

AGRICULTURAL MANAGEMENT ON THE BASIS OF INFORMATION TECHNOLOGIES

Olena Sivakovska¹, Mykola Rudinets², Mykhailo Poteichuk¹

¹Lutsk National Technical University, Faculty of Computer Science and Information Technology/Computer Technology and Vocational Education Department, Lutsk, Ukraine,

²Lesya Ukrainka Eastern European National University, Faculty of International Relations/International Economic Relations and the Project Management, Lutsk, Ukraine

Abstract. *The article presents conceptually scientific and methodological principles of agricultural management on the basis of Information Technologies. It has determined the main directions of using Information Technologies in Agricultural Manufacturing. It has systematically investigated the manufacturing by agricultural producers, and it has determined and stressed the main functions and relationships between the two systemic parts – technical and technological as well as organizational and technical. There have been determined the hierarchical structure of the configuration for the husbandry systems. It was explored that this configuration consists of nine main parts, and which of them have their own configuration. It was a conceptually determined processes of architecture management of agricultural programs (portfolios) and the configuration of agricultural products. The developed structural and project approach to configurations management of systemic parts for agricultural manufacturing is the part of scientific and methodological principles of this manufacturing management using Information Technologies.*

Keywords: management, projects, Information Technologies, decision support system

ZARZĄDZANIE ROLNICTWEM NA PODSTAWIE TECHNOLOGII INFORMACYJNYCH

Streszczenie. *Artykuł przedstawia koncepcje naukowe i metodologiczne zasady zarządzania rolnictwem na podstawie technologii informacyjnych. Określono główne kierunki wykorzystania technologii informacyjnych w produkcji rolniczej. Systematycznie badano produkcję przez producentów rolnych. Ustalono i podkreślono główne funkcje i związki między dwiema częściami systemowymi – techniczną i technologiczną oraz organizacyjną i techniczną. Określono hierarchiczną strukturę konfiguracji systemu agrarnego. Zbadano, że ta konfiguracja składa się z dziewięciu głównych części, które mają własną konfigurację. Określono koncepcyjnie procesy zarządzania architekturą programów rolniczych (portfeli) i konfiguracji produktów rolnych. Opracowane podejście strukturalne i projektowe do zarządzania konfiguracjami części systemowych do produkcji rolniczej jest częścią naukowych i metodologicznych zasad zarządzania produkcją z wykorzystaniem technologii informatycznych.*

Słowa kluczowe: zarządzanie, projekty, technologie informacyjne, system wspomagania decyzji

Introduction

The climate change and growth of the worlds need for foodstuffs issues new challenges for Agricultural Science. Obviously, mostly in resources of agricultural manufacturing (earth, water and agrometeorological conditions) which must be used for each country, so this country could make-up the most security of foodstuffs for other countries with its deficit and the country doesn't have to lower internal quality of foodstuffs. Unfortunately, this scenario progress is specific for Ukraine because its agricultural manufacturing is mostly resource consuming, harmful for the earth cover of productive resources (agricultural land). The main reason of this is faulty managing department system with the help of national and agricultural producers. In particular, real production management systems are characterized by subjectiveness, the deficit of reliable information resources of decision support system on the basis of Information Technologies.

1. The analysis of recent researches and publications

Nowadays, knowledge management [5] is developing extremely, particularly in Agriculture [3]. Especially [1] collecting knowledge of Projects Management in the last thirty years. The aim of this knowledge is to create different Standards in some activities. The publications of Management Production on basics of the using of Information Technologies appears more and more often. But in most cases they refer to its separate parts [2, 7, 9, 10].

Analysis of these publications allows us to assert that the tasks of Production Management in Agriculture are researched but unsolvable not only in Ukraine, but also in the world.

2. Objectives

Identify conceptually scientific and methodological principles of Agricultural Management on the basis of Information Technologies.

