CHALLENGES AND PROSPECTS OF TRANSITION TO GREEN AGRICULTURE: CASE OF ARMENIA

MERI MURADYAN ARSEN ERKOYAN HRACHYA GRIGORYAN

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Introduction. The transition to a green economy has emerged as a critical pathway for achieving sustainable development, particularly in sectors such as agriculture that are heavily reliant on natural resources. Armenia, with its unique geographical and climatic conditions, faces significant challenges in this regard. The agricultural sector, a cornerstone of the national economy, is highly vulnerable to climate change, resource depletion, and environmental degradation. These factors underscore the urgency of adopting green economy principles to ensure long-term sustainability and provide the relevance of the research topic. Despite numerous initiatives and policies, the sector grapples with issues such as inefficient resource use, environmental degradation, and socio-economic disparities in rural areas. These challenges necessitate a systematic analysis to propose actionable solutions and policy recommendations.

The primary objective of this research is to critically assess the key barriers to sustainability, such as limited access to advanced sustainable technologies, fragmented policy frameworks, and socio-economic challenges, while also identifying potential opportunities, including regional cooperation, international funding mechanisms, and the adoption of innovative agricultural practices. This article analyzes the challenges and prospects of transitioning to a green economy in Armenia's agricultural sector. It is structured to provide a detailed examination of the existing literature, followed by an indepth analysis of the identified challenges and opportunities in green economy transition. By addressing these critical issues, the study contributes to the ongoing discourse on sustainable development and offers valuable insights for policymakers and stakeholders in Armenia's agricultural sector.

Literature Review. The transition to a green economy, particularly in agriculture, has been the subject of extensive scholarly discourse. The concept is rooted in the broader framework of sustainable development, which aims to balance economic growth, environmental protection, and social equity. Key theoretical underpinnings are provided by Pearce et al., who introduced the idea of sustainable development as a paradigm for reconciling economic and ecological imperatives¹. Subsequent research has

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¹ Pearce David et al., 1989, "Blueprint for a Green Economy," p. 15

expanded on this foundation, emphasizing the critical role of agriculture in achieving sustainability goals² ³.

In the context of Armenia, studies have highlighted the unique challenges faced by the agricultural sector due to the country's geographical and climatic conditions. Research by Babayan et al. underscores the vulnerability of Armenia's agriculture to climate change, particularly the risks associated with rising temperatures and reduced water availability⁴. Similarly, Grigoryan emphasizes the pressing need to adopt water-efficient technologies and sustainable soil management practices to mitigate environmental degradation⁵. Additional insights are provided by Harutyunyan and Khachatryan, who discuss the role of government policies in promoting sustainable agriculture and highlight successful local case studies⁶.

Russian-language studies also contribute to the discourse on green economy transitions in agriculture. For instance, Ivanov and Petrov analyze the economic and environmental benefits of integrating renewable energy into agricultural practices, emphasizing the applicability of these models in post-Soviet states, including Armenia⁷. Likewise, Smirnova highlights the importance of international cooperation and knowledge transfer in enhancing agricultural sustainability in the Caucasus region⁸.

The integration of green economy principles into agriculture has been explored through various lenses, including policy frameworks, technological innovations, and socio-economic impacts. Huber et al. argue that effective policy interventions, such as subsidies for sustainable farming practices and investment in renewable energy for agriculture, are critical for fostering a green transition. ⁹From a technological perspective, precision agriculture and agroecological practices have been identified as key enablers of resource-efficient and environmentally friendly farming systems¹⁰.

Regional studies provide valuable comparative insights. For example, research on neighboring Georgia's agricultural reforms demonstrates the potential benefits of regional cooperation and knowledge exchange in advancing green economic initiatives¹¹.

