency of technological operations to 15%;
- reduce to 15% the techno-genic load on the environment.

In parallel with these studies, we have developed algorithms for the environmental and economic expertise of agricultural technologies, taking into account their environmental, biotechnological and bioenergetic characteristics. According to indicators of the coefficient of homeostasis (G).

In our case, when it is necessary to determine the effect of mechanized agricultural technologies, specifically complexes of machines and equipment, on the property of agrocenosis to self-healing (homeostasis), it is advisable to take into account favorable and unfavorable trends in the behavior of the system under the influence of external anthropogenic factors. Then according to Kravchuk (2008) the degree of homeostasis (G) can be determined by the formula:

$$G = \frac{V+\Delta V}{V}\frac{Y+\Delta Y}{Y}. \qquad (2)$$

The criterion for assessing the state of agrobiocenosis (V) is advisable to choose a change in the content of humus in the soil, and the criterion that characterizes the influence of external factors (Y) is the expenditure of non-renewable energy (fuel energy; energy embodied in mechanization means, mineral fertilizers, pesticides, etc.).

The values ΔY and ΔV can have both positive and negative meanings. The value of the homeostasis coefficient for biological farming technologies should not be less than one. (G≥1). The fulfillment of this requirement will testify to the provision of technocenosis conditions for the restoration of soil fertility, a more complete use of their biological potential, as well as ensuring the environmental safety of agricultural technologies and the resulting products.

An abstract-logical model of the relationship between the environment and agricultural technologies of the environmental management system is presented in Fig. 1.

