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THE IMPORTANCE OF INNOVATION POLICY FOR SUSTAINABLE TRANSFORMATION OF AGRICULTURE IN SERBIA

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Abstract: Innovation in agriculture is increasingly recognized as a critical driver of sustainable economic growth, particularly in developing countries like Serbia. The agricultural sector in Serbia plays a vital role in the national economy, necessitating a shift towards sustainable agricultural practices that leverage innovation and technology. Government support is essential for fostering an innovative agricultural environment. Effective policies that promote agricultural extension services and provide financial assistance are crucial for encouraging farmers to adopt new technologies and practices. Given the centralized system of innovation support, Serbian government has a pivotal role in creating a conducive regulatory framework that not only facilitates innovation but also addresses the unique challenges faced by the agricultural sector, such as land management and environmental sustainability. This paper examines specific ways in which public support for innovation in agricultural sector is carried out in Serbia, mainly through analyzing the activities of the Innovation Fund of Serbia.

Key words: Agriculture, Innovation, Sustainability, Public policy, Innovation Fund

1. INTRODUCTION

Innovation in agriculture is increasingly recognized as a critical driver of sustainable economic growth, particularly in developing countries like Serbia. The agricultural sector in Serbia plays a vital role in the national economy, necessitating a shift towards sustainable agricultural practices that leverage innovation and technology. Research indicates that the adoption of innovative approaches, such as precision agriculture, can significantly enhance productivity and sustainability in Serbian agriculture (Dimitrijević, 2024; Jurjević et al., 2019). Furthermore, the integration of advanced technologies, including drone applications for plant protection, has been identified as a promising avenue for improving agricultural efficiency and environmental stewardship (Ivezić, 2023).

Government support is essential for fostering an innovative agricultural environment. Effective policies that promote agricultural extension services and provide financial assistance, such as agricultural loans, are crucial for encouraging farmers to adopt new technologies and practices (Madžar, 2021). The Serbian government has a pivotal role in creating a conducive regulatory framework that not only facilitates innovation but also addresses the unique challenges faced by the agricultural sector, such as land management and environmental sustainability (Milošević et al., 2020). Moreover, the promotion of organic agriculture through tax incentives and supportive legislation has been shown to enhance the competitiveness of Serbian agriculture on both national and international stages (Kryszk et al., 2022; Despotović et al., 2019). Thus, the synergy between innovation and government support is fundamental for the advancement of agriculture in Serbia. By prioritizing innovative practices and providing robust support mechanisms, the Serbian agricultural sector can enhance its competitiveness, ensure sustainable development, and contribute significantly to the overall economic growth of the country. The ongoing commitment to innovation, coupled

with effective government policies, will be essential for transforming Serbia's agricultural landscape and achieving long-term sustainability.

The aim of paper is to provides an overview of policy support for innovation in agricultural sector in Serbia, connected to the centralized way of innovation policy is operationalized through the activities of the Innovation Fund - to support agricultural sector.

2. LITERATURE REVIEW

Public expenditure in agriculture is a critical area of research, particularly in developing countries where agriculture plays a vital role in economic development and poverty alleviation. This literature review synthesizes various studies that explore the impacts, effectiveness, and dynamics of public spending in the agricultural sector across different contexts. One significant aspect of public expenditure in agriculture is its relationship with rural welfare and poverty reduction. Mogues et al. (2011) highlight that while substantial public spending on agriculture in Ethiopia is aligned with the government's development strategy, the effectiveness of such expenditures can be undermined by critical shortcomings in public policy. Similarly, Arham et al. (2020) argue that public expenditure alone does not necessarily lead to a reduction in rural poverty in Indonesia, attributing this to a misalignment between spending and agricultural productivity. This suggests that the mere allocation of funds is insufficient; rather, the strategic implementation of these resources is crucial for achieving desired outcomes in poverty alleviation. Moreover, the interaction between public and private investment is a recurring theme in the literature. Ayuba's study on Nigeria indicates that public agricultural spending can either crowd out or complement foreign direct investment (FDI), depending on the context and implementation (Ayuba, 2021). This is echoed by Nwosa (2021), who found that public expenditure significantly affects agricultural productivity and that it works in tandem with private investment to enhance overall agricultural output.