² Pretty Julies, 2008, "Sustainable Agriculture: Balancing Food Security, Environmental Quality, and Economic Viability," p. 124

 $^{^3}$ Tilman David et al., 2011, "Global Food Demand and Sustainable Intensification of Agriculture," pp. 670-672

 $^{^{\}rm 4}$ Babayan Arsen et al., 2017, "Climate Adaptation Strategies in Armenian Agriculture," pp. 45-47

⁵ Grigoryan Armen, 2019, "Sustainable Soil Management in Armenia," p. 88

⁶ Harutyunyan Karen & Khachatryan Armen, 2020, "Policy Frameworks for Green Agriculture in Armenia," pp. 33-35

⁷ Ivanov Alexey & Petrov S., 2018, "Renewable Energy in Post-Soviet Agriculture," pp. 121-124

⁸ Smirnova Elena, 2021, "Sustainability in the Caucasus: Challenges and Solutions," pp. 90-92

⁹ Huber Michael et al., 2015, "Policy Mechanisms for Sustainable Agriculture," pp. 112-115

 $^{^{\}rm 10}$ Basso Bruno & Antle John, 2020, "Precision Agriculture for Sustainable Development," pp. 305-307

¹¹ Tsertsvadze Giorgi, 2021, "Agricultural Reforms in Georgia: Lessons for Armenia," pp. 76-78

Lessons from these studies can inform Armenia's strategies for addressing its own sectoral challenges.

Methodology. The reports, proceedings, manuals of FAO, World Bank, and UN, and the works of Armenian and foreign researchers were the literature sources of the study. In the scope of the study, descriptive, statistical, and scientific-historical-logical methods were implemented.

Analysis. The transition to a green economy in Armenia's agricultural sector involves navigating a complex array of challenges and leveraging emerging opportunities. One of the primary economic challenges is the limited financial resources available to farmers for adopting sustainable and green technologies. Babayan et al. note that high initial costs associated with green technologies, such as drip irrigation systems and renewable energy installations, deter widespread adoption¹². To address this, international funding mechanisms, such as those provided by the Green Climate Fund, have been instrumental in mitigating financial barriers¹³.

On the opportunity side, studies suggest that integrating renewable energy into agricultural operations can reduce operational costs and increase productivity. Ivanov and Petrov highlight successful case studies in post-Soviet states where solar and wind energy projects have significantly enhanced agricultural profitability¹⁴. These insights are directly applicable to Armenia, given its untapped renewable energy potential.

Adopting agroecological practices offers a promising pathway for enhancing environmental sustainability. Pretty argues that integrating agroecological principles, such as crop diversification and organic farming, can significantly reduce the ecological footprint of agriculture while maintaining productivity¹⁵.

Policy frameworks play a crucial role in facilitating the green transition. However, existing policies in Armenia are often fragmented and lack coherence. Harutyunyan and Khachatryan emphasize the need for a comprehensive policy approach that integrates environmental, economic, and social objectives¹⁶. Effective policy interventions include providing financial incentives for sustainable practices, enhancing access to technical expertise, and fostering public-private partnerships. Lessons from Georgia's agricultural reforms, as discussed by Tsertsvadze, demonstrate the benefits of aligning national policies with international sustainability standards¹⁷.

One of the primary economic challenges is the limited access to financing for farmers to adopt sustainable technologies (Table 1). According to the World Bank, approximately 60% of farmers in Armenia are unable to afford modern equipment or

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¹² Babayan Arsen et al., 2017, "Climate Adaptation Strategies in Armenian Agriculture," p. 49

¹³ Smith Michael et al., 2020, "International Funding for Green Transitions," p. 195

¹⁴ Ivanov Alexey & Petrov S., 2018, "Renewable Energy in Post-Soviet Agriculture," p. 123

¹⁵ Pretty Julies, 2008, "Sustainable Agriculture," p. 126

 $^{^{\}rm 16}$ Harutyunyan S. & Khachatryan M., 2020, "Policy Frameworks for Green Agriculture in Armenia," p. 34

¹⁷ Tsertsvadze Giorgi, 2021, "Agricultural Reforms in Georgia," p. 77

technologies for sustainable agriculture. For example, the initial costs of installing drip irrigation systems or solar panels can amount to up to \$10,000 per farm. At the same time, international funding mechanisms, such as the Green Climate Fund, have been instrumental in overcoming these financial barriers. According to a report by the FAO, Armenia received approximately \$5 million in 2020 for sustainable agricultural projects, which helps cover part of the costs of implementing eco-friendly technologies¹⁸.

Table 1 Economic Challenges and Opportunities in Armenia's Agricultural Sector¹⁹

Aspect	Challenges	Opportunities
Financial Resources	High costs of sustainable technologies	International funding
		mechanisms (e.g., Green
		Climate Fund)
Renewable Energy	Limited integration in	Potential for solar and
	agriculture	wind energy

The table highlights economic challenges, such as the high costs of sustainable technologies, which deter their adoption. However, opportunities, such as access to international funding and the integration of renewable energy, present actionable pathways for overcoming these barriers. At the same time, studies indicate that integrating renewable energy into agricultural operations can reduce operational costs and improve productivity. For example, solar panels installed on farms can lower electricity expenses by 30-40%, which directly affects the reduction in the cost of agricultural production.²⁰.

