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Integrating Circular Economy Principles in Armenia's Agriculture: A Pathway to Sustainable Development

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ABSTRACT

Armenia's transition to a circular economy (CE) in agriculture represents a critical opportunity to address environmental degradation, optimize resource use, and improve food system resilience. Despite ongoing policy alignment with the European Union and initial pilot projects, Armenia's agricultural sector still lacks a coherent CE strategy and institutional capacity for wide-scale implementation. This paper explores a strategic framework for CE adoption by analyzing international best practices including cases of Italy, Georgia, Finland, Moldova, Spain and Serbia. Using comparative case analysis and policy mapping, the study identifies key components essential for Armenia's transition: waste valorization, closed-loop nutrient systems, regenerative farming practices, enabling policy reforms, financial instruments, and capacity building. The findings offer a roadmap for integrating CE principles into national agricultural planning, with recommended milestones leading to a 50% reduction in agricultural waste, 40% increase in organic input use, and widespread deployment of biogas and composting infrastructure by 2040.

Introduction

The global agricultural sector faces urgent and complex challenges—ranging from resource depletion and climate change to soil degradation and food insecurity. In this context, the circular economy (CE) has emerged as a transformative paradigm that prioritizes waste minimization, resource efficiency, and regenerative production systems. Unlike the conventional linear model of "take-make-dispose," CE in agriculture fosters a closed-loop system where organic waste is repurposed into valuable inputs, and production processes are designed to preserve ecosystem health (https://ellenmacarthurfoundation.org/completing-the-picture).

The circular economy (CE) in agriculture focuses on maximizing resource efficiency by valorizing waste, implementing closed-loop systems, and promoting sustainable farming practices. It aligns closely with the principles of Resource Efficient and Cleaner Production (RECP)—a framework that seeks to optimize the use of water, energy, and materials while reducing emissions, pollution, and waste generation throughout the production process. Together, CE and RECP form a complementary

foundation for transforming agriculture into a more sustainable and economically viable sector.

For Armenia—a landlocked and resource-constrained country with agriculture contributing significantly to employment and rural livelihoods—the adoption of CE and RECP principles are not only desirable but necessary. Yet, while Armenia has initiated pilot efforts and aligned some policies with EU environmental directives, the agriculture sector remains largely linear. Agricultural residues, including grape pomace, fruit peels, wheat husks, and animal manure, are often underutilized or discarded, contributing to environmental degradation and missed economic opportunities.

Materials and methods

This study argues that Armenia is uniquely positioned to leverage circular economy models and RECP strategies to transform its agricultural sector. Drawing upon international case studies, the research highlights both the potential impact and the necessary conditions for CE implementation in Armenia. These cases demonstrate how targeted investments in waste valorization, nutrient recycling, and regenerative practices yield substantial environmental, social, and economic benefits.

Through comparative policy analysis, investment profiling, and technological mapping, this paper identifies scalable strategies for Armenia to build a CE-aligned agricultural system. Special focus is placed on policy reform, financial mechanisms, capacity-building initiatives, and the alignment of Armenian practices with international CE and RECP standards. The paper further proposes a phased roadmap and monitoring framework to support long-term transition, aiming to reduce agricultural waste by 50%, increase the use of organic fertilizers by 40%, and expand CE-related infrastructure and certifications by 2040.

By embracing CE and RECP principles and adapting global best practices to its local context, Armenia can modernize its agricultural system, foster green innovation, and establish itself as a regional leader in sustainable food production.

Results and discussions

Agriculture, as both a major resource consumer and waste generator, is uniquely positioned to benefit from the integration of CE (https://ellenmacarthurfoundation.org/completing-the-picture) and RECP frameworks. These two interrelated concepts offer a strategic pathway to decouple agricultural development from environmental degradation, while enhancing productivity, climate resilience, and economic value.

Circular Economy in agriculture refers to a model that designs out waste, keeps resources in use for as long as possible, and regenerates natural systems. It emphasizes biological loops—where organic matter is continuously recycled into the soil through composting, biofertilizers, and other nutrient recovery processes—and technical loops, which involve the reuse and remanufacturing of agricultural equipment, irrigation systems, and packaging.

In the context of advancing the circular economy, it is essential to concurrently assess the principles and applications of RECP as a complementary framework for sustainable transformation. RECP is about optimizing resource use, minimizes waste, and reduces environmental impact while maintaining or improving productivity. RECP focuses on three main areas - efficient use of resources; minimizing waste and pollution; and enhancing economic and environmental performance. In agriculture, RECP is mainly applied through precision farming (https://www.unido.org/sites/default/files/files/2019-10/RECP_Guidelines.pdf).

