INNOVATION IN AGRICULTURE AND SUSTAINABLE DEVELOPMENT

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Abstract: *The rapid development of individual countries often has unprecedented environmental consequences. This is why more and more innovations are being used to ensure, in addition to economic development, the preservation of environmental quality. In addition to transport and industry, agriculture is an important environmental factor. There are many studies in the literature dealing with the relationship between agricultural development and sustainable development, as well as the study of the economic and social role of innovation in this field. The paper aims to examine the relationships between innovation in agriculture and sustainable development, based on extensive scientific literature. The results of the research show that agriculture, such as organic agriculture, is one of the interesting solutions for maintaining the principles of sustainable development. Such an innovation, concerning the mode of production in agriculture, can have many positive benefits for sustainable development from both an economic and environmental point of view.*

Keywords: *Sustainable development, Innovation, Agriculture, Environmental protection.*

1. INTRODUCTION

Innovation is one of the hallmarks of the modern lifestyle. „Inventing or adapting environmentally desirable processes or products is already part of everyday life for a large majority of firms and, thus, a field of scientific research" (Rennings, 2000, p. 320). It occurs as a direct result of the development of society and conditioned by advances in techniques and technologies. As a result of their implementation, there is an increase in production efficiency and total gross domestic product of the country, as well as a decrease in environmental pollution.

At the level of the national economy, innovation significantly changes the structure of the economy, and therefore plays a decisive role in economic development. On the other hand, at the level of business entities, the benefits are mainly reflected by increasing their competitiveness in the market. In addition, there are other non-economic effects. They are reflected in changing social relationships, production methods, and improving the quality of life of people. The environmental effects of innovation are often emphasized because innovation is precisely linked to the protection and prevention of excessive environmental pollution. Thus, there are economic, environmental and social benefits from the application of innovation in society.

The subject of the research is to define and determine the goals of the concept of sustainable development within the agricultural activity. The work consists of two parts. The first part describes the importance of innovation in agriculture for sustainable development. This section

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defines innovation, the concept of sustainable development, and identifies their interlinkage. The second part looks at possible innovations in agriculture, the basic conditions and ways to implement the sustainable development goals, with particular emphasis on organic or ecological agriculture.

2. THE IMPORTANCE OF INNOVATION IN AGRICULTURE FOR SUSTAINABLE DEVELOPMENT

„Innovation is a relative dimension because it arises in a social relationship and is determined by comparing the measurable behaviour of two or more individuals, groups, communities, contrasting ‚more innovative' with ‚less innovative' and ‚non-innovative' „ (First-Dilić, 1974, p. 12). Innovations at the micro level enhance the efficiency of the production process, while at the macroeconomic level they have to meet two basic socio-economic goals related to improving the standard of living and tackling environmental pollution, as shown in Figure 1. Therefore, there is a fully justified opinion on the importance of investment in research and development activities.

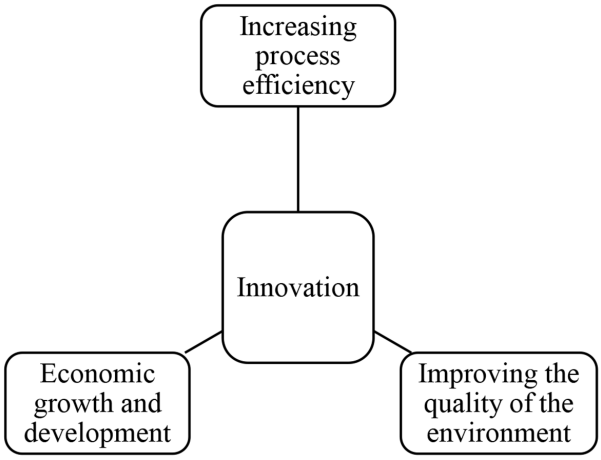

Figure 1. Basic goals of innovation
Source: Authors' presentation.

Rennings (2000) states that there are three determinants of innovation. The first are conditioned by technological pressures related to the requirements for increasing energy efficiency and product quality. The second are the result of: market demands that include increased competition, labour costs and changing consumer needs. Finally, the third group of determinants relate to the normative requirements that are associated with existing legal solutions, as well as the expected regulations in the field of ecology and sustainable development.