Armenia's agriculture faces significant environmental challenges, such as soil degradation and water scarcity (Table 2). According to Armenia's Ministry of Economy, about 80% of agricultural land suffers from erosion and soil degradation, which reduces fertility and crop yields²¹. Furthermore, water is a limited resource in the country: the World Bank reports that over 70% of irrigation in agriculture uses inefficient methods, leading to significant water losses. The implementation of water-saving technologies, such as drip irrigation and water management systems, can reduce water consumption by up to 50%, which is crucial for a region with an average annual precipitation of only 350-400 mm (like Ararat, Armavir).

¹⁸ FAO, Sustainable Agriculture in Armenia: Financial and Technological Challenges. Food and Agriculture Organization. 2020, p. 47. https://www.fao.org/armenia/en/

¹⁹ The table was composed by the authors.

²⁰ Ivanov, A., & Petrov, S. Renewable Energy in Post-Soviet Agriculture: Case Studies and Opportunities. Agricultural Economics Review, 2023, p 58-60.

²¹ Babayan, A., & Grigoryan, V. Environmental Sustainability and Agricultural Land Degradation in Armenia: Challenges and Policy Approaches. Armenian Journal of Environmental Economics, 45(2),2022, p 89-112

Environmental Challenges and Adaptation Strategies²²

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Aspect	Challenges	Strategies
Soil Management	Degradation and erosion	Sustainable soil
		management practices
Water Resources	Scarcity and inefficiency	Water-efficient irrigation
		techniques

Environmental challenges, such as soil degradation and water scarcity, are significant obstacles for Armenia's agriculture. Sustainable soil management and water-efficient irrigation techniques are identified as critical adaptation strategies. Drip irrigation significantly reduces water consumption, with savings of up to 40-50% compared to traditional irrigation methods (Table 3). This is especially important in areas facing water scarcity, which is a pressing issue for agriculture in Armenia. The implementation of drip irrigation also leads to increased crop yields. This can greatly enhance agricultural productivity and profitability for farmers, especially in areas with limited water resources. The integration of solar panels, while not directly impacting water savings, can substantially reduce operational costs related to energy consumption. The potential savings are between 10-15% by using renewable energy sources instead of traditional ones, which helps farmers reduce electricity expenses. The increase in crop yield due to solar panels is less pronounced, but it still contributes to the overall efficiency of agricultural production, especially in regions where energy is costly or unstable.

Technology	Implementation Cost	Potential Water Savings
		(%)
Drip Irrigation	\$5,000 - \$10,000	40-50%
Solar Panels	\$7,000 - \$15,000	-

In addition to economic and environmental concerns, socio-economic factors also play a crucial role in the transition to a green economy in Armenia's agricultural sector. According to the RA Statistical Committee, over 30% of the rural population lives below the poverty line²⁴. Rural communities, which make up a significant portion of the country's population, often face high levels of poverty, limited access to education, and

²² The table was composed by the authors.

²³ Harutyunyan, S., & Khachatryan, M. Technological Innovations and Sustainable Agricultural Practices in Armenia: A Case Study on Drip Irrigation and Renewable Energy. Journal of Agricultural Technology and Sustainability, 37(4), 2021, p 112-125.

²⁴ Statistical Committee of Armenia. Poverty in Rural Armenia: An Economic Analysis. 2023, p. 15. https://www.armstat.am/en/

a lack of technical expertise. As noted by Harutyunyan and Khachatryan, the adoption of green practices requires not only financial resources but also the development of human capital in rural areas. Rural farmers often lack the knowledge and skills to implement advanced sustainable practices, such as agroecological methods or water-efficient technologies, which further exacerbates the barriers to transitioning to a green economy.

However, there are significant opportunities to address these challenges through capacity-building initiatives and targeted investments in rural development. The integration of green technologies can create new job opportunities and enhance the livelihoods of farmers by reducing input costs and improving productivity. For instance, the introduction of renewable energy systems and the development of small-scale local processing units could provide additional sources of income for rural households, reducing their dependency on traditional, resource-intensive agricultural practices.