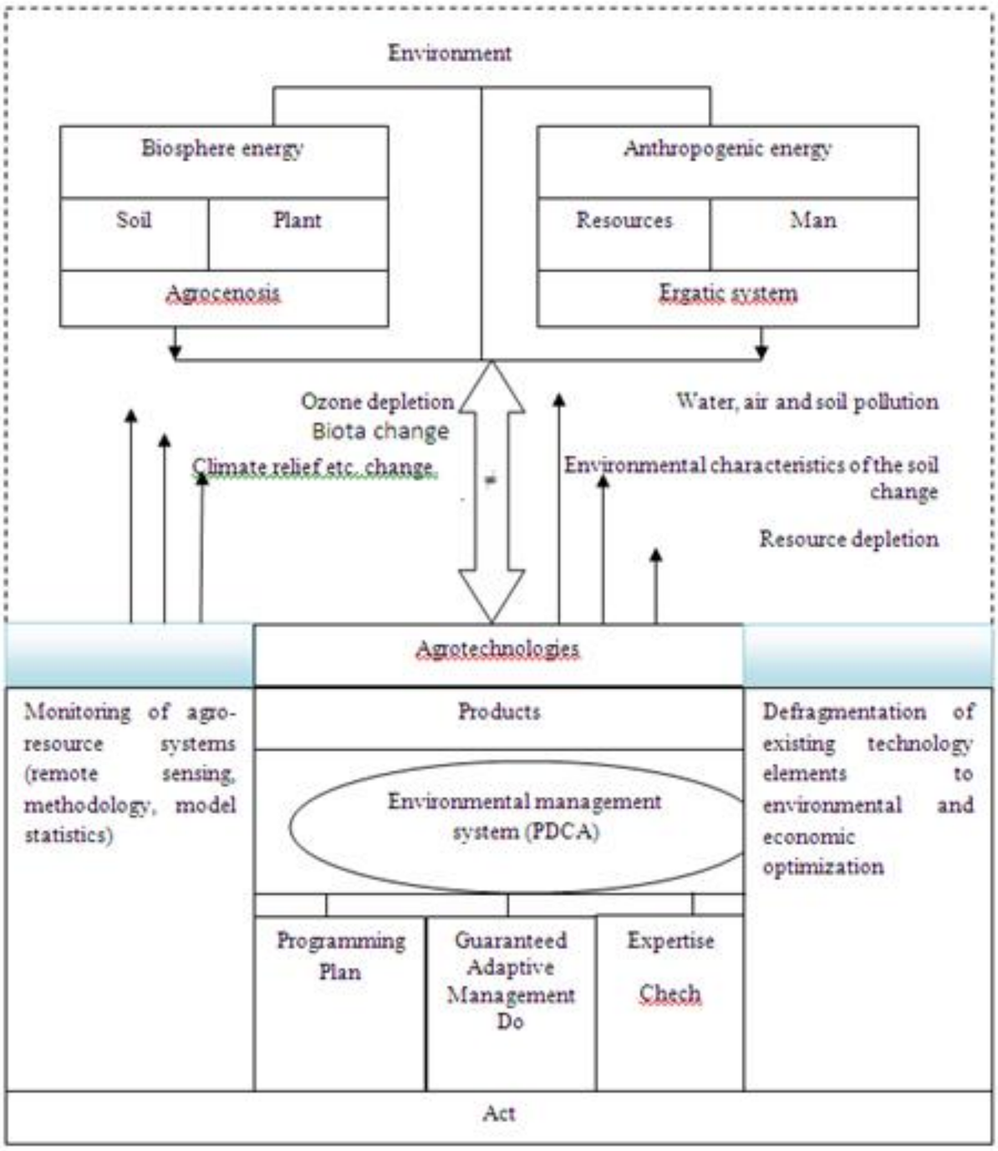

Fig. 1. Logical model of the relationship of the environment and agricultural technologies of the environmental management system

CONCLUSION

The methodology proposed by us for environmental and economic management of agricultural technologies not only complies with the dominant concept in different countries to minimize the intensification of production processes, but also provides a forecast for multifactor development (action) to increase productivity and further improve the environmental characteristics of products.

Such a systematic approach to managing agrocenosis should, in our opinion, be further developed on the basis of a cenological approach to the integrated use of the following components:

- information and forecast systems for remote aerospace sensing;
- advanced information ergatic-resolving systems of precise (controlled) farming;
- the integrated use of biotechnological alternatives (biologically active fertilizers, entomological and microbiological preparations for plant protection and increasing soil fertility);
- methodologies for the selection of scientifically based rational agricultural technologies and corresponding sets of machines based on the development of acceptable forecasts of indicators of a multivariate production system "soil-climatic conditions - variety - agricultural technology - technological operations - a set of machines - quantitative and qualitative indicators of production".

REFERENCES

Kravchuk, V. (2005) Theoretical basis for the adaptation of Sylgospodar machines: Monograph. - K.: NAU. - 208 p.

Kravchuk, V. (2009) Integrated system of précised farming – necessary means for new technologies / V. Kravchuk, S. Lyubchenko, V. Voinovsky, V. Serbiy // Technique and Technological AIC. No. 1. S. 32-34.

Kravchuk, V. (2009) New technical and technological solutions for various soil cultivation and sowing systems, for growing grain crops. Project "AgroOlimp 150" / V. Kravchuk, V. Pogoriliy, L. Shustik // Machinery and Technologies in AIC. - No. 1, S. 22-27.

Kravchuk, V.I. (2008) Development of ecological technologies, agricultural machinery and equipment based on the phenological approach / V.I. Kravchuk, V.S. Targonya, V.O. Dubrovin // Science Annals, National Agrarian University. - VIP. 125. S. 372-378.

Kravchuk, V.I. (2000). The concept of guaranteed-adapted management of the working processes of the machine and the machines. Technique of the agroindustrial complex. - No. 11-12. - S.14-16.

Kushnaryov, A. (2010) New scientific approaches to the choice of soil cultivation method / A. Kushnaryov, V. Kravchuk // Machinery and technologies of the agro-industrial complex, - No. 5 (8). - S. 6–10.

Micale, F. AGR 14 CAST: Meteo & Agrometo infrastructure in the MCYFS http://mars.jrc.it/

Pogoriliy, L. (2003) Ways of stabilization and recovery of agricultural and ecological systems potential / L. Pogoriliy, V. Targonya // News of the Ukrainian Academy of Engineering Sciences. - No. 2. - S. 15-20.

Website: https://www.clubofbologna.org