3. The main results of the research

Now Information Technologies get different Management Systems in the Agrarian Sphere (see Table). Separately, these technologies are used in the mobile agricultural equipment and agricultural gangs of new generation. They provide the stress decline through the work of mechanics. The automated control for technical state of machines ensures the effectiveness increase of their engineering service and repair. These Information Technologies are used for the driving of agricultural gangs, report of their application, fuel rate and operators' charge, which make possible the effectiveness of extension for mechanical husbandry. These technologies are used in exact husbandry too. It allows them to rise its ecological and economical aspects [6].

Geoinformation Technologies of forecasting of agricultural harvest are based on Information Technologies too. Some information allows to manage by crop markets and to forecast its prize. So, we can make the conclusion under the practice analysis and science of the using Information, that Technologies in Agricultural production that information and analytical systems for managing of its functioning and development aren't created by science now.

Conceptually we can discover scientific and methodological approaches of the using for Information Technologies in Agricultural Production Management at rate of Agricultural Manufacturing.

We can use the system approach for that. This approach allows to mark out two main systems (subsystems): technical and technological system (Z), and organizational and technical system (management system) (U) (Fig. 1). Every component executes some functions, which all together provide the agricultural manufacturing. In this case the technical and technological system (TTS) makes qualitative transformations of labour objects (ground, seeds, fertilizers and harvest), and the organizational and technical system (OTS) provides the forming of conditions for qualitative and efficacious transformations of these objects.

Table 1. Main directions and results of the using Information Technologies in Machine Management and Agricultural Production Management

No	Directions for using	Control processes	Results
1	2	3	4
1	Intellectualization of mobile agricultural equipment	Workflows of mechanisms, knots and agricultural gangs	Stress decline in the work of operators
2	Control of the technical state for stock machines	Changing process of technical condition for machines	Effectiveness increase of repair maintenance works
3	Driving agricultural (machine) gangs on fields	Movement processes for agricultural gangs	Exact driving increase
4	Report of fuel rate and amount of executed mechanized works	Report processing	Effectiveness increase of mechanized works
5	Report the using of mobile agricultural equipment and operators' works (mechanics' works)	Report processing	Effectiveness increase of report and mechanized processes
6	Exact husbandry	Control of state soil and making meliorants (fertilizers etc.)	Ecological and economical increase of manufacturing
7	Aero photos and monitoring of crops	Control of state crop	Increase of exact harvest forecast

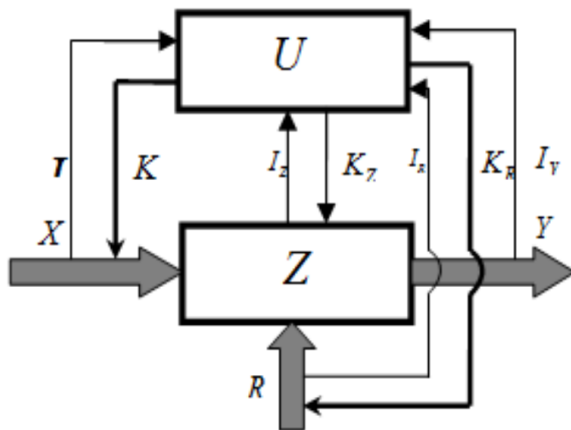


Fig. 1. Scheme of the system for the agricultural manufacturing where X – characteristics of the input stream of the manufacturing contract for agricultural projects; Z – parameters of the technical and technological system (subsystem); R – characteristics of resources provision for projects; Y – rates of the manufacturing production; I_Z, I_Z, I_Y, I_R – characteristics of the input information; U – parameters of the technical and technological system (management system/subsystem); K_X, K_Z, K_R – rates of output orders

Qualitative transformations of these labour objects take place, with the help of some organized technologies. They make separate projects, programs and portfolios in the section of separate fields, agricultural crops and kinds of project work. The managing of these projects, programs and portfolios are realized by organizational and technical system (OTS), which consist of managers and Decision Support System (DSS). Managers make decisions and managing difficult situations with the help of DSS, and they prove decisions in reference to the initiation of some commands (K) for doing agricultural projects on the basis of issues. These commands can concern input streams of the manufacturing contract for agricultural projects (X), parameters of TTS (Z), and the resources provision for projects (R).

