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CONCEPTION OF CREATION OF FLEXIBLE TECHNOLOGICAL SYSTEMS AND MANAGED ECOFEELING AGRICULTURE

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The work is devoted to methodological bases of functional scheme elaboration of technological tasks decision of agricultural production. The task is considered on the base of "agro-technical-information-ecological-economic" structure with flexible technological systems realization. Conclusion has been drawn that technologies and machines for agriculture are to be adaptive or readjustable under concrete mixed conditions of the operation.

Key words: conception, methodological base, agricultural production, technological system, agriculture, ecological, economic.

Introduction. Production of farm product is difficult, alive, determined and stochastic dynamic system with great amount of variable probabilistic factors, greatly influencing final result. Production and natural conditions, especially their extreme significances (drought, over moistening, daily weather conditions duration, works accomplishment terms displacement and others), usually are set with their maximum (minimum) significances, frequency of appearance and time of action. The factors frequency greatly influences production and prime-cost of farm product. Under over noted conditions, first of all, it is necessary to worked out more perfect generally formalized logical and mathematical model of technological and technical tasks decision for agriculture.

Last years development and extension of different systems being combined under the name of "Precision agriculture", being constructed on GPS-technologies and information technologies allow us on their base to formulate the conception of creation of flexible, adaptive and managed agriculture on the base of flexible technological systems (FTS) creation [1-5]. *Id est* to define role and place of mechanized technologies or machines at profitable production and weak chain search of the given system [5-8]. Basing on the given aspects technologies and machines for agriculture production are to be adaptive or to be able to readjust the given variable conditions of their operating. Such problem approach enables to decrease the risk in agriculture up to zero and enables to obtain product positive profitability in different years under different weather conditions. Thus adaptive technologies is to be ecofeeling without violation of ground and environment life-support ecosystem.

Such "agricultural-technological-information-ecological-economic" structure consists of many blocks [4] and is to be realized by FTS [2]. Than their amount with substantiated functional connections both in block and between blocks will be greater, that probability level of structural model and its utilization borders will be higher. And this will give the opportunity to create flexible production systems [1, 2].

Today expert (agro-technical monitoring) and automated management systems of technological and production processes are being got the development. Such systems general constituents are the bases of data and knowledge of subject field; general processes mathematical models and decision acceptance rules.

Materials and methods. Technological process model of farm crops production can be constructed as Markosky management process on eventual time interval. Let's divide continuous process on discrete conditions classes: X_t, $t = 0, \ldots, n$, X_t – class of crop and ground condition at time of t. Transition from one condition class to another is realized with managements: A_t, $t = 1, \ldots, n$, where A_t – management class at moment t. Management farm class of A_t realizes the transition from class condition of X_{t-1} into X_t. Class conditions of X_n are named as final or eventual conditions. One is able to think that such process is Markovsky, because transition from one condition class to another one does not depend on transitions "history", but depends only on that class in which it is at transition moment.

Let's consider the example where corn development process are divided on four conditions classes:

X_0 – initial condition, $X_0 = \{x_{01}, x_{02}, \ldots, x_{0n}\}$: ground condition on nourishing elements, moister content in ground and other.;

X_1 – ground condition for sowing, $X_1 = \{x_{11}, x_{12}, \ldots, x_{1n}\}$: ground agrophisical properties $\rightarrow$ conditions for crops perfect development;

X_2 – crops condition on the first stage, $X_2 = \{x_{21}, x_{22}, \ldots, x_{2n}\}$: germination (satisfactory or no);

X_3 – crops condition on the second stage, $X_3 = \{x_{31}, x_{32}, \ldots, x_{3n}\}$: sicknesses and pests presence (high, average, low);

X_4 – harvest, $X_4 = \{x_{41}, x_{42}, \ldots, x_{4n}\}$: yield estimation (high, low).

Management multitude element for transition from one condition into another is the separate technological operation with technical measurements set for its realization.

Management multitude represents following:

A_1 – ground cultivation, $A_1 = \{a_{11}, a_{12}, \ldots, a_{1k}\}$ (transitions realization from conditions of X_0 class into conditions of X_1 classes): general ground cultivation + hardwares list; facial tilling + hardwares list; facial tilling + presowing tilling + hardwares list and so on.

A_2 – sowing, $A_2 = \{a_{21}, a_{22}, \ldots, a_{2k}\}$: sowing with mineral fertilizes applyment + hardwares list; direct sowing + hardwares list and so on,

A_3 – sowing care, $A_3 = \{a_{31}, a_{32}, \ldots, a_{3k}\}$: fight with pests + hardwares list; side-dressing + hardwares list; fight with pests + side-dressing + hardwares list and so on;

A_4 – harvesting, $A_4 = \{a_{41}, a_{42}, \ldots, a_{4k}\}$: direct harvesting (combine "ДОН-1500"); separate harvesting (header + combine) and so on.