Together, these two approaches offer a comprehensive strategy for agricultural sustainability—RECP minimizes resource consumption and waste generation, and CE ensures the regeneration and reintegration of those resources. In Table 1 below, it is presented the differences and similarities between these two terms.

In the context of Armenia, it is particularly relevant to conduct an in-depth examination of both the CE and RECP frameworks.

Within the CE, waste valorization refers to the process of transforming agricultural waste and by-products into valuable resources, rather than discarding them as pollutants - reusing waste as input for new production processes. This principle is central to the CE and focuses on extracting economic and environmental benefits from waste materials. At the same time, a closed-loop system focuses on reusing, recycling, and repurposing waste materials to minimize resource depletion and environmental impact (https://www.eea.europa.eu/themes/economy/resource-efficiency/country-profiles/estonia). Unlike a linear economy, which follows a “take-make-dispose” approach, a closed-loop system ensures that waste from one process becomes an input for another, reducing overall waste generation and enhancing resource efficiency. Key components of closed-loop systems includes nutrient recycling; biogas production from agricultural waste and water recycling and reuse (https://www.eea.europa.eu/en/analysis/publications/circular-economy-and-bioeconomy).

Table 1. CE and RECP: Similarities and differences*

Aspect	Circular Economy (CE)	RECP
Definition	An economic system aimed at eliminating waste and keeping resources in use for as long as possible.	A production-focused approach that enhances efficiency while reducing waste and pollution.
Main Goal	Designing out waste, keeping materials in circulation, and regenerating natural systems.	Reducing the use of natural resources and minimizing pollution during production.
Approach	Systemic transformation of production and consumption cycles.	Optimization of processes and resource inputs.
Focus Area	End-of-life resource reuse and regeneration.	Input use and waste prevention during production.
Stage of Application	Primarily applied at the end of the production cycle and beyond.	Applied early in the production process.
Key Strategies	Composting, recycling, reuse, bio-based production, product redesign.	Energy and water efficiency, cleaner production technologies, emissions reduction.
Environmental Impact	Reduces landfill, improves biodiversity, supports closed-loop nutrient cycles.	Reduces emissions, pollution, and water/energy waste.
Economic Benefit	Creates new markets for recycled products, boosts green innovation.	Lowers input costs, increases production efficiency, reduces environmental fines.
Role in Agriculture	Transforms waste into resources (e.g., compost, bioenergy); promotes regenerative farming.	Improves input efficiency in irrigation, fertilization, and energy use.
Relation to Sustainability	Focuses on long-term circularity and material sustainability.	Supports environmental compliance and operational efficiency.

*Composed by the authors.

At the same time, promoting sustainable farming practices involves adopting regenerative agricultural techniques that enhance soil fertility, conserve water, and reduce environmental impact. This includes crop rotation to prevent soil depletion and pest outbreaks, conservation tillage to protect soil structure and retain moisture, and organic fertilizers to replace synthetic inputs and restore natural nutrient cycles. Agroforestry, which integrates trees into agricultural landscapes, can enhance biodiversity, improve soil health, and sequester carbon, while precision farming technologies, such as drip irrigation and sensor-based nutrient management, optimize resource use and minimize waste. Additionally, reducing pesticide and herbicide dependency through integrated pest management supports pollinators, maintains ecosystem balance, and safeguards long-term productivity (https://www.fao.org/3/i6583e/i6583e.pdf).

It is evident that well-designed policy frameworks and targeted incentive mechanisms play a pivotal role in accelerating the transition toward a circular economy in the agricultural sector, by facilitating the widespread adoption of sustainable practices among farmers, agribusiness enterprises, and associated value chain actors. Effective policy interventions provide regulatory support, financial incentives, and institutional/regulatory frameworks that promote waste reduction, resource efficiency, and long-term environmental sustainability (https://www.oecd.org/en/data/datasets/policy-instruments-for-the-environment-pine-database.html).

Governments play a key role in promoting circular economy (CE) education by integrating CE principles into agricultural training programs. Through national training initiatives, digital platforms, financial incentives, and public-private partnerships, they can expand knowledge-sharing and support widespread adoption. These efforts empower farmers, boost resource efficiency, and foster sustainable growth.

Thus, RECP and CE are complementary approaches: RECP minimizes waste and pollution at the production stage, while CE focuses on reusing and recycling outputs into valuable products. Together, they offer a comprehensive model for sustainable and efficient agriculture.