The complementarity between public and private investments is further supported by Akber and Paltasingh (2019), who explore the dynamics of public and private investments in Indian agriculture, suggesting that effective public investment can stimulate private sector engagement. The role of public investment in enhancing agricultural productivity is also emphasized in the context of specific interventions. For instance, Fan et al. (2008) discuss how targeted subsidies and investments in research, education, and infrastructure have been instrumental in promoting agricultural growth and reducing poverty in India. Similarly, Abate et al. (2016) note that Ethiopia's significant allocation of public spending to agriculture has led to increased cereal production and growth in the agricultural gross domestic product. These findings underscore the importance of not only the quantity of public expenditure but also the quality and focus of these investments.

Additionally, the literature highlights the importance of financing mechanisms in agricultural development. Gao et al. (2022) discuss how digital inclusive finance can enhance agricultural productivity by fostering technological innovation and optimizing industrial structures. This aligns with the findings that rural financial development is crucial for agricultural technology innovation, thereby contributing to sustainable agricultural practices (Liu et al., 2021). The interplay between financial inclusion and agricultural productivity is further explored by Fowowe (2020), who suggests that enhancing financial access can significantly improve agricultural outcomes, particularly for marginalized groups. Therefore, the literature indicates that public expenditure in agriculture is multifaceted, with its effectiveness contingent upon strategic alignment with productivity goals, the interplay between public and private investments, and the incorporation of innovative financing mechanisms. Future research should continue to explore these dynamics, particularly in the context of evolving agricultural challenges and the need for sustainable practices.

3. IMPORTANCE OF INNOVATION IN SERBIAN AGRICULTURE

Innovation in agriculture is crucial for enhancing productivity, sustainability, and resilience in Serbia's agricultural sector. Over the past years, the integration of advanced technologies and innovative practices has emerged as a key driver for improving agricultural output and addressing challenges such as climate change, resource scarcity, and market competitiveness. This section synthesizes relevant literature to highlight the importance of innovation in Serbian agriculture.

The adoption of precision agriculture technologies, including GPS, Geographic Information Systems (GIS), and data analytics, has been shown to significantly enhance agricultural productivity in Serbia. Jurjević et al. (2019) emphasize that these technologies facilitate better resource management and optimize crop yields while minimizing environmental impacts. The implementation of precision farming techniques allows farmers to make informed decisions based on real-time data, which is essential for improving efficiency and sustainability in agricultural practices (Gawande et al., 2023). This aligns with their findings that precision farming promotes eco-friendly agriculture by optimizing resource allocation and reducing environmental pollution (Gawande et al., 2023). Moreover, the integration of Internet of Things (IoT) and artificial intelligence (AI) into agricultural practices is revolutionizing livestock management and crop production. As highlighted by Issa (2024), these technologies are part of the broader Agriculture 4.0 movement, which aims to create a more advanced and sustainable agricultural system. The potential of AI in agriculture extends to various applications, including yield prediction, crop health monitoring, and resource optimization, thereby enhancing overall productivity (Uzhinskiy, 2023).

Innovation is not only vital for increasing productivity but also for achieving sustainable agricultural development in Serbia. Innovation is a key factor in promoting sustainable economic growth and agricultural development (Despotović et al., 2019). The authors emphasize that Serbia, as a country where agriculture plays a significant role in the economy, must prioritize innovation to ensure long-term sustainability and competitiveness in the global market. This perspective is supported by the findings of Basso (2024), who notes that technological advancements in agriculture can significantly contribute to sustainability by improving resource efficiency and reducing environmental impacts. Furthermore, the importance of knowledge transfer and extension services in disseminating innovative practices to farmers cannot be overstated, given that effective dissemination of improved agricultural technologies is crucial for advancing the sector (Oladoyinbo, 2023). The role of agricultural extension services in facilitating access to information and training on new technologies is essential for empowering farmers and enhancing their productivity.

Despite the potential benefits of innovation in agriculture, several challenges persist in Serbia. The adoption of advanced technologies can be hindered by factors such as limited access to financing, inadequate infrastructure, and a lack of digital literacy among farmers. Additionally, the historical focus on traditional agricultural practices may slow the transition to more innovative approaches. Therefore, targeted policies and investments are necessary to foster an environment conducive to innovation. Future research should focus on evaluating the effectiveness of current agricultural policies in promoting innovation and identifying best practices for technology adoption among Serbian farmers. Enhancing collaboration between research institutions, government agencies, and the private sector will be crucial for driving innovation and ensuring that Serbian agriculture remains competitive in the global market. In conclusion, innovation plays a pivotal role in enhancing productivity, sustainability, and resilience in Serbian agriculture. By embracing advanced technologies and fostering knowledge transfer, Serbia can position itself to meet the challenges of modern agriculture and achieve sustainable development goals.

