A NEW MODEL OF AGRICULTURAL DEVELOPMENT IN THE REPUBLIC OF SERBIA UNDER CLIMATE CHANGE CONDITIONS

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ABSTRACT:

The paper presents a theoretical and descriptive consideration of a new model of agricultural development in the Republic of Serbia under conditions of climate change. It starts from the need to transform the traditional production model into a model based on science, technology, precision and smart agriculture, and a new agricultural policy. Particular attention is given to adaptation and mitigation, water resource management, digitalization, IoT, artificial intelligence, institutional support, and risk management. The paper has a conceptual and descriptive character and does not represent an empirical assessment of the effects of the proposed measures.

Keywords: *Serbian agriculture, climate change, agricultural policy, adaptation, mitigation, sustainable development, precision agriculture.*

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1. INTRODUCTION

The agriculture of the Republic of Serbia faces a historic challenge of transforming the tradi-tional production model into a modern, scientific-technological model capable of responding to the challenges emerging in the 21st century. Climate change's exacerbations include increasingly

frequent extreme weather events, prolonged droughts, floods, and volatile temperature changes [10]. This requires a change in the approach to agricultural production.

Serbia has exceptional natural potential for agricultural production, but the traditional ap-proach is becoming increasingly less effective under conditions of heightened climate uncer-tainty. The consequences are manifested in crop and livestock production through yield instabil-ity, increased costs, water-related problems, heat stress, and greater income risk for producers. Climate risk is thus becoming both an economic and a social risk.

The new model of agricultural development in Serbia — based on science and technology, as well as a new agricultural policy — is not merely a reaction to climate change but also an opportunity for the modernization of production. In this model, precision and smart agriculture have the role of the technological corner stone. In addition to that, policy, knowledge, and institutions support the conditions for their optimal implementation.

2. THE SCIENTIFIC-TECHNICAL FOUNDATION OF THE NEW MODEL

The development of science through the implementation of technology finds fertile ground for application in agricultural production. In this regard, precision and smart agriculture are be-coming key pillars of the new development model. Precision agriculture relies on sensors and monitoring systems, satellite technologies, data analysis, and precise resource management [6].

Smart agriculture represents the synergy of new technologies as IoT, AI, big data, and robotics, integrating them into traditional agricultural practices [5]. The concept is based on sensor monitoring, data analytics, and automation [2]. Such an architecture enables decisions to be based on measurements rather than solely on estimation and experience [8, 9].

Smart irrigation and water resource management occupy a special place. Efficient irrigation, based on soil moisture measurements and other data, can link drought adaptation with more rational water use [3]. The contemporary literature on IoT and intelligent irrigation systems emphasizes the importance of connecting sensors, models, and management decisions into one holistic system.

Biotechnology, genetics, soil microbiology, biofertilizers, and biopesticides complement this digital approach and the integration. Consequently, the development of climate-adapted varieties can increase resistance to drought, surging temperatures, and new pest outbreaks. Thereby, technological and biological adaptation become constitutive elements of the same development framework and system.

3. THE NECESSITY OF A NEW AGRICULTURAL POLICY

Climate change represents one of the most difficult challenges facing contemporary society, particularly the agriculture and forestry sector. Under these negative effects and conditions, traditional agricultural policies are rapidly becoming less effective. This situation creates a need for adaptive and more flexible instruments and policies for mitigation of negative effects of climate change.

The new agricultural policy should transform the way public funds are distributed. Direct subsidies as financial resources, which often encourage unsustainable production, should be allocated toward payments for ecosystem services to the farmers' side. Support should stimulate efficient water use, soil conservation, the adoption of technology, emission reduction, and increased resilience.

The new agricultural policy must recognize the new reality in which there is no universal solution to climate challenges. Mitigation and adaptation measures must be tailored to specific local conditions. This implies the regionalization of measures, risk monitoring, and continuous adjustment of instruments.

In the context of European integration, IPARD can represent one of the institutional mechanisms for directing investment toward modernization and rural development. An analysis of the implementation of the IPARD II program in Serbia points to the importance of institutional capacities, access to financing, and the ability of beneficiaries to prepare and implement investments [7].

4. MITIGATION AND ADAPTATION AS COMPLEMEN-TARY APPROACHES

Climate change represents one of the greatest challenges of contemporary agriculture. In ad-dressing this phenomenon, two key approaches can be distinguished: mitigation measures, which reduce greenhouse gas emissions, and adaptation measures, which reduce vulnerabil-ity to climate impacts.

Conservation tillage, crop rotation, and cover crops can simultaneously contribute to soil quality and carbon sequestration. Improved manure management and biogas facilities can re-duce methane emissions while also providing energy value from agricultural residues [1].

In addition, climate change adaptation measures are necessary. With increasingly frequent droughts in the region, efficient water resource management is becoming a key adaptation mea-sure. The introduction of more resistant varieties and hybrids represents another important adaptation measure. Synergy between mitigation and adaptation measures is also needed.

Many smart agricultural practices simultaneously contribute to both climate change mitiga-tion and adaptation. Crop rotation and cover crops improve soil quality and carbon sequestra-tion while also increasing resistance to erosion and extreme weather conditions. Agroecological practices such as agroforestry also demonstrate potential for both aspects.

5. INSTITUTIONS, KNOWLEDGE, AND RISK MANAGE-MENT

Under conditions of climate change, continuous learning and adaptation are becoming key suc-cess factors. This implies strengthening the capacities of advisory services, developing specific educational programs, and establishing demonstration farms. Technology has limited effect if producers lack access to the knowledge needed to interpret data and apply recommendations.

Successful implementation of the new agricultural policy requires significant strengthen-ing of institutional capacities, including the involvement of agricultural producers, scientific research institutions, the private sector, civil society, and local communities. Measures for low-land areas, mountainous regions, and areas with pronounced drought risk must differ according to natural and socio-economic conditions.

Climate change increases uncertainty and risk in agricultural production. The new agricul-tural policy must develop risk management systems:

innovative insurance products adapted to climate risks, public-private partnerships, compensation mechanisms, and support for income diversification. Their role is not to eliminate climate risk, but to reduce its financial conse-quences.

Investments in technology should be assessed through total cost of ownership rather than merely equipment price [4]. Maintenance, calibration, connectivity, software, and training costs can be decisive for long-term sustainability. For this reason, the economic analysis of technol-ogy must encompass the entire life cycle of the investment.

6. CONCLUSION

Climate change is altering the fundamental conditions of agricultural production and requires a thorough transformation of agricultural policy. The new agricultural policy must recognize the dual role of agriculture — as a sector highly vulnerable to climate change and as part of the solution through its potential for carbon sequestration and greenhouse gas emission reduction. The transition toward climate-smart agriculture is not only an environmental imperative but also an economic necessity.

New technologies have transformative potential in the process of climate change adaptation and mitigation in agriculture. They enable more precise resource management, better prediction of and response to climate change, and the development of innovative solutions that can simulta-neously increase productivity and reduce negative environmental impact. However, technology alone is not sufficient.

The main limitation of this paper is its conceptual and descriptive character and the absence of an empirical assessment of the proposed measures. The next step would be the development of climate resilience indicators and the testing of various agricultural policy instruments based on data from real-world production.

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