Eventual stage is characterized with the function of r – final pay (resources which can be obtained at harvest realization). Transition from one conditions class to another one is estimated with function of q – current pay (resources having been spent on technological operation accomplishment), as a rule, q function is negative. Conditions and managements sequences being transit from condition to condition is the way – $l = x_0 a_1 x_1, \ldots, a_n x_n$.

Task aim is in optimum way search, that is, sum of current results and final one is to be maximum.

If the process is determined, that is, transition from condition into condition is realized no by chance, so one is able to decide the task by all possible variants selecting. However, in common case transition is random, that is, on multitude of X_t condition at t time moment some probability distribution is set, so choice is realized at its consideration. Also at this some initial μ distribution is given. If the process is given

on final interval, the task can be decided with dynamic programming methods. To set probability distribution is main difficulties there. They (probabilities) can be set with expert method, can be calculated with experiments plan. One is able to conduct, for example, measurements of crops development parameters or to use other intermediate test and analysis. On the base of obtained information these parameters distributions are constructed or specified. Dynamic programming can be used when the process is given on the finite interval (technologies development model on some years).

Thus technology model is constructed as Markovsky managed process on finite time interval. Process is set with following elements:

a) X_t, t = 0, …, n – conditions multitude at moment t;
b) A_t, t = 1, …, n – management multitude at moment t;
c) f multitude of management reflection $A = \bigcup_{t=1}^{n} A_t$ into such conditions multitude

$$X = \bigcup_{t=0}^{n} X_t \text{ that } f(A_{t+1}) = X_t;$$

d) distribution of $p(.|a)$ probabilities on X_t. $p(.|a)$ function is named transitional function, if defines transition law in X_t;
e) q function on management multitude of $A = \bigcup_{t=1}^{n} A_t$ – current pay;
f) r function on final conditions multitude of X_n – final pay;
g) initial distribution of probabilities – μ.

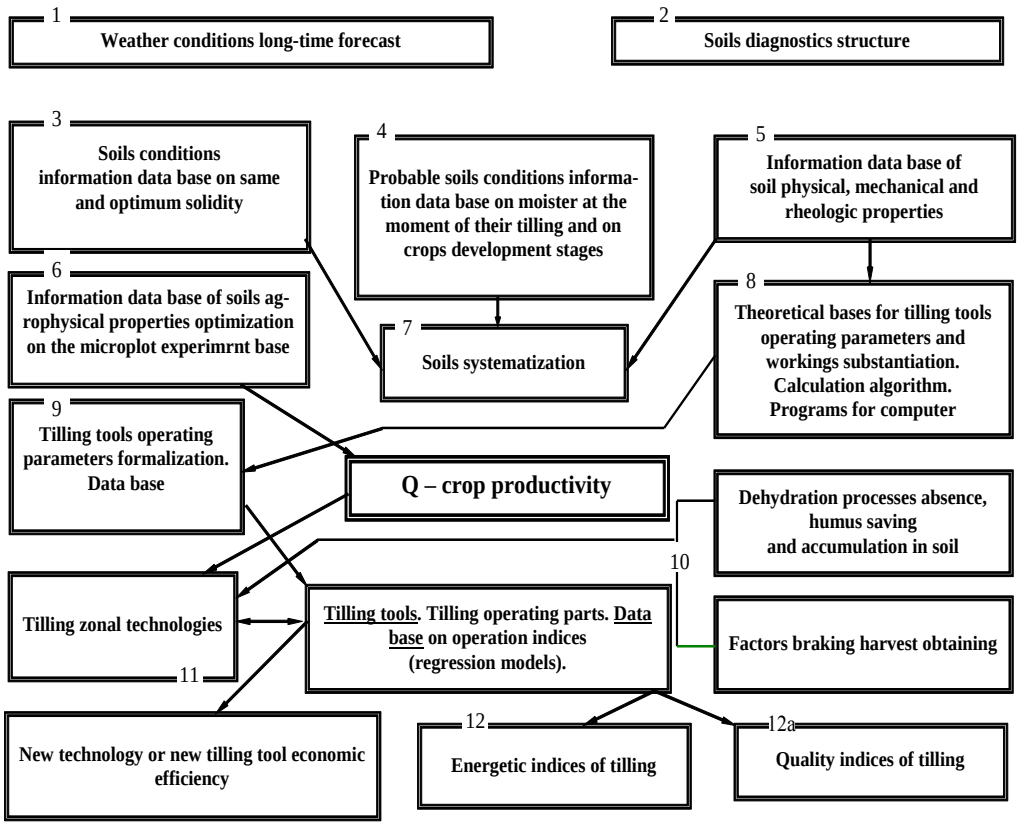
Object being satisfied conditions a) – g) is named technology model and designated as Z_μ.