We can write dependencies for Y and U in the complete view on the basis of definite parts for System Production of Agricultural products:

$$Y = f(X, Z, R, I, U, K, T) \quad (1)$$

$$U = f'(X, Z, Y, R) \quad (2)$$

At the same time, the dependency (2) is the basis of the substantiation for DSS Configuration (structure) (U_c):

$$U = (Mt, Tm_y, Tm_i, Tm_c, Al, Pp_y, Db, Kb) \quad (3)$$

where: Mt – management tasks, Tm_v – technical means for automated problems solving in Management, Tm_i – technical means for identification of the state for parts of agricultural technological systems (X, Z, R, Y), Tm_c – technical communication means, Al – algorithm of management problems solving, Pp_y – program products for automated problems solving in Management, Db – data bases, which are used for agricultural management projects (programs and portfolios), Kb – knowledge bases for these Projects Management.

Each of these DSS parts in Agriculture is a set, which depends on some parameters of technological systems in some way [6].

Regarding DSS as the apparatus (tool) in Agricultural Projects (programs and portfolios) Management, we can say that they must have the configuration which can provide finite problem solving set in Management. These tasks must refer to the configuration of such main system parts: 1) land resources (LR); 2) agricultural production which is produced by separate agricultural producers (AP); 3) architectures of programs and portfolios of agricultural projects which are realized for this manufacturing production (A PP); 4) technological and recourse implication (TRI); 5) machine and technological equipment that provides the realization of agricultural programs and portfolios (MTE); 6) energetic and recourse implication (ERI) of organizational and technical systems (OTS); 7) DSS (Fig. 2). There are systemic cause-effect relations between designated configurations. These relations are established by results of problem solving tasks in Management.

Each of designated configurations and architecture of agricultural projects, programs and portfolios is the result of managing for some part of this system.



Fig. 2. Scheme of hierarchical structure for configuration agricultural systems: Ac, LR, AP – agrometeorological conditions, configuration of land recourses and configuration of agricultural production; APP – architecture of agricultural programs and portfolios; TRI, MTE – configuration of technological and recourse implication and machine and technological equipment; ERI, OTS – configuration of energetic and recourse implication and organizational and technical system; DSS – configuration of DSS

Configuration Management of Agricultural Production is realized under each of Project modality, which provides its manufacturing. At the same time, these projects modalities, which are combined in programs or portfolios, create accordingly their architecture. This architecture management provides the configuration forming of agricultural production, which is manufactured by these or those agricultural producers. According to this, we can systematically show the structure of completed conditional process for Configuration Management of agricultural production (CM AP). The result of this is the configuration of this production (C P) (Fig. 3a). Analogically we can determine all nine enlarged processes of Configuration Management for the agricultural system parts, especially, the agriculture architecture programs (portfolios), machine and the technological equipment and DSS (Fig. 3 b, c, d).