4. THE ROLE OF INNOVATION POLICY IN SUPPORTING SUSTAINABLE AGRICULTURE IN SERBIA

The analysis of public expenditure on agriculture in Serbia over the past 15 years reveals a complex interplay of policy decisions, economic conditions, and external influences that have shaped the agricultural landscape. Public expenditure on agriculture in Serbia has shown a gradual increase, particularly in the context of aligning with European Union (EU) standards and policies. According to Đurić et al. (2019), government support for farmers has been primarily through market measures and budgetary transfers, which have been evaluated using the Producer Support Estimate (PSE) methodology. This approach indicates that while there has been an increase in budgetary transfers, the overall support level remains lower than that of EU countries, with Serbian subsidies per hectare being significantly less than those in the EU (Babić et al., 2015). In recent years, the agricultural budget has been reported to constitute approximately 5% of the total national budget, with direct payments emerging as a dominant form of subsidy (Đurić, 2024). Dimitrijević (2023) notes that this trend reflects a broader recognition of agriculture's critical role in Serbia's economic development, particularly in light of its contribution to GDP and employment. The increase in the agrarian budget has been accompanied by a rise in lending to farmers by commercial banks, which is essential for enhancing agricultural productivity and sustainability.

Despite the upward trend in public expenditure, significant challenges remain. Ristić et al. (2018) highlight that insufficient financial resources allocated to agriculture are a key limitation for the sector's development. The agricultural budget has historically been low, with less than 5% of the national budget allocated to agriculture for an extended period (Mizik, 2016). This underfunding hampers the potential for agricultural growth and rural development, emphasizing the need for increased budgetary support to enhance the economic viability of the agricultural sector (Grujić-Vučkovski et al., 2022). Moreover, the structure of subsidies has been criticized for being inadequate to meet the diverse needs of farmers. The existing agricultural policies have often favored larger producers, leaving smallholder farmers at a disadvantage (Đurić, 2024). This disparity in support can lead to uneven development within the agricultural sector, exacerbating rural poverty and limiting the overall effectiveness of public spending. The process of EU integration has significantly influenced Serbia's agricultural policy and public expenditure. As Serbia aligns its agricultural strategies with EU standards, there has been a push towards improving the quality and effectiveness of public spending in agriculture. Ljubojević et al. (2022) discuss how the harmonization of national legislation with EU rules has led to a more structured approach to agricultural financing, aiming to enhance competitiveness and sustainability. This alignment is crucial for accessing EU funds, such as the Instrument for Pre-Accession Assistance for Rural Development (IPARD), which provides additional resources for agricultural development (Grujić et al., 2019).

5. THE INNOVATION FUND'S ROLE IN SUPPORTING AGRICULTURAL INNOVATION

The Smart Specialization Strategy 2020, which delineated strategic orientations and priorities for innovation policy in the upcoming years, serves as the cornerstone of innovation policy in Serbia. The 4S identifies four priority areas-food for the future, ICT, future machinery and manufacturing processes, and creative industries-that should be the focus of policy initiatives and resource allocation due to their strategic importance and competitive advantages. In the process of raising the general productivity and competitiveness of the national economy, these four domains were determined to have the best chance of successfully developing and implementing innovations. The entrepreneurial discovery process, which involved a careful examination of domestic capabilities and available resources, led to the selection of innovation priorities rather than being arbitrary. This process involved a thorough analysis of available resources and domestic capacities, as well as the prospects for growth and development based on knowledge and innovation, and it was carried out

in the form of a widespread social dialogue including key stakeholders within the national innovation system (businesses, science and research sector, academia, policymakers and civil society experts). This fact further corroborates the fact that agriculture is recognized as a valuable national resource with significant and robust potential for future development.

