

ECONOMIC ASPECTS OF SUSTAINABLE AGRICULTURE AND ENVIRONMENTAL PROTECTION

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Abstract

This paper explores the economic aspects of sustainable agriculture and its impact on environmental protection. It analyzes the economic benefits and costs of sustainable agricultural practices, including agroecological methods, organic farming, and smart agricultural technologies. Additionally, it discusses the policies and subsidies that support sustainable agriculture, as well as the challenges and opportunities for the future. Sustainable agriculture can provide economic benefits, reduce environmental impact, and improve the social sustainability of rural communities. Sustainable agriculture represents a key strategy for achieving ecological, economic, and social sustainability. In recent decades, conventional agricultural practices have led to soil degradation, reduced biodiversity, and water pollution, creating a need for more sustainable approaches. Reducing the negative impact on the environment, increasing efficiency, and conserving natural resources, aimed at environmental preservation, are encompassed by sustainable agriculture. Agriculture is essential for the survival and well-being of the human population, but it faces serious challenges that threaten its sustainability. The implementation of sustainable agricultural practices, such as organic farming, precision agriculture, and agroecology, can significantly contribute to resource conservation and increased productivity. Future efforts should focus on education, research, and policy that support these practices in order to ensure food security and environmental preservation.

Keywords: sustainable agriculture; economic aspects; environmental protection; agroecology; economic development.



EKONOMSKI ASPEKTI ODRŽIVE POLJOPRIVREDE I ZAŠTITE ŽIVOTNE SREDINE

Apstrakt

U ovom radu se istražuju ekonomski aspekti održive poljoprivrede i njen uticaj na zaštitu životne sredine. Analiziraju se ekonomske koristi i troškovi održivih poljoprivrednih praksi, uključujući agroekološke metode, organske farme i pametne poljoprivredne tehnologije. Pored toga, diskutuje se o politikama i subvencijama koje podržavaju održivu poljoprivredu, kao i o izazovima i mogućnostima za budućnost. Održiva poljoprivreda može pružiti ekonomske koristi, smanjiti uticaj na životnu sredinu i unaprijediti socijalnu održivost ruralnih zajednica. Održiva poljoprivreda predstavlja ključnu strategiju za postizanje ekološke, ekonomske i socijalne održivosti. U posljednjih nekoliko decenija, konvencionalne poljoprivredne prakse dovele su do degradacije zemljišta, smanjenja biodiverziteta i zagađenja vode, što je stvorilo potrebu za održivijim pristupima. Smanjenje negativnog uticaja na životnu sredinu, povećanje efikasnosti i očuvanje prirodnih resursa koje imaju za cilj očuvanje životne sredine obuhvata održiva poljoprivreda. Poljoprivreda je od suštinske važnosti za opstanak i blagostanje ljudske populacije, ali se suočava sa ozbiljnim izazovima koji ugrožavaju njenu održivost. Implementacija održivih poljoprivrednih praksi, kao što su organska poljoprivreda, precizna poljoprivreda i agroekologija, može značajno doprinijeti očuvanju resursa i povećanju produktivnosti. Budući napori treba da se fokusiraju na edukaciju, istraživanje i politiku koja podržava ove prakse, kako bi se osigurala sigurnost hrane i očuvanje životne sredine.

Ključne riječi: održiva poljoprivreda, ekonomski aspekti, zaštita životne sredine, agroekologija, ekonomski razvoj.

INTRODUCTION

Household economic resilience is increasingly In the first half of the twentieth century, humans introduced the use of pesticides, mineral fertilizers, and high-yielding plant genotypes in agriculture, and began using heavy machinery for land cultivation. The number of hungry people decreased, but humanity faced a serious environmental crisis. Agriculture, as a fundamental human activity, has a significant impact on the environment. This paper identifies the main challenges and offers possible solutions for sustainable agricultural practices.