Agriculture is an economic activity that is significantly sensitive to climate change. Climate change is precisely the result of the application of the current concept of linear economy. „Endangering the environment contributes to further jeopardizing of agricultural production through the impact of the climate change" (Njegomir et al., 2017, p. 1040). On the other hand, it is an important activity where water is used and land degraded (Prokić, 2019). Innovations that promote recycling, reduce waste and the use of materials must be in focus within the conservation principles of the circular economy and sustainable development (Cainelli et al., 2020).

„Until a few decades ago, the concept of a circular economy was not applicable due to the fact that technology could not support his ideas" (Radivojević, 2018, p. 38). Therefore, there is a jus-

tifiable view that innovation is one of the major drivers of the circular economy (closely linked to key elements of sustainable development). In fact, there are two primary goals of innovation related to circular economy and sustainable development: introducing regenerative circular systems and reducing the dependence of economic growth on increased use of non-renewable materials and environmental degradation (Brown et al., 2019).

Innovation in agriculture is of paramount importance, especially in economies that have a higher relative share of agriculture in the production of gross domestic product. Namely, agriculture is the source of many environmental problems. Particularly, its negative effects are manifested in less developed countries due to the presence of dirty technologies, uncontrolled or inadequate agro-technical (chemical) measures, as well as energy sources that are bad for air quality and the entire ecosystem and which, after all, lead to global warming. Thus, although it provides food security and dominantly affects the health of the population (which is one of the factors of economic development), agriculture can also cause a deterioration in the quality of life, which is reflected through pollution of land, air and water.

Znaor (1996) points out that sustainable agriculture is characterized by several elements:

- Ability to maintain yields without increasing inputs,
- Relying on renewable resources and energy sources without endangering natural resources,
- High productivity and stability of production value,
- Cost-effectiveness,
- Using of eco-technology,
- Production of high quality and diversified products.

Agricultural innovation, linked to the objectives of the sustainable development concept, can be mechanical and chemical. Thus, within sustainable agriculture, there are mechanical innovations related to the use of new forms of energy in food production (Đekić, 2010), such as biofuels (biogas and biodiesel) and biomass (where bio-waste is used for fuel production), wind energy and solar energy. These energy products significantly reduce the use of conventional non-renewable energy sources. The use of microbial fertilizers is most often emphasized through the so-called chemical innovations in agriculture.

On the road to the EU, it is necessary to strengthen the infrastructure in agriculture of developing countries. For this purpose, significant funds have been provided for the implementation of technologies and practices that are based on the principles of a healthy environment, which will lead to a greening of agriculture and the implementation of the concept of a circular economy. Therefore, it is necessary to define a clear procedure, but also to control the use of resources in agricultural production. It is undoubtedly an economic activity that is an essential pillar of sustainable development, with significant comparative advantages especially in developing countries (Despotović et al., 2019).

3. OPPORTUNITIES FOR APPLICATION OF INNOVATION IN AGRICULTURE

An increased need for innovation, except at the level of the national economy, exists in the agricultural sector. Although there are many problems, most notably the slowness and limitations in the diffusion of new knowledge into agriculture as a traditional sector, since the post-war period there has been an intense application of technology and knowledge (science) to the agri-food sector (Morgan, & Murdoch, 2000).

Innovations in agriculture are determined by the advancement of society, both through the development of science and technology, and with changes in lifestyles. The speed of their adoption is determined by the nature of the farmers themselves, their economic status as well as their age. Thus, some farmers will immediately apply some innovative solutions, while others will wait and decide depending on the experiences of their friends, relatives or neighbours. Other factors include education, risk-taking and the realization of the socioeconomic benefits of applying innovation. The size of farms also plays an important role in deciding on the application of innovation in agriculture. Innovation is mainly done by younger farmers, with a higher level of education but less experience in business, and who come from urban areas and thus contain significantly higher social capital. Therefore, a link must be created between existing manufacturers, and through the exchange of experience or association the aim is to try to overcome their own shortcomings. „The above challenges present a major opportunity for the development of a circular economy using innovative technologies and profitable business practices to address the utilization of agricultural wastes, by-products and co-products" (Toop et al., 2017, p. 77).