Given Serbia's centralized approach to smart specialization, the government plays the most important role in this top-down framework. This includes innovation policy, which is primarily carried out by the Innovation Fund (IF). Although it has been in operation since 2011, the institution technically predates S4, and its strategies and operations have evolved to align with the 2020 Smart Specialization Strategy's priorities. Within the scope of innovation policy, IF's role is to fund, promote, and advise two important clusters of innovation carriers: the business sector and the scientific research sector. It does this both independently and by promoting cooperation between academics and entrepreneurs. Given the importance of the Innovation Fund in the Serbian system for promoting innovation, a review of its resources and their allocation along the lines of industrial sectors can reveal to what extent public support resembles strategic priorities defined by the Smart Specialization Strategy.

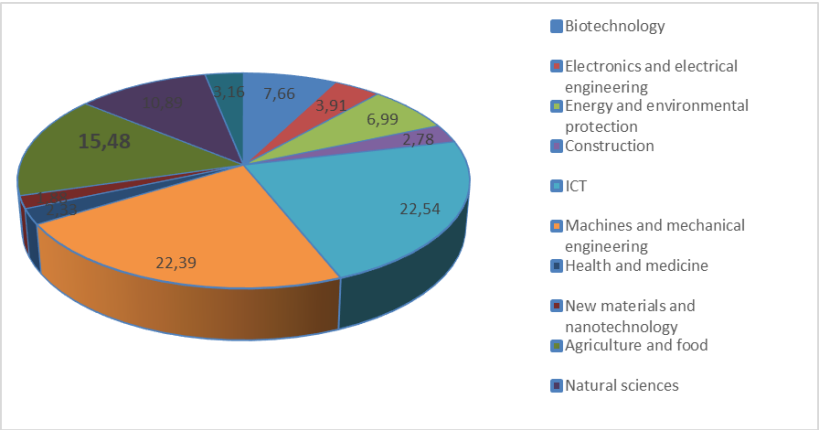

Figure 1. Distribution (%) of approved projects across industry sectors

The above graph reveals one of the most relevant aspects of the Innovation Fund's activities - the industrial sector breakdown of approved projects. By analyzing sectoral distribution of IF's support, it is possible to ascertain whether and to what extent the IF's activities align with priority areas outlined in the Smart Strategy. Several conclusions can be drawn from observing dominant industries that are being supported by the IF. Firstly, it is evident that ICT and Machines and mechanical engineering combined account for roughly half of the funded projects, followed by Agriculture and food industry and projects related to Natural sciences. Other prominent sectors include Biotechnology and Energy and environmental protection. Broadly speaking, this distribution of funds corresponds to the 4S priority areas and in that regard, it can be considered that IF practices are generally in accordance with the strategic direction of innovation policy. The one priority area that is not represented in the IF's portfolio is related to Creative industries. However, given that the classification of the Innovation Fund and the one deployed in 4S differ from each other, it can be assumed that the significant portion of innovative activities involved in creative industries is related to various aspects of implementation of information technologies and therefore falls under the ICT category placement in IF's project portfolio.

Second, the way projects are distributed across industry sectors can be seen as a reflection of the resource availability, competitive advantages, and ultimately capacity for innovation in different industries. Given that the programs' selection criteria and general process are intended to mimic market conditions, the results of IF's selection process ought to mirror the performance structure that

would be attained through market selection. Consequently, the structure of inputs inevitably determines the distribution and structure of approved projects, i.e. the ability of the applicants to develop innovations effectively. At the macro level, the sectoral allocation of IF projects are inevitably conditional upon the initial concentration of competitive advantages, which significantly impacts the innovative capacity of individual applicants. Therefore, the way that projects are distributed across various industries also reflects how and in which specific economic sectors Serbia's innovation resources are distributed, as well as how the initial allocation of innovation capacities affects the results of individual projects in terms of obtaining public funding.

Thus, the fact that agriculture occupies a prominent place in the IF's portfolio of supported projects reflects the inherent reality of its innovative potential as well as the current capacities (on behalf of farmers) to capitalize on the available opportunities to secure public funding. The programme of Innovation Vouchers, which connects small businesses with scientific institutions in the process of developing novel products and applicable solutions, has proven to be particularly popular among agricultural entrepreneurs, as it affords them the necessary flexibility in choosing academic partners and types of services rendered. Innovation Vouchers have numerous advantages for entrepreneurs: Advantages for entrepreneurs:

- Increasing competitiveness: Helping in the development of new technologies, products or services allows companies to become more competitive in the market.
- Access to expertise: Entrepreneurs can use the services of experts and research institutes without the need for large investments in their own resources.
- Stimulating innovation: The program enables companies to implement faster innovation and business improvement through the use of the latest technologies and business practices.