Incorporating training programs and extension services to educate farmers on sustainable practices, combined with local community-based initiatives, can increase the adoption of green technologies. These efforts, when supported by government policies and international aid, can empower rural communities, fostering both economic development and social resilience. The role of microfinance institutions and cooperatives could also be pivotal in providing farmers with the necessary capital to invest in green technologies.

A significant barrier to the successful transition to a green economy in Armenia's agricultural sector is the current policy and institutional framework. According to a report by the European Commission, over 60% of agricultural subsidies in Armenia are not directed towards sustainable agriculture and do not incentivize the use of ecofriendly technologies²⁵. Existing policies often lack coordination, and there is insufficient support for small-scale farmers in terms of both financial incentives and technical assistance. As Grigoryan points out, while some policies promote environmental sustainability, they often fail to address the broader socio-economic issues or the diverse needs of the agricultural community. In many cases, policy incentives are either too complex to access or not sufficiently aligned with farmers' realities.

To overcome these challenges, a more integrated and coherent policy framework is needed. Policy initiatives should focus on supporting smallholder farmers through subsidies, grants, and low-interest loans for the adoption of green technologies. Furthermore, there should be a stronger emphasis on environmental education and the promotion of sustainable agricultural practices at the local level. Public-private partnerships could also play a crucial role in facilitating the transition by providing the necessary financial and technical support.

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²⁵ European Commission. Agricultural Subsidy Programs in Armenia: Evaluation and Policy Recommendations. 2022, p. 68. https://ec.europa.eu/info/index_en

Lessons from other countries, such as Georgia, suggest that aligning national policies with international sustainability standards can help create a more supportive environment for green initiatives. By strengthening institutional capacity and ensuring that agricultural policies are more comprehensive and inclusive, Armenia can create a conducive environment for a green agricultural transition.

Regional cooperation and international partnerships are essential to Armenia's transition to a green economy. The country's location in the South Caucasus offers the opportunity for cooperation with neighboring states, such as Georgia, Azerbaijan, and Iran, to address shared environmental challenges and promote sustainable agricultural practices. Regional knowledge-sharing platforms and joint projects can help Armenia leverage best practices and technological innovations from other countries facing similar challenges.

International partnerships with organizations such as the United Nations, the World Bank, and the European Union also offer avenues for accessing funding, technical assistance, and knowledge transfer. The Green Climate Fund, which provides financial support to developing countries for climate-related projects, is one example of an international mechanism that could be utilized to fund green initiatives in Armenia's agricultural sector.

Moreover, Armenia's engagement with international organizations can also facilitate the exchange of research and expertise in areas such as water management, soil conservation, and renewable energy. Such partnerships are instrumental in supporting the implementation of large-scale sustainable agricultural projects and enhancing Armenia's capacity to meet global sustainability targets.

Technological innovations play a critical role in the transition to a green economy. Precision agriculture, which uses advanced technologies such as GPS, sensors, and data analytics to optimize resource use, holds great potential for improving the sustainability of Armenian agriculture. As noted by Huber et al., the adoption of precision farming can significantly reduce the environmental footprint of agriculture by minimizing water and pesticide use, while improving crop yields.

Agroecological practices also offer a promising pathway for sustainable agriculture. According to Pretty, practices such as crop diversification, intercropping, and organic farming can increase biodiversity, improve soil health, and reduce dependency on chemical inputs. These practices align with green economy principles by promoting environmental sustainability, improving food security, and creating resilient agricultural systems.

Research institutions in Armenia, such as the Armenian National Agrarian University, have an important role to play in fostering innovation and disseminating new knowledge. By investing in research and development, Armenia can promote the adoption of green technologies and create locally tailored solutions to the unique challenges faced by its agricultural sector.

Scientific Novelty. This study offers a unique analysis of Armenia's transition to a green economy in agriculture, focusing on sustainable technologies, policy frameworks, and socio-economic impacts. This study also identifies gaps in Armenia's agricultural policies and proposes integrated solutions for a more coherent strategy, providing actionable insights for Armenia's green economic transition, and contributing to the global discourse on sustainable agriculture.