Sustainable agriculture represents an approach aimed at balancing the need to increase agricultural production with the preservation of natural resources and environmental protection. It involves practices that reduce negative impacts on ecosystems, improve soil fertility, and increase resource use efficiency. The economics of sustainable agriculture and environmental protection focus on long-term economic benefits and challenges related to the implementation of sustainable practices.

Agriculture is an ecologically sensitive part of the economy, and environmental protection issues gradually gained importance, first during the 1930s crisis, when soil erosion became a major problem, and later, in the 1960s, when the excessive use of pesticides and air pollution were highlighted. Environmental protection within the EU's Common Agricultural Policy (CAP) has gained increasing significance in the last two decades, as CAP has shifted from a sector-oriented policy to one with a regional approach to integrated rural development. The latest CAP reform in 2013 places even greater emphasis on environmental protection through "green" direct

payments, which account for 30% of national funds and are intended for producers who implement practices aimed at climate change and environmental protection. Regarding rural development policy in the 2014-2020 period, the budget framework has allocated funding at a similar level, with a portion of the funds directed toward the protection of agro-environments and supporting the development of organic farming. Environmental protection policy in Serbian agriculture has not received adequate attention, and the fact that Serbia has committed to EU integration means that pre-accession negotiations necessitate greater focus on agro-environmental protection. The legacy of the pre-transition period and inadequate agro-environmental protection policies during the transition period have resulted in Serbia lacking adequate agro-ecological measures. Therefore, Serbia needs to make the best use of the funds available from the IPARD program, as their proper utilization can have a positive impact on the agro-environment.

AGRICULTURE AND THE ENVIRONMENT

Agriculture is a fundamental activity that provides food for the growing global population, but it also has a significant impact on the environment. From land and water use to greenhouse gas emissions, agriculture can substantially contribute to ecosystem degradation. Unsustainable practices often lead to biodiversity loss, pollution, and climate change, even though the goal of agriculture is food production and maintaining economic development.

Although the global population growth rate has been declining since the 1970s, the overall increase in the number of people still means an annual growth of over 60 million people, and it is projected that by 2025, the population will rise to around 8 billion people (Brown, 2004). The implications of this projected population increase will be seen in the growing demand for food, and with further economic development, there will also be a permanent rise in food demand per capita.

The rapid growth in food production occurred as a result of the technical and technological progress in agriculture following the "Green Revolution." However, the "Green Revolution" did not come without certain negative ecological effects, primarily related to the depletion of basic natural resources, such as land and water.

In fact, high yields in plants are easily achieved by using mineral fertilizers and herbicides, which inevitably leads to soil pollution and increased plant susceptibility, while also requiring additional amounts of chemical inputs. Richard Merrill presented this accompanying phenomenon of the "Green Revolution" through the concept of a constantly rotating wheel, illustrating the dependence of agriculture on chemical inputs (Image 1) (Merrill, 1976).