Armenia is in the early stages of transitioning toward the CE, with key focus areas including agriculture, waste management, and energy efficiency. While CE principles have been recognized in national strategies and development dialogues—especially through Armenia's partnership with the European Union—their practical application remains fragmented and underdeveloped. The country's circular economy agenda is still largely driven by donor-supported pilot projects, scattered institutional efforts, and a limited number of policy commitments.

Table 2. Main Policy Frameworks and Sustainability Initiatives in Armenia*

	Policy/Initiative	Description
Circular Economy & Green Transition	EU-Armenia CEPA	Legal agreement aligning Armenia's environmental laws with EU directives.
	EU4Environment - Green Economy	Program to integrate circular economy, EPR schemes, and green governance.
	Green Agenda Project (2023-2026)	Project aligning Armenia with EU Green Deal principles and sustainability goals.
Waste Management	Law on Waste (2004)	Framework for waste classification, handling, and disposal.
	Law on Waste Collection and Sanitary Cleaning (2011)	Defines municipal waste collection responsibilities.
	National Waste Management Strategy (2017-2036)	Set goals for landfill reduction and recycling; repealed in 2021.
	Waste Sector Reform Plan (2024-2031)	World Bank plan proposing EPR schemes, regional landfills, and legislative updates.
	EPR Initiatives	Ongoing policy effort to implement producer responsibility schemes.
Water Management	Water Code of Armenia	Main law governing water allocation, protection, and use rights.
	EU Water Directive Alignment	Efforts to align national law with EU water policies under CEPA.
	Water Sector Adaptation Plan (2022)	Addresses climate-driven water security and adaptation.
	OECD Water Policy Reforms	Technical support to modernize Armenia's water governance.
Environmental Governance & Climate Policy	EIA and SEA Laws	Mandate project and policy-level environmental impact assessments.
	UNFCCC 4th National Communication	Reports Armenia's climate actions and obligations.
	Energy Sector Program to 2040	Long-term plan for renewable energy and GHG reduction.
ISO	ISO 14001	Environmental Management Systems (EMS)
	Armenia has not yet formally adopted or integrated the new ISO 59000 series including:	
	ISO 59004:2024	Circular economy - Vocabulary, principles and guidance for implementation
	ISO 59010:2024	Circular economy - Guidance on the transition of business models and value networks
	ISO 59020:2024	Circular economy - Measuring and assessing circularity performance
	ISO/UNDP WD 53001.2 – (emerging working draft)	Linking Circular Economy to the SDGs (Armenia has not incorporated it into policy discourse, training curricula, or investment screening mechanisms.)
Institutional & Civil Society Initiatives	ISO 37120	Sustainable development of communities - Indicators for city services and quality of life

*Composed by the authors.

An overview of Armenia's key laws, regulations, strategies, and initiatives related to the circular economy, environmental protection, waste management, and water governance are presented in the Table 2.

Armenia's commitments under the EU-Armenia Comprehensive and Enhanced Partnership Agreement (CEPA) have laid a solid basis for alignment with the EU Waste Framework Directive and the broader CE

Action Plan. Yet progress in legislative harmonization and institutional adaptation has been slow. Efforts remain scattered, and no central agency or legal framework for CE currently exists. This institutional gap has caused poor coordination between ministries and diminished the capacity for cross-sectoral CE planning. At the same time, Armenia's membership in the Eurasian Economic Union (EAEU) adds regulatory complexity, as EAEU policies on waste and environmental management are still developing and lack full alignment with CE principles. Navigating between EU and EAEU standards presents challenges in governance and implementation. Nonetheless, Armenia's experience in aligning with EU environmental norms and piloting CE initiatives enables it to act as a regional connector. It can support CE integration within the EAEU by sharing best practices, advocating for harmonized standards, and contributing to regional policy dialogue.

At the same time, international cooperation has played an instrumental role in seeding CE-related reforms and pilot initiatives. The EU4Environment Program has delivered policy support, RECP audits, EMS integration, and SME training. In parallel, the Green Agriculture Initiative (GIZ) has promoted eco-innovation and circular practices in rural agri-value chains. Programs such as SwitchMed and CirculUP! have contributed to the promotion of eco-entrepreneurship and sustainability in light industry and startups. While these initiatives demonstrate promise—particularly in composting, biogas production, and organic input innovation—they remain limited in geographic scope and heavily donor-dependent, with little integration into national policy structures.

Pilot projects, like those led by ORWACO and Armbiotechnology SPC, offer tangible models for circular farming and waste valorization, including composting and biofertilizer production. However, these remain isolated examples. National replication is constrained by insufficient co-financing, weak ownership by public institutions, and limited capacity building for rural actors.