Aim – to define management method when maximum is mean significance (expectation) of estimation:

$$J(l) = \max_{a_j \in A_j, x_n \in X_n} F(q(a_j), r(x_n)),$$ way $l = x_0 a_1 x_1, \ldots, a_n x_n$, or such way searching when $J(l) = max\ F\ (q(a_j), r(x_n))$, where F – some function (aim function).

In correspondence with the principle of optimum stages choice of decision acceptance process management relatively to synthesis and development of structure and FTS – elements, in time the process is divided on range of sequence steps, and the defined optimization task is decided on each step [1, 2].

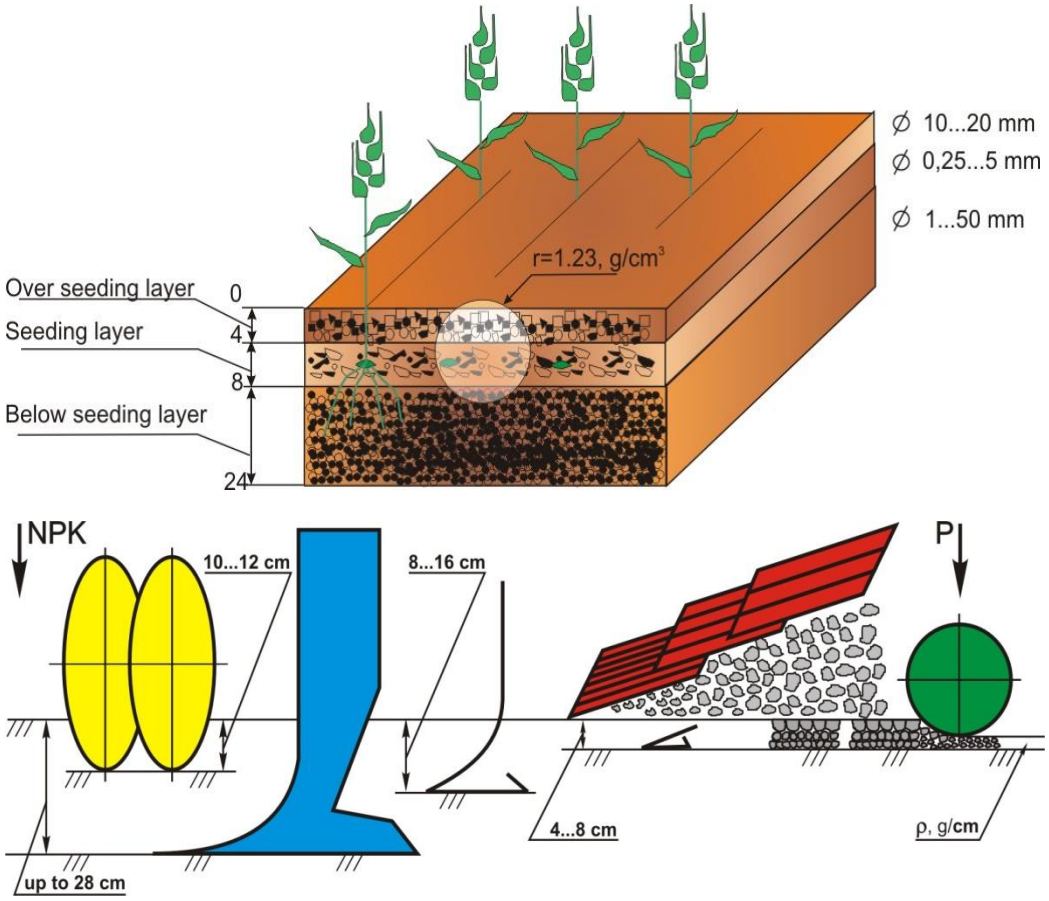
Results and their discussion. Particularly such approach can be considered on the ground cultivation block. Block has been considered as complicated system element of management agriculture on single scheme of "ground cultivation machines with formalized parameters – agricultural crop – ground environment" with the defining of technological tasks, ground environment parameters, optimization criteria and estimating models indices being able to be used later in the structure of managed agriculture (picture 1 [5]).