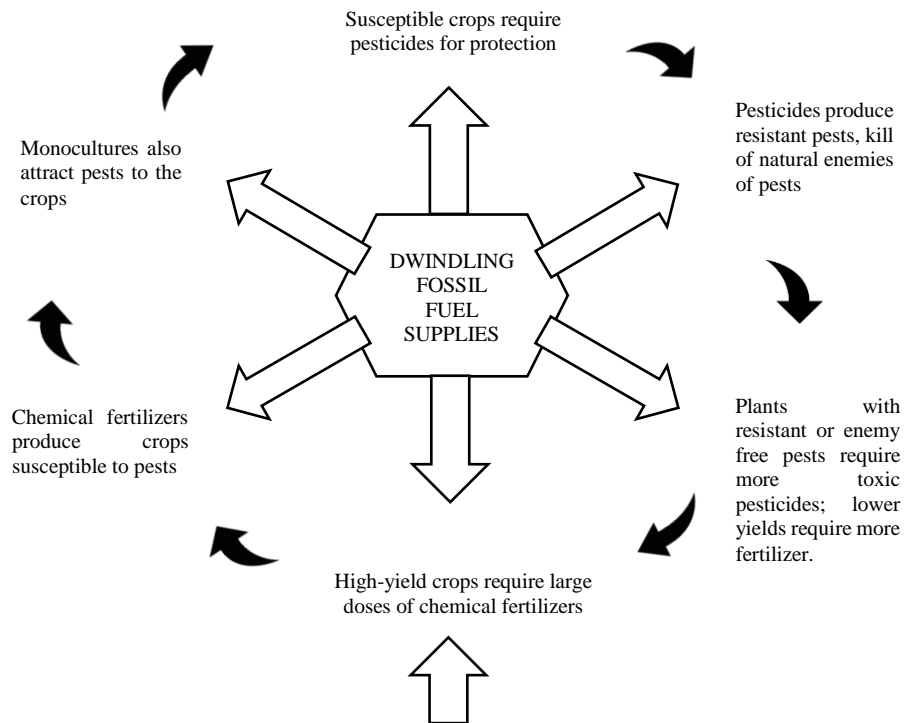


Image 1.

The treadmill of chemical dependence, fostered by the high-energy technologies of modern agriculture and nurtured by a series of ecological backlashes

Due to the increasing production orientation toward monoculture in certain areas, enabled by the use of large quantities of chemical agents, soil quality is declining. This, in turn, causes crops to become more susceptible to pest attacks and plant diseases. This, again, requires the use of even greater quantities of pesticides and fungicides to maintain a certain level of production... And so, the cycle continues. (Adapted from the article "Toward a Self-sustaining Agriculture," printed in Richard Merrill, "Radical Agriculture", pp. 303.).

PROBLEM OF SOIL EROSION AND DEGRADATION

Soil degradation is a significant issue in Serbia, especially in regions with intensive agricultural production. Erosion, soil fertility reduction, and soil compaction are the most common problems (Bogdanović et al., 2015). Intensive agricultural practices, including desertification, erosion, and reduced fertility, can lead to soil degradation. The excessive use of chemical fertilizers and monocultures can deplete the soil and reduce its ability to support plant growth. Soil erosion caused by unsustainable farming practices can also contribute to water ecosystem pollution and decrease

agricultural productivity. According to a United Nations report, around 24 billion tons of fertile soil are lost each year due to erosion.



Image 2.
Soil Erosion

Soil erosion is the process of removing the topsoil due to the action of water, wind, or human activities. Unsustainable agricultural practices such as intensive tillage, inadequate soil protection from erosion, and improper use of chemicals can lead to soil degradation (Harris, 2020). This reduces soil fertility and its ability to support long-term agricultural production.

Soil erosion results in the movement of soil by the action of water and wind and can cause various problems, such as increased agricultural production costs due to lower soil productivity and external costs related to sedimentation, as recent studies show that external costs (loss of recreational value, damage to lakes and water habitats, disruption of water transport systems, growing water treatment costs for the population and industry) are higher than costs on the farm itself (Harris, 2020).

When discussing measures that policymakers can implement to prevent erosion, these typically involve education and technical assistance, primarily from agricultural advisory services. Some proposed solutions include establishing perennial vegetation, building windbreaks, and using land cultivation methods that do not cause serious erosion problems. In some countries, there have been cases where land prone to erosion is withdrawn from production.

PROBLEMS WITH PESTICIDE USE

Pesticides are widely used in agriculture to control pests and plant diseases. However, their excessive use can have negative consequences on the environment. Pesticides can contaminate water sources, soil, and negatively affect non-target organisms, including beneficial insects, birds, and aquatic life. Long-term exposure to pesticides can lead to biomagnification and bioaccumulation in the food chain, posing a risk to

human health. Pesticides have been shown to decrease bee populations, which directly affects plant pollination.