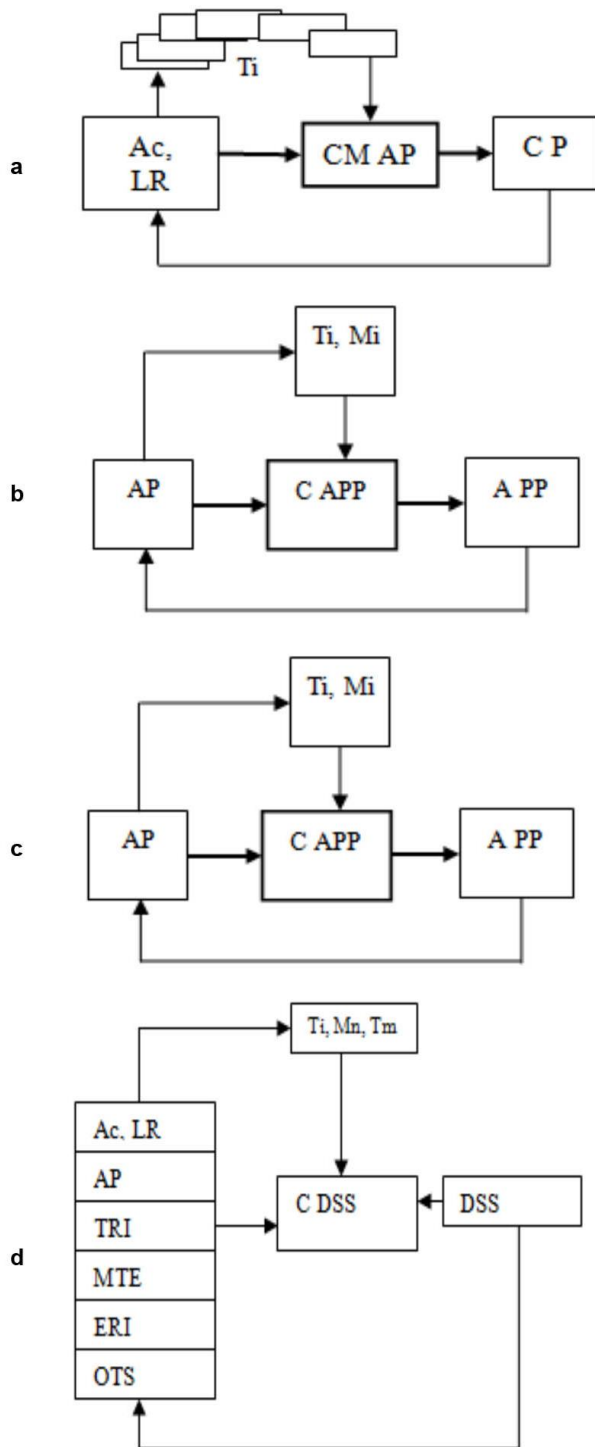


Fig. 3. Structural schemes of enlarged processes of Configuration Management: a) agricultural production (CM AP); b) agriculture architecture programs and portfolios (C APP); c) machine and technological equipment (C MTE); d) DSS (C DSS); Ti – technological knowledge; Mi – Configuration Management methods of agricultural programs and portfolios; Mo – Configuration Management methods of machine and technological equipment; Mn – Configuration Management methods of DSS; Tm – agricultural management tasks

The management process of agriculture architecture programs and portfolios is based on technological knowledge according to crop-growing and harvesting. This knowledge allows to forecast specific Project modality $\{p\}_{\gamma k}$ of p -kind (mechanized works)

according to each γ – field in which k -crop is grown or harvested. The management process ($M_{\gamma k}$) of Project modality $\{p\}_{\gamma k}$ is expressed as:

$$M_{\gamma k} : \{p\}_{\gamma k} \supset \{P_{\gamma kp}\} \Leftarrow Ti_{\gamma k} \quad (4)$$

where $Ti_{\gamma k}$ – technological information about growing and harvesting of k -crop in γ -field; $\{P_{\gamma kp}\}$ – potential Project modality (especially, alternative projects) according to growing and harvesting of k -crop in γ -field, which is predetermined by the technology ($Ti_{\gamma k}$).

Project modality $\{p\}_{\gamma k}$ forms the manufacturing program of agricultural production for k -crop in γ -field. The agricultural producer manufactures a variety-of-parts in agricultural production, that's why their programs are mixed. Nomenclature (configuration) management M_{AP} of agricultural production defines some configuration programs and portfolios, but also, as mentioned earlier, their architecture:

$$M_{AP} : \{P_{\gamma k}\} = \sum_y \sum_k \{p\}_{\gamma k} \quad (5)$$

where $\{p_{\gamma k}\}$ – program modality of gathering and harvesting for k -crops in γ -field modalities.

Program modality $\{p_{\gamma k}\}$ shows programs and portfolios architecture of agricultural manufacturing by this or that producer [4]. In view of the above, the structural scheme of enlarged process for architecture management of agricultural programs and portfolios has this show – Fig. 3b.

The architecture of agricultural programs and portfolios (A PP), and technological knowledge (Ti) are the basis of configurations management: TRI; MTE; ERI, OTS; DSS (Fig. 3 c, d). In this way the configuration of each next part is generally determined by the configuration of previous parts.