Picture 1. **Elaboration and estimation structural scheme of zonal technologies and technical means for tilling**

Data bases relatively ground conditions, technical characteristics and operating parameters of tillage tools have been used for transitional function estimation. Thus information data bases have been joined. First of all these bases are connected with ground systematization and their conditions, tillage tools operating characteristics as well as mechanical-mathematical and regression models being connected with interaction of operating parts with ground environment and its influence on agricultural crops productivity in the limits of technology model of Z_{μ}. Besides such approach allows to define "weak links" in technological process.

Presowing ground cultivation has been related to "weak link" in ground cultivation, because it has defined eventual result of mechanical ground cultivation – plough-layer rational composition. This technological and technical necessity has enabled to create new kind of tillage technique – ground separator. For its elaboration intermediate optimization criterion has been substantiated. This criterion is functional dependence of agricultural crops Q productivity from plough-layer mechanical composition: $Q = f(Y_1,Y_2,Y_3,Y_4)$, where Y_1,Y_2,Y_3,Y_4 – parameters defining plough-layer composition. Thus Q depends on graded structural consumption and ground solidity for the defined conditions: crop, ground kind, year conditions relatively moistening (picture 2).



Picture 2. **Differential structure formation of plough-layer constitution on the FTS base on tilling**

That is, ground is prepared under the given conditions with the dependence of year conditions and crop requirements. Besides, we'll obtain simple composition of ground facial layer through separator operation. This greatly simplifies the task for operating parts creation and adaptation of seeders, potato and root harvesting machines, irrigating machines. As such machine universality goes, ground separator autonomous block can operate combined sowing units composition, can include fertilization devices, dependently on year conditions (ground solidity and moisture, field impurity) ground separator is able to accomplish facial tilling. Separator technical ideology enables full lifting of weeds and their roots on the field surface that corresponds to crops growth unherbicides technologies requirements.

Soils fertility is connected with florula and microfauna animation of plough-layer. And according to mechanical influence that denotes anhydrous aggregate saving. And that is not comminution and overpuddling of soil argonomically valuable fractions of 0.25 – 5 mm. Through these fractions biota creates. This index has been accounted at tooling parts adaptive parameters definition.

Thus FTS creation is based on creation of technical means being reliable, functionally efficacy, adaptable for mounting and repair that have simple adjustments and technological operations being flexible and managed. To estimate optimum significances of the corresponding operation quality indices of machines and technological operations is required on the first step using formalization methods. Information data bases continuous administration and improvement is required for obtainment reliable data relatively technique exploitative technological efficiency in wide range of ambient. Following step is to form flexible technological systems optimum strategies and their hardware management variants on the technologies model of Z_μ base.

Conclusions

Managed agriculture elaboration is the most important task for nowadays scientists. Progressive information technologies enable to elaborate that system and average farms volume in Ukraine will enable its greatly efficient utilization. Besides information having been obtained according such system is valuable as for investors putting money and requiring guaranteed result so for farm technique technologists and constructors. That is, at elaboration or modernization of machine, its operating parts there is possibility to foresee economic expediency of technological or technical decision.

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КОНЦЕПЦИЯ РАЗРАБОТКИ АДАПТИВНЫХ ТЕХНОЛОГИЙ И ТЕХНОЛОГИЧЕСКИХ СРЕДСТВ В ЗОНАЛЬНОМ ЗЕМЛЕДЕЛИИ

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Работа посвящена методологическим основам функциональной схемы разработки решения технологических задач сельскохозяйственного производства. Задача считается на базе «агротехническо-информационно-эколого-экономической» структуры с гибкой реализацией технологических систем. Был сделан вывод, что технологии и машины для сельскохозяйственных работ должны быть адаптивными или перестраиваемыми под конкретные смешанные условиях эксплуатации.

Ключевые слова: концепция, методологическая основа, сельскохозяйственное производство, технологическая система, сельское хозяйство, экология, экономика.

КОНЦЕПЦІЯ РОЗРОБКИ АДАПТИВНИХ ТЕХНОЛОГІЙ І ТЕХНОЛОГІЧНИХ ЗАСОБІВ У ЗОНАЛЬНОМУ ЗЕМЛЕРОБСТВІ

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Робота присвячена методологічним основам функціональної схеми розробки рішення технологічних задач сільськогосподарського виробництва. Завдання вирішується на базі "агротехнічно-інформаційно-еколого-економічної" структури з гнучкою реалізацією технологічних систем. Був зроблений висновок, що технології і машини для сільськогосподарських робіт повинні бути адаптивними або перебудовувані під конкретні змішані умови експлуатації.

Ключові слова: концепція, методологічна основа, сільськогосподарське виробництво, технологічна система, сільське господарство, екологія, економіка.