Image 3.
Use of pesticides

The use of pesticides is a widespread practice in modern agriculture, aiming to protect crops from pests, diseases, and weeds. While pesticides play a crucial role in increasing yields and reducing losses, their use carries significant risks to the environment and human health (Smith & Jones, 2020). This paper analyzes the key issues related to pesticide use, including ecological consequences, impacts on human health, and alternative methods that could reduce dependence on chemicals.

While pesticides (herbicides, insecticides, and fungicides) have contributed to the rapid growth of food production, they also have numerous negative effects on the environment and human health, as they are present in food, water, and air. Research shows that pesticides can cause cancer, central nervous system disorders, and, importantly, long-term negative health effects. National policies should regulate the registration of pesticides and their expiration dates, as well as determine the maximum acceptable level of pesticide residues. Based on pesticide toxicity, tolerance levels, and proper pesticide waiting periods should be defined. Newer approaches to this issue suggest conditioning government support to farmers who reduce pesticide use or imposing taxes on pesticide use to make it less economically viable in the short term.

The challenges associated with pesticide use represent a significant issue for modern agriculture, with far-reaching consequences for the environment and human health. Effectively reducing pesticide use requires a multidisciplinary approach, including education, regulation, and the development of sustainable practices such as Integrated Pest Management (IPM) and organic farming. Future efforts should focus on promoting alternatives that can reduce the harmful effects of pesticides while maintaining agricultural efficiency.

SUSTAINABLE AGRICULTURE

Sustainable agriculture is defined as a system of managing agriculture that is environmentally friendly, economically viable, and socially just. Key principles include the conservation of biodiversity, improvement of soil and water quality, reduction of chemical use, and increased resource efficiency. Agricultural practices have a significant impact on ecosystems and biodiversity. Conventional agricultural methods often lead to soil degradation, water pollution, and biodiversity loss. Sustainable agriculture, on the other hand, utilizes practices such as crop rotation, agroforestry, organic farming methods, and conservation agriculture, which help conserve natural resources.



Image 4
Organic Farming

Sustainable agriculture represents a crucial strategy for ensuring long-term food security, preserving natural resources, and reducing negative environmental impacts. While there are challenges in implementing sustainable practices, their benefits make them indispensable for the future of global agriculture. Support through education, research, and policy can significantly contribute to the spread of sustainable agricultural systems and achieving sustainable development goals. Sustainable agriculture emphasizes the conservation of natural resources, minimizing environmental impacts, and promoting social and economic sustainability. This approach is becoming increasingly important in the context of a growing global population, climate change, and limited resources. Sustainable agriculture is based on principles that include ecosystem protection, biodiversity conservation, and increased resource-use efficiency (Pretty et al., 2018).

Considering the growing problems caused by the negative impacts of agriculture on the environment, analyst Lester Brown (2004) argues that ecological limits have

already been reached and that this will prevent further rapid expansion of agricultural production. While his predictions that the first decades of the 21st century would resemble the previous four decades have not materialized, it is possible that they have only been postponed, and we may expect them in the coming decades.

Due to the negative effects of agriculture on the environment, there is an increasing need to incorporate environmental protection programs into agricultural and rural development policies. Numerous organized attempts to address this problem include (European Commission, 2023): the Declaration on Environment and Development (Rio Declaration), Agenda 21 (Program for the 21st Century), the Convention on Climate Change, the Convention on Biological Diversity, and Principles for the Management, Protection, and Sustainable Development of All Types of Forests.

Sustainable agriculture involves combining elements of traditional and modern techniques, with an emphasis on maximizing the use of renewable resources. Additionally, it focuses on crop rotation, intercropping of different types of crops on the same land, efficient irrigation, minimal tillage techniques, and integrated pest management. The open question remains whether this form of agriculture can yield comparable or even equal results to those obtained with intensive inputs, but it is certain that the environmental impact of these new techniques is less harmful.