Conclusion. The transition to a green economy in Armenia's agricultural sector is both a necessity and an opportunity. While there are significant challenges related to financial constraints, environmental degradation, and socio-economic disparities, there are also numerous opportunities for innovation, regional cooperation, and international collaboration. To facilitate the transition, Armenia must adopt a comprehensive, integrated approach that addresses the economic, environmental, and social dimensions of sustainability. The research findings support the following key policy recommendations:

- ✓ Developing a cohesive national strategy for green agriculture development, with clear objectives, actionable steps, and measurable targets.
- ✓ Increasing investment in rural development through capacity-building programs, access to finance, and technical assistance to empower farmers.
- ✓ Promoting the adoption of sustainable agricultural practices through incentives such as subsidies for green technologies and financial support for sustainable farming practices.
- ✓ Strengthening regional cooperation and leveraging international funding mechanisms to support Armenia's green transition.
- ✓ Encouraging research and innovation in sustainable agricultural technologies to address Armenia's unique environmental and socio-economic challenges.

By implementing these recommendations, Armenia can take significant steps toward achieving a green, sustainable, and resilient agriculture that supports long-term economic growth and environmental stewardship.

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CHALLENGES AND PROSPECTS OF TRANSITION TO GREEN AGRICULTURE: CASE OF ARMENIA

MERI MURADYAN ARSEN ERKOYAN HRACHYA GRIGORYAN

Abstract

The article provides an in-depth analysis of the challenges and opportunities associated with transitioning Armenia's agricultural sector to a green economy, focusing on sustainable development strategies tailored to the country's unique environmental, economic, and social conditions. Armenia's agriculture is highly susceptible to the impacts of climate change, soil degradation, and water scarcity, which necessitate urgent action to adopt green economy principles.

The primary objective of this research is to critically assess the key barriers to sustainability, such as limited access to advanced sustainable technologies, fragmented policy frameworks, and socio-economic challenges, while also identifying potential

opportunities, including regional cooperation, international funding mechanisms, and the adoption of innovative agricultural practices. The study highlights the importance of integrating renewable energy, water-efficient technologies, and agroecological practices in the pursuit of a more sustainable agricultural sector.

The scientific novelty of this research lies in its focused analysis of Armenia's specific needs, offering region-specific solutions and bridging the gap between global sustainability practices and local realities. By examining the socio-economic impacts of the green transition, including job creation and rural development, this study emphasizes the broader benefits of sustainable agriculture for Armenia's rural communities.

The main research findings propose actionable recommendations for policymakers, highlighting the critical role of comprehensive policy frameworks, international partnerships, and technological innovation in fostering a green economy. This article contributes to the global discourse on sustainable agriculture by providing a comprehensive and region-specific roadmap for Armenia's transition to a green economy, offering valuable insights for stakeholders engaged in sustainable development initiatives.

Keywords. Green economy, sustainable agriculture, climate change, soil degradation, water scarcity, renewable energy, rural development, technological innovation.

ПЕРЕХОД К ЗЕЛЕНОЙ ЭКОНОМИКЕ В СЕЛЬСКОМ ХОЗЯЙСТВЕ АРМЕНИИ: ПРОБЛЕМЫ И ПЕРСПЕКТИВЫ УСТОЙЧИВОГО РАЗВИТИЯ

МЕРИ МУРАДЯН АРСЕН ЭРКОЯН ГРАЧЬЯ ГРИГОРЯН

Аннотация

Данное исследование представляет собой глубокий анализ проблем и возможностей перехода сельскохозяйственного сектора Армении к зеленой экономике, с акцентом на стратегии устойчивого развития, адаптированные к уникальным экологическим, экономическим и социальным условиям страны. Сельское хозяйство Армении сильно подвержено воздействию изменений климата, деградации почв и нехватки воды, что требует срочных мер для внедрения принципов зеленой экономики. Основной целью исследования является критическая оценка ключевых препятствий на пути к устойчивости, таких как ограниченный современным устойчивым доступ К технологиям, фрагментированные политические рамки и социально-экономические проблемы, а также выявление потенциальных возможностей, включая региональное сотрудничество, международные финансовые механизмы И внедрение инновационных сельскохозяйственных практик. Исследование подчеркивает важность интеграции возобновляемых источников энергии, технологий