However, not every indicator is equally optimistic. For instance, annual data on the use of available IPARD funds in Serbia reveals a somewhat underwhelming picture regarding the farmers' capacities to obtain and effectively employ available funds. In the most recent year with published data (2021), only slightly above one third (35%) of available funds from IPARD were used by agricultural producers (Miletić and Simić, 2024). This finding suggests the existence of substantial barriers which hamper the agricultural community's ability to access and benefit from these (quite significant) funds. It may also signal the fact that a substantial population of agricultural subjects are effectively out of reach of the innovation policy and thus find themselves out of the domain covered by the activities of the Innovation Fund. Moreover, these subjects are usually the ones with fewest own capacity to generate innovation, while conversely (due to their low level of technological advancement) possessing the biggest marginal benefit of introducing (even very modest) innovative solutions and practices into their business. Having in mind the fact that Innovation Fund's mandate is not only to provide direct financial support (even though providing funds makes up the bulk of its activities) to innovators, but to encourage and actively engage in making productive connections and cooperation between innovators and academia, this 'soft skill' part of the IF's activity may be particularly useful in the endeavor to approach those businesses that are currently inactive regarding innovation and whose innovation potential is dormant due to different constraints (financial and otherwise). Agricultural producers could benefit significantly from establishing connections with the scientific sector in the process of boosting their innovation capacity and improving competitive advantages on the market, while transforming their business on sustainable grounds.

6. CONCLUSION

In conclusion, public expenditure on innovation in agriculture in Serbia plays a crucial role in enhancing the sector's competitiveness and sustainability. The agricultural landscape in Serbia is characterized by a predominance of small and family farms, which are vital for food security, employment, and ecological preservation. However, these farms often face significant challenges, including low investment levels and a lack of access to modern technologies, which hinder their

ability to innovate and adapt to changing market demands. Government support through public expenditure is essential for fostering innovation, as it can facilitate the adoption of advanced agricultural practices and technologies. This support is particularly relevant in the context of Serbia's integration into the European Union, where alignment with EU agricultural policies is necessary for accessing funding and resources. The implementation of programs such as the Instrument for Pre-accession Assistance for Rural Development (IPARD II) highlights the importance of targeted financial assistance in addressing the unique needs of Serbian agriculture.

Moreover, the promotion of research and development initiatives, as well as the encouragement of open innovation practices among agricultural enterprises, can significantly enhance productivity and sustainability. By investing in innovation, Serbia can not only improve its agricultural output but also contribute to broader economic development goals, including rural revitalization and environmental sustainability. Therefore, a strategic approach to public expenditure that prioritizes innovation in agriculture is essential for the long-term viability and growth of this critical sector in Serbia. In that regard, innovation policy measures can play a substantial role in terms of facilitating technological advancement and transformation of Serbian agriculture on sustainable grounds. Innovation policy in Serbia, as outlined by the Smart Specialization Strategy 2020 defines the area of modern agriculture and food industry as one of its strategic priorities. By analyzing the Innovation Fund's approved projects and their distribution along sectoral lines, we show that agriculture and food production indeed takes a prominent position among the funded projects, which is in line with the strategic orientation established in the S4 and further underlines this sector's innovation potential and capacities. On the other hand, there are significant weaknesses which may pose threats to future development, unless addressed properly by the policymakers. The suboptimal use of available IPARD funds suggests that there are numerous barriers that inhibit the capacity of agricultural businesses to effectively use available resources, which is the one key area of concern that public policy needs to tackle in order to alleviate identifies shortcomings.

To summarize, while public expenditure on agriculture in Serbia has increased over the past 15 years, challenges related to funding adequacy, subsidy structure, and the need for alignment with EU policies persist. Future research should focus on evaluating the effectiveness of these expenditures in promoting sustainable agricultural practices and rural development. Additionally, exploring innovative financing mechanisms and enhancing support for smallholder farmers will be essential for maximizing the impact of public spending in the agricultural sector.

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