EU AGRO-ECOLOGICAL POLICY

As the Common Agricultural Policy (CAP) of the European Union represents a complex policy for managing agriculture and rural development in the EU, it is the first and rare policy through which member states have transferred their sovereignty to joint bodies. The CAP has a history of nearly sixty years, characterized in its first three decades by price supports and stability, and since the late 1990s, it has undergone numerous changes in defining its original objectives, along with permanent adjustments in agricultural and rural development policies. Interest in agro-ecological policy within the CAP began growing in the early 1980s when various negative aspects of agricultural production started to become apparent.

Initially, the CAP, defined by the 1957 Treaty of Rome, did not focus much on agro-ecological policies. However, concrete steps to raise ecological awareness among farmers began in 1985 with the adoption of the document "The Future of the Common Agricultural Policy" (Perspectives for the Common Agricultural Policy), which led to the "Green Paper" reform. This reform aimed to reduce production in sectors with significant surpluses, provide more effective support for small and medium-sized farmers, while protecting the agro-environment and promoting sustainable rural development. The focus shifted to controlling agricultural processes harmful to the environment and compensating farmers for using environmentally friendly production methods.

About thirty years after the formulation of the CAP, the largest and most comprehensive reform, known as the MacSharry reform of 1992, was implemented. One of the causes of this reform was the negative environmental impact caused by the link between agricultural support and production volume (Lovre, 2013). This reform introduced a new dimension to agriculture, positioning it as a promoter of rural development and an environmental steward. Significant funds for rural development

were allocated, and measures for structural adjustment, such as early retirement and afforestation of agricultural land, were introduced.

The 1999 CAP reform, known as Agenda 2000, gave much more emphasis to agro-ecological measures under the rural development policy. Agenda 2000 introduced a new legislative framework for CAP, which incorporated a second pillar – rural development policy. This reform increased funds for environmental protection and introduced cross-compliance, requiring farmers to protect the environment as a condition for receiving subsidies. This reform also emphasized animal welfare, consumer interests regarding food quality and safety, and the multifunctionality of agriculture, which now played roles beyond food production, such as rural development, public health, and environmental protection.

The 2003 CAP reform strengthened environmental protection standards, food quality and safety, and animal welfare. Emphasis was placed on maintaining land in good agricultural and environmental condition, with penalties and reductions in support for farmers who failed to meet these requirements. This concept of cross-compliance was further enhanced in the rural development measures and additional funds available through modulation.

The environmental protection policy for agriculture, based on the type of compensation and activities it covers, can be classified into three groups. However, the question arises about the boundary between measures that require compensation and those considered good agricultural practices:

Good agricultural practice – legal regulations in the field of environmental protection that agricultural producers must comply with, and for which no compensation is provided;

Other mandatory activities – activities regulated by legal provisions, which go beyond good agricultural practices, and for which compensation is provided based on opportunity costs;

Agro-environmental programs – implemented on a voluntary basis, with compensation exceeding opportunity costs.

With the definition of the EU's rural policy for the period starting in 2007, environmental protection became part of the second pillar, covering measures for sustainable resource management. These measures include various direct payments that cover additional costs or lost income from production, as well as better management of natural resources, the environment, and higher animal welfare, or for farming in Less Favored Areas (LFA). Member states define their priorities within this pillar, in line with EU guidelines, while taking into account national priorities and specifics during the programming of national rural development strategies. Activities funded under this pillar should clearly target priorities such as combating climate change, improving biodiversity and water quality, and reducing the risks from natural disasters.

For the 2007-2013 rural development program, agro-environmental measures of EU member states were linked with EU policies in areas such as the environment, biodiversity of agricultural land and landscapes, water, and climate change. The budget allocated for agro-environmental measures during this period was significantly increased to around 20 billion euros, which represents 22% of rural development funds (European Commission, 2023).