Although the environment is a gift of nature, it is rapidly destroyed, leaving with far-reaching consequences (Njegomir et al., 2017). Innovation is often seen as an essential new component of the sustainable development concept. They are closely related not only to the economic, but to all the traditional components of sustainable development (Marković, 2018a). Therefore, in this sense, the development of science and research and development plays an important role. Technological advances in agriculture are closely linked to the breakthrough of innovation in this industry (Diederen et al., 2003). It also supports the goals of the country's sustainable economic development. In addition, „most agricultural innovations are functionally interconnected, so adopting one allows for adopting other innovations" (First-Dilić, 1974, p. 11). This provides a significant breakthrough in innovation, at once or most often, in mutually dependent phases.

The penetration of information and communication technology and new software solutions in the economy is increasing. Certain technical solutions and innovations also find their application in the field of agriculture. Innovation is changing the way businesses operate, where it seeks to increase competitiveness. They need to use innovation as a means of enhancing the quality of products that comply with the principles of environmental conservation. That is why eco-innovations are of the utmost importance. In this respect, eco-design, which „has made it possible to update the circular business model by including strategies for creating and capturing value through the marketing of products that are more environmentally friendly", is particularly prominent (Garcia-Muiña et al., 2019, p. 2). Therefore, there is a need for innovation, which in many respects is a key element of the concept of circular economy and sustainable socioeconomic development.

„Organic agriculture is one of the constituent elements of the idea of sustainability" (Puđak, & Bokan, 2011, p. 138). Besides, „ecological (organic) agriculture is a social innovation" (Tomaš-Simin, & Janković, 2014, p. 522). This production is based on the use of renewable energy sources, the reduced use of non-renewable energy sources, and the reduced use of chemicals. In this way, innovation ensures the modernization of agriculture. Organic farming in particular requires a high degree of innovation. That is why financial incentives of the state are important for the implementation of organic agriculture, so that the entire burden of protecting ecosystems does not fall on farmers (Tomaš-Simin, & Janković, 2014). This support for agrarian policy can come in a wide range of subsidies to farmers. Thus, agriculture, as the creator of inputs for various forms of manufacturing industry, will make its contribution, while increased production will not mean greater environmental pollution and violation of the principles underlying the concept of sustainable development.

4. FUTURE RESEARCH DIRECTIONS

As the paper is a synthesis of the research to date in this area, future studies should be based on both extending the theoretical scope of the link between innovation in agriculture and sustainable development, and the possibility of applying concrete solutions. In addition, research should also be based on evaluating the efficiency and effectiveness of incentives for organic farming using specific mathematical and quantitative methods based on relevant databases.

5. CONCLUSION

Manufacturing innovation, linked to structural changes in the economy, must ensure both sustainable economic development and sustainable social development. This does not pollute the environment and, in turn, enables the sustainable development of agriculture to be achieved. In addition, it enables new employment in the recycling industry, the opening of new plants and the establishment of businesses, as well as an additional increase in the overall national production and energy savings.

The breakthrough of modern technological solutions in agriculture are significant in order to eradicate world hunger, ensure food security and increase yields. However, along with the increase in production efficiency, environmental problems have arisen, which has led to the emergence of organic farming and innovation that is contributing to the reduction of environmental pollution. Organic agriculture is one of the basic manifestations of sustainable agriculture (Marković, 2018).

The need to reduce production costs, production time or higher yields also exists in agriculture. That is why, in modern conditions, through certain funds or projects, this sector is increasingly supported, especially by individuals who, when starting a business, decide to innovate.

However, in this industry there is great resistance to change, because it includes mainly traditional and older farmers, so this economic activity lags far behind in applying innovation to other sectors of the economy. The role of highly educated people, even though they do not have agricultural experience, is invaluable, as they have more knowledge that can be applied, as well as a wide network of social contacts.

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