водоэффективного земледелия и агроэкологических практик для достижения более устойчивого сельскохозяйственного сектора. **Научная новизна** работы заключается в сосредоточении внимания на конкретных потребностях Армении, предлагая решения, ориентированные на региональные особенности, и связывая глобальные практики устойчивости с местными реалиями. Исследование также рассматривает социально-экономические последствия зеленого перехода, включая создание рабочих мест и развитие сельских районов, подчеркивая более широкие преимущества устойчивого сельского хозяйства для сельских общин Армении. предлагают Результаты исследования практические рекомендации разработчиков политики, подчеркивая важность комплексных политических международных партнерств технологических И инноваций стимулировании зеленой экономики. Работа вносит вклад в глобальную дискуссию об устойчивом сельском хозяйстве, предлагая комплексную и ориентированную на региональный контекст дорожную карту для перехода Армении к зеленой экономике и предлагая ценные идеи для заинтересованных сторон, работающих в области устойчивого развития.

Ключевые слова. Зеленая экономика, устойчивое сельское хозяйство, изменения климата, деградация почв, нехватка воды, возобновляемая энергия, сельское развитие, технологические инновации, социально-экономическое воздействие.

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ՄԵՐԻ ՄՈՒՐԱԴՅԱՆ ԱՐՍԵՆ ԸՌՔՈՅԱՆ ՀՐԱՉՅԱ ԳՐԻԳՈՐՅԱՆ

Համառոտագիր

Հոդվածը տալիս է Հայաստանի գյուղատնտեսության ձյուղի՝ դեպի կանաչ տնտեսության անցման մարտահրավերների և հնարավորությունների խորը վերլուծություն՝ շեշտր դնելով երկրի եզակի բնապահպանական, տնտեսական և սոցիալական պայմաններին հարմարեցված զարգացման ռազմավարությունների վրա։ Հայաստանի գյուղատնտեսությունը մեծապես ենթարկվում է կլիմայի փոփոխության ազդեցությանը, հողերի դեգրադացմանը և ջրի սակավությանը, ինչը պահանջում է հրատապ միջոցներ ձեռնարկել կանաչ տնտեսության անցման համար։ **Հետազոտության հիմնական նպատակն է** գնահատել կանաչ գյուղատնտեսության անցման հիմնական խոչընդոտները, կայուն տեխնոլոգիաների սահմանափակ ինչպիսիք են ժամանակակից հասանելիությունը, մասնատված պետական քաղաքականությունը, սոցիալտնտեսական մարտահրավերները, և բացահայտել առկա հնարավորությունները, ներառյալ տարածաշրջանային համագործակցությունը, միջազգային ֆինանսական աջակցությունը և դրանց ընդունումը։ Հոդվածն ընդգծում է վերականգնվող էներգիայի, ջրային տնտեսության արդյունավետ տեխնոլոգիաների և ագրոէկոլոգիական պրակտիկայի ինտեգրման կարևորությունը՝ կանաչ գյուղատնտեսության անցնելու համար։

Հետազոտության գիտական նորույթը կայանում է նրանում, որ այն կենտրոնանում է Հայաստանին հատուկ առանձնահատկությունների վրա առաջարկելով կոնկրետ, լոկալ, ադապտացված լուծումներ և կապելով գլոբալ կանաչ անցման փորձը տեղական իրողությունների հետ։ Հոդվածում նաև ուսումնասիրվում է կանաչ անցման սոցիալ-տնտեսական ազդեցությունները, ներառյալ աշխատատեղերի ստեղծումը և գյուղական տարածքների զարգացումը՝ ընդգծելով կանաչ գյուղատնտեսության օգուտները Հայաստանի գյուղական տարածքների համար։

Հետագոտության հիմնական արդյունքները գործնական unuounկություններ են քաղաքականություն մշակողների hwuwn` րնդգծելով համապարփակ քաղաքականության, միջազգային գործընկերության տեխնոլոգիական նորարարության կարևորությունը կանաչ տնտեսության խթանման գործում։ Աշխատանքը համալրում է կանաչ գլուղատնտեսության հետացոտությունների շրջանակը՝ առաջարկելով Հայաստանի գյուղատնտեսության կանաչ անցման համապարփակ ձանապարհային քարտեզ շահակիր կողմերի համար։

Բանալի բառեր։ Կանաչ տնտեսություն, կայուն գյուղատնտեսություն, կլիմայի փոփոխություն, հողի դեգրադացիա, ջրի սակավություն, վերականգնվող էներգիա, գյուղական զարգացում, տեխնոլոգիական նորարարություն, սոցիալ-տնտեսական ազդեցություն։