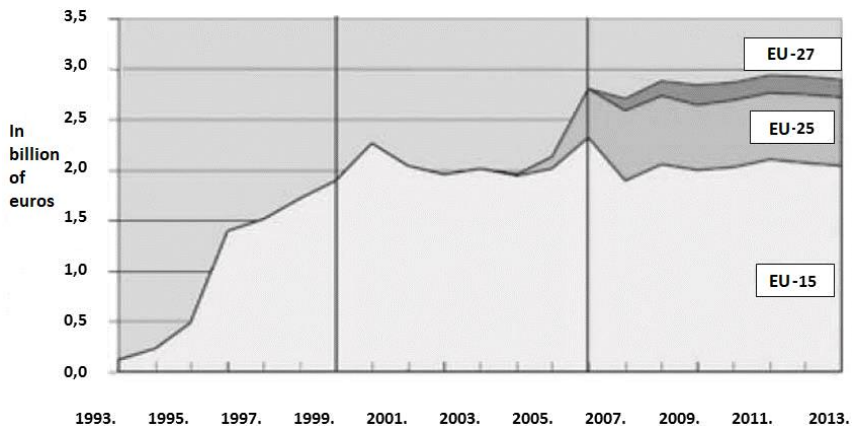


Image 5.

Payments for agro-environmental measures in the EU from 1993 to 2013.

Changes in the CAP mechanisms after 2013 were largely a result of the economic crisis, with environmental protection and natural resource issues, as well as disparities between European rural regions, becoming more prominent. The ecological challenges facing the new CAP reform primarily relate to resource efficiency, soil and water quality, and potential threats to habitats and biodiversity. The 2014-2020 CAP reform is based on the principle of "public money for public goods," meaning that agricultural producers contributing to environmental preservation are rewarded (Matthews, 2023). This reform also introduced a rebalancing of payments between the two CAP pillars, redirecting funds from the first pillar towards rural development. Between 2014-2020, CAP instruments will be combined to contribute to greater sustainability. One such instrument, cross-compliance, will be simplified but will insist on increased responsibility for farmers to manage their farms in a sustainable way in order to receive direct support. A new component introduced in 2015 is "greening," which adds to basic payments and rewards farmers who adopt environmentally friendly practices that do not lead to negative climate impacts. These payments can account for up to 30% of the funds for that year, and there are three "greening" schemes: maintaining permanent pastures, crop diversification, and maintaining areas of ecological importance. Crop diversification requires producers with more than 10 hectares of arable land to grow at least two crops, and those with more than 30 hectares must grow at least three crops. The main crop can occupy no more than 75% of their arable land, and two main crops can occupy up to 95%.

The Current CAP 2023-27 focuses on sustainability by strengthening environmental standards and offering farmers more voluntary eco-schemes and rural development

incentives to adopt greener practices. In order to ensure better sustainability, at least 35% of the rural development funds are directed towards agro-environmental measures to support climate, biodiversity, environment, and animal welfare, or projects related to investments in innovative measures that contribute to environmental preservation (Matthews, 2023).

CONCLUSION

Sustainable agriculture offers numerous economic benefits and can significantly contribute to environmental protection. However, success depends on the integration of technological innovations, supportive policies, and farmer education. Further research is needed to better understand the long-term economic impacts of various sustainable practices. Agriculture has a significant impact on the environment, but there are many ways to reduce this impact through sustainable practices and innovations. Organic and regenerative agriculture, precision farming, Integrated Pest Management (IPM), and agroforestry are key strategies that can help preserve natural resources and reduce pollution. Collaboration between governments, industry, farmers, and consumers is needed to encourage sustainable practices and ensure the future of agriculture that aligns with environmental conservation.