On the financing side, Armenia has access to instruments like the Green Climate Fund (GCF) and the EBRD's Green Economy Financing Facility (GEFF). However, CE project uptake remains modest, largely due to regulatory uncertainties, limited bankable project pipelines, and gaps in technical proposal preparation. These constraints prevent effective mobilization of climate and green finance at scale.

In terms of sectoral potential, agriculture emerges as the most viable entry point for circularity—especially in the areas of waste valorization, closed-loop irrigation, composting, and biogas production. Despite this, the real-world application remains rare, and knowledge among farmers is low. Most actors lack the necessary information, training, and capital investment needed for a CE transition.

Systemic shortcomings are especially evident in the waste management sector. By 2022, Armenia's total waste generation reached nearly 60 million metric tons, including an estimated 400,000 metric tons of municipal solid waste (MSW). "Recycling rates in the country remain at a mere 4.5%, far behind the targets set by the EU's Circular Economy framework." The lack of waste separation at source, infrastructure for recycling and composting, and energy recovery systems underscores the urgent need for policy and investment reforms (Kurkdjian and Hayrapetyan, 2024).

In the energy and industrial sectors, there is growing conceptual interest in bioenergy (e.g., livestock waste-to-energy), but actual deployment is minimal, with only a few small biogas plants in operation. Concepts like industrial symbiosis, eco-design, and circular manufacturing are largely absent from current industrial policy. When green upgrades do occur, they tend to be donor-driven rather than market-driven, limiting their scalability and long-term impact.

In summary, Armenia's CE journey is at a critical juncture. Foundational strategies and international partnerships are in place, and the country has demonstrated initial success through pilot initiatives. However, progress remains hampered by fragmented governance, weak enforcement, insufficient financing, and underdeveloped infrastructure. With concerted action, Armenia can evolve from pilot-based initiatives to mainstream CE adoption, contributing meaningfully to the country's climate goals, economic resilience, and regional sustainability leadership.

To identify the most effective circular economy (CE) strategy framework for Armenia's agricultural sector, a comprehensive analysis of successful CE strategies is essential. Comparative success cases such as those of Italy, Georgia, Finland, Moldova, Spain, Estonia, and Serbia provide practical models that resonate closely with Armenia's own socio-economic and environmental context.

Launched in 2012, Italy's AgriWasteValue Project is a successful circular economy initiative that transforms olive oil production waste—such as pomace and leaves—into high-value bio-based products. Supported by the EU, the project promotes waste reduction, resource efficiency, and new income streams for farmers. Through advanced biotechnology, residues are converted into essential oils, antioxidants, and biopolymers with

applications in pharmaceuticals, food, cosmetics, and bioplastics (https://www.agriwastevalue.eu/). This model has reduced environmental impact while supporting rural development and innovation. For Armenia, the AgriWasteValue experience offers practical insights into how similar waste—like fruit pulp, grape pomace, and wheat husks—can be repurposed into profitable, eco-friendly products, advancing both sustainability and economic diversification. Georgia has pioneered waste valorization in its winemaking sector, transforming grape pomace into bioethanol and organic fertilizers. This initiative not only reduces over 30,000 tons of winery waste annually but also cuts CO_2 emissions by 10–15% and enhances soil fertility (https://www.ge.undp.org/content/georgia/en/home/presscenter/articles/2021/grape-waste-to-green-energy.html). Georgia's success in transforming grape pomace into bioethanol and organic fertilizers is the result of a coordinated strategy that blends policy support, pilot demonstration projects, and collaboration with international partners such as the FAO, UNDP, and the World Bank. The strategy aligns waste valorization with Georgia's broader green growth and climate action agenda, integrating it into national policies that support the Sustainable Development Goals (SDGs). With the help of these international partners, the country introduced technologies such as fermentation systems and composting solutions specifically adapted for the wine sector. Public–private partnerships between wineries, research institutions, and technology providers enabled the scaling of pilot projects and the sharing of best practices across regions. These efforts were further reinforced by rural development goals, allowing wineries—particularly in wine-rich areas like Kakheti—to diversify income and create new employment opportunities.

Although incentive structures were limited, donor-supported subsidies and financing mechanisms helped small and medium-sized producers invest in waste processing infrastructure. Georgia also emphasized awareness-raising and capacity building, training farmers on the benefits of circular practices and sustainable soil management. Ultimately, Georgia's approach was not a standalone initiative, but part of a multi-stakeholder, internationally backed strategy embedded in the country's circular economy vision. Its experience illustrates how targeted sector-specific valorization, supported by both policy and practice, can drive sustainable transformation. As such, Georgia's model provides important lessons for Armenia and other wine-producing countries aiming to integrate circular economy principles into agriculture.

