# Development of scientific support and prototype multilevel information resource system for creating digital farming systems

*Vladimir* Badenko[1*], *Alexander* Fedotov[1], *Alexander* Tarakanov[1], *Anton* Terentev[2] and *Rahul* Dev Garg[3]

[1]Peter the Great St. Petersburg Polytechnic University, 195251, St.Petersburg, Polytechnicheskaya, 29, Russian Federation
[2]All-Russian Institute of Plant Protection, 196608, St.Petersburg, Pushkin, Podbelskogo 3, Russian Federation
[3]Indian Institute of Technology Roorkee, 247667, Roorkee, Uttarakhand, India

**Abstract.** In the context of changing political, socio-economic, natural and climatic conditions, there is a need for effective tools to manage agricultural activities. Such tools are digital farming systems, which are a set of interconnected agrotechnical, reclamation and organizational measures aimed at the effective use of agricultural landscapes, preservation and improvement of soil fertility, and obtaining high crop yields. The paper describes the basics of development of scientific support and a prototype of the multilevel information resource system for creating digital farming systems.

## 1 Introduction

Farming systems may include many components such as agricultural cultivation management plan of crop rotation, the realization of weather and soil resources of crop production process, use of fertilizers and plant protection products, precise watering, crop yield prediction, etc. [1]. In the context of changing political, socio-economic, natural and climatic conditions, there is a need for effective management tools to adapt agricultural activities [2]. Such tools are digital farming systems, which are a set of interconnected agrotechnical, reclamation and organizational measures aimed at the effective use of agricultural landscapes, preservation and improvement of soil fertility, and obtaining high crop yields [3]. Agriculture systems can be either local, adapted for specific farms and taking into account the local specifics of factors affecting the efficiency of agricultural production, or regional, aimed at achieving regional level indicators, which depend on local authority regulation [4]. Various forecasting methods based on the use of complex mathematical models help to increase the efficiency of this process. In crop production, both the statistical and dynamic simulation forecast models have been developed. The latter are more accurate and adaptive and allow getting an answer to the question about the

* Corresponding author: vbadenko@gmail.com

development of agricultural ecosystems in changing climatic conditions and application of various agrotechnical measures [5]. Thus, the modern effective way to develop farming systems is to use dynamic simulation forecast models of the production process. Moreover, the effective functioning of such tools is possible only if necessary amount of input data is available, which can be ensured through automation and integration of production and management processes into a multi-level information resource system [6].

## 2 Materials and methods

At the level of regional agro-industrial complex management, in addition to the task of implementing the federal policy of stimulating priority areas of agricultural activity and the formation of regional farming systems, it is necessary to take into account environmental and economic factors and conduct agricultural activities in the paradigm of sustainable development, observing the requirements of environmental legislation.

At the level of agricultural producers, the most urgent task is the rational conduct of agricultural production with the ability to dynamically plan agricultural activities and making tactical management decisions based on imitative forecasting modelling.

The objectives of this paper are creation of a universal and scalable information-analytical system for dynamic monitoring and forecasting of the features of agricultural territories and usage of the developed system to perform a series of computer experiments in dealing with management tasks of various levels:

• macroscale calculations: assessment and monitoring of the achievable potential productivity of major crops on a national scale.

• mesoscale calculations: model analysis and optimization of agricultural technologies on a regional scale.

• microscale calculations: an analysis of the effectiveness of precision agriculture technologies at a scale of crop farming or specific agricultural fields.

## 3 Results and discussion

The scientific problem to be solved within the framework of this paper lies at the junction of two perspective directions of technological development: “sustainable development” and “organic farming”. The sustainable development aspect is the use of decision support system software based on crop modelling in traditional food crops rotation. The most important element of organic farming is the refusal of mineral fertilizers and chemical plant protection usage and the intention to maintain soil fertility, as well as agriculture productivity and phytosanitary condition through the use of exclusively organic fertilizers and biological plant protection methods, such as green manures and biopesticides.

Adequate assessment of all technological, economic and environmental consequences of the proposed modification of farming systems on a medium-term temporal scale requires consideration of many aspects and accounting for a variety of influencing factors: inter-seasonal variability of weather conditions; enumeration and sequence of cultures from crop rotation scheme; efficiency, value and ecological safety of green manures etc.

Principal goal is to develop a universal, scalable software environment for big data calculations using dynamic model of agricultural ecosystem for the monitoring and evaluation of crop productivity potential of different agricultural areas. This approach suggests the following points to be taken into account::

• A specific set of input data (the structure and the amount of input data required for single model run) depends on the model used and type of the problem to be solved. At the same time, static data sets on such factors as "territory" and "soil" with different spatial

details, which are imported in the environment of multivariate analysis from external geographic information system, are invariant with respect to the model and the nature of the computational experiment.

• Sources and mechanisms of operational replenishment of the data having dynamic character in the crop model calculations (e.g., current meteorological information) may be different, but the principle of their usage in computing experiments for different purposes is universal and following: the operative changes in the respective gradation of "weather" factor in the spectrum of pre-determined weather scenarios.

• Big data model calculations based on a representative set of spatial points are carried out within the framework of a common ideology of batch running of all the scenarios generated by project computational experiment, where a scenario linking with particular point is determined by the corresponding gradations of the "soil" and "location" factors.

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