The negative consequences of agricultural modernization in the last century have imposed the need to focus attention on agro-environmental protection. The Common Agricultural Policy (CAP) of the European Union has seen a trend towards increased legal regulation related to environmental protection measures in agriculture. Support for the implementation of ecologically friendly methods in agricultural production was introduced with the MacSharry reform, and with Agenda 2000, environmental protection became a component of rural development. The CAP reforms of 2003 and 2008 placed even greater emphasis on agro-environmental protection and sustainable agriculture, and since 2013, direct payments have been directed towards "greening." The new reform also aims for crop diversification on farms, with at least 30% of rural development funds allocated to agro-environmental measures, organic production support, and innovative environmental protection measures.

Inadequate agro-environmental protection in Serbia is the result of insufficiently adequate policies in this area, as well as the regulations that have followed them. In recent years, funding for sustainable rural development aimed at environmental protection has been insufficient, with funds mainly allocated towards organic production development and the preservation of genetic resources. In the direction of EU harmonization, agro-environmental protection programs should be linked to income support for farmers. Access to IPARD funds and renewed economic growth were expected to lead to more significant funds being allocated to environmental protection in agriculture starting in 2017. However, due to various administrative barriers, this has not yet happened to a sufficient extent. Agro-environmental policy should be designed according to specific national, regional, and local needs, which requires strengthening the administrative capacity in the implementation and monitoring of environmental protection legislation.

The economic aspects of sustainable agriculture and environmental protection play a crucial role in the successful transition to sustainable agricultural production systems.

While sustainable agriculture offers numerous economic benefits, including cost reduction, increased resilience, and access to new markets, there are also significant challenges in implementation, such as high initial costs and market risks. Through a combination of financial support, education, ecological taxes and incentives, as well as support for market mechanisms, it is possible to improve the economic sustainability of agricultural systems and contribute to environmental protection.

ABBREVIATIONS

The following abbreviations are used in this manuscript:

CAP	Common Agricultural Policy
IPM	Integrated Pest Management
LFA	Less Favored Areas

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REZIME

Ovaj rad naglašava značaj održive poljoprivrede kao ključnog pristupa u savremenoj poljoprivrednoj praksi, sa potencijalom da uskladi ekonomski rast i očuvanje životne sredine. Analizirani su ekonomski aspekti održive poljoprivrede, uključujući troškove

i koristi primjene praksi kao što su organska proizvodnja, agroekologija i pametne poljoprivredne tehnologije. Rezultati pokazuju da, uprkos početnim izazovima, održiva poljoprivreda pruža dugoročne ekonomske i ekološke koristi, uključujući smanjenje zagađenja, očuvanje biodiverziteta i povećanje efikasnosti korišćenja resursa. Pregled politika Evropske unije i međunarodnih inicijativa pokazuje da postojeći okviri pružaju značajnu podršku razvoju održivih poljoprivrednih sistema. Politike koje uključuju subvencije za ekološki prihvatljive prakse, kao i mjere unakrsne usklađenosti koje povezuju poljoprivrednu podršku sa obavezama zaštite životne sredine, predstavljaju važne korake ka integraciji principa održivosti u poljoprivrednu proizvodnju. Međutim, Srbija se suočava sa značajnim izazovima u primjeni ovih praksi, zbog nedovoljno razvijenih agroekoloških mjera i slabije razvijenih politika zaštite životne sredine. Radi unapređenja održivosti poljoprivredne proizvodnje, preporučuje se bolje korišćenje IPARD fondova, jačanje edukacije poljoprivrednika i unapređenje primjene zakonskih okvira koji podstiču ekološki prihvatljive prakse. Zaključno, održiva poljoprivreda ne doprinosi samo očuvanju prirodnih resursa i smanjenju negativnih uticaja na životnu sredinu, već ima i potencijal da unaprijedi ekonomski razvoj i društvenu održivost ruralnih zajednica. Kontinuirana istraživanja, edukacija i prilagođavanje politika ključni su za širenje održivih praksi i obezbjeđivanje dugoročne prehrambene sigurnosti i zaštite životne sredine.