The structuralisation of manufacturing parts of agricultural production is the basis of scientific and methodological principles of DSS creation for automated problem-solving tasks in Management and substantiation of some solutions. Only the project approach to this management suffers to adequately show the management process of agricultural manufacturing on the basis of Information Technologies.

4. Conclusions

The analysis of scientific researches and some bibliography shows the using of Information Technologies in Management of separate parts for agricultural production, but there is no integrative Systems of Management now.

Conceptual systemic analysis of Agricultural Production allows to separate and structure decision support systems for management of its development and function.

Structuring agriculture of nine main parts and significant of their configurations allow to separate seven extended processes of these Configurations Management, which have some systemic relations.

Configurations Management of main systematic production parts requires the using Project-oriented Approach. This approach shows adequately its production and management processes.

The structural and projected approach was created for Configurations Management of Agricultural Production parts, and methodological principles for the using of Information Technologies in this Production Management.

References

- [1] Bushuev S.D., Bushueva N.S., Babaev I.A.: Creative technology management projects and programs: monograph. Sammit-Kniga, Kyiv 2010.
- [2] Chertov V.G.: Guidelines for the development and complex software application "Automated Workplace of an Agronomist" (AWP). Mikhaylovsk 2011.
- [3] Demiyenko S.I.: Management of agricultural enterprises. KNEU, Kyiv 2005.
- [4] Lepa E.V., Mikheev E.K., Krinitsyn V.V.: Decision Support System: Textbook. Part I. HELI, Herson 2006.
- [5] Meskon M., Albert M., Hedoury F.: Principles of management. Delo, Moscow 1994.
- [6] Mikheev E.K., Lysogorov K.S.: Automated support system of technological solutions in precision farming systems. Part I: DSS PFS. "Agrotechnolog". HSU, Herson 2006.
- [7] Morozov V.V., Lysogorov K.S., Shaporynska N.M.: Geoinformation systems in the agricultural domain: Textbook. HSU, Herson 2007.
- [8] Tkachenko O.M.: Informational and analytical decision support system in the plant as part of an electronic extension. Computer-integrated technologies: education, science and industry 10/2011, 89–198.
- [9] Yakushev V.P., Yakushev V.V.: Information support of precision agriculture. Publisher PIJF RAS, Sankt Petersburg 2007.
- [10] Zhalnin E.V., Marashev A.D., Bulanets V.I.: Automated system of agrotechnological forming and optimization of composition for machine and tractor fleet ASFAT-MTP. VIM, Moscow 1999.

Ph.D. Olena Sivakovska

e-mail: sivom@ukr.net

Senior Lecturer of Computer Technology and Vocational Education Department, Lutsk National Technical University, Ph.D. in the specialty "Project and Program Management". Scientific and practical interests are related to such areas as the project management, automated information systems, innovative technologies in education. Author of more than 35 scientific publications.

ORCID ID: 0000-0002-9300-0039



Ph.D. Mykola Rudinets

e-mail: rudinetc@meta.ua

Associate Professor of International Economic Relations and the Project Management, Lesya Ukrainka Eastern European National University, Ph.D. in the specialty "Project and Program Management". Scientific and practical interests are related to such areas as the project management, automated information systems, occupational health. Author of more than 60 scientific publications.

ORCID: 0000-0002-0793-5963

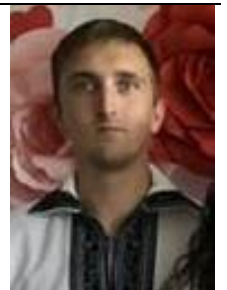


B.Sc. Mykhailo Poteichuk

e-mail: misha.poteichuk@lutsk-ntu.com.ua

Assistant of Computer Technology and Vocational Education Department, Lutsk National Technical University, postgraduate. Scientific and practical interests are related to such areas as automated information systems, the artificial intelligence, and materials science. Author of two scientific publications.

ORCID: 0000-0001-7263-0958



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