For Armenia, a country with a rich winemaking tradition, this model offers a replicable strategy to tackle agricultural waste, support renewable energy initiatives, and create rural employment. Establishing cooperative-based processing facilities and promoting policy incentives could help local producers scale up similar practices.

Finland has made significant progress in advancing nutrient recycling as part of its circular economy strategy in agriculture. By converting animal waste into biofertilizers through composting and bio-fermentation, Finland has reduced reliance on synthetic fertilizers, improved soil health, and minimized environmental impacts. The strategy's key components include policy support (setting clear targets, providing subsidies, and allocating €12 million in pilot funding to encourage nutrient recycling), infrastructure development (with over 130 biogas plants processing 2 million tons of waste annually to generate renewable energy and fertilizers), capacity building (training farmers in composting and fermentation, leading to the processing of over 600,000 tons of waste annually at composting centers), and integrated farming practices (such as precision fertilization and crop-livestock nutrient exchanges to minimize runoff and enhance fertilizer efficiency).) These efforts led to reduced chemical fertilizer use, lower GHG emissions, improved water quality, and the creation of over 5,000 jobs, while also positioning Finland as a leader in nutrient recycling technology exports (https://julkaisut.valtioneuvosto.fi/).

Finland's nutrient recycling strategy offers valuable insights for Armenia's transition to circular agriculture, particularly in transforming animal waste into biofertilizers through composting and bio-fermentation—reducing dependence on synthetic fertilizers while improving soil health and biodiversity. Armenia can adapt Finland's model by introducing targeted policy incentives, such as subsidies and pilot funding, and investing in biogas and composting infrastructure in livestock-intensive regions like Shirak and Gegharkunik. Additionally, Finland's emphasis on farmer training and research-based innovation highlights the importance of building capacity through institutions like ANAU. Integrated farming approaches—such as precision fertilization and regional manure exchange systems—further demonstrate scalable solutions Armenia could apply to optimize resource use and prevent environmental degradation. Notably, Finland's experience shows that nutrient recycling not only lowers emissions and water pollution but also generates green jobs and exportable technologies. Drawing from these practices, Armenia can build a sustainable, resilient, and economically viable nutrient management system aligned with its circular economy goals.

In Moldova, the agricultural sector has adopted decentralized composting systems, especially in fruit-producing regions. Small-scale composting units, farmer training, and policy incentives have driven the reuse of organic waste into biofertilizers, effectively closing the nutrient loop (https://www.fao.org/moldova/news/detail-events/en/c/1413636/). Armenia, particularly in the Ararat Valley and other fruit-growing areas, can benefit from this model by reducing dependence on synthetic fertilizers, improving soil quality, and supporting local compost markets.

Spain's AlVelAl Project demonstrates the value of regenerative agriculture, using no-till farming, agroforestry, and water-efficient irrigation to restore degraded land. The initiative has led to a 35% reduction in soil erosion, improved biodiversity, and a 20% increase in farmer income through organic certification (https://www.commonland.com/project/alvelal/). Given Armenia's semi-arid conditions, adopting similar practices can improve land productivity while also aligning with EU market standards for organic produce.

Estonia's national CE roadmap is a comprehensive example of policy integration. The country combines financial incentives for circular technologies, such as biogas and precision farming, with strong monitoring frameworks and mandates for on-farm composting (https://envir.ee/en/circular-economy-roadmap). Armenia can follow Estonia's lead by developing a CE roadmap that includes specific agricultural targets, regulatory reforms, and targeted funding.

Serbia has focused on education and capacity building, launching a national CE training program aimed at rural communities. By 2022, over 3,000 farmers were trained in composting and biogas production, and organic waste recycling in agriculture increased by 25% (https://www.rs.undp.org/content/serbia/en/home/library/environment_energy/circular-economy-capacity-building.html). Armenia, where awareness of CE principles remains limited among smallholders, can adapt Serbia's model to boost grassroots implementation through field demonstrations, digital learning, and financial support for training.

In conclusion, these countries offer complementary models that Armenia can customize to suit its agricultural landscape. Georgia and Moldova provide technical models for waste reuse and nutrient cycling. Spain and Estonia offer holistic approaches that combine land regeneration with economic and environmental monitoring. Serbia presents a blueprint for building long-term CE capacity among rural stakeholders. Integrating these lessons into Armenia's national strategy can accelerate the shift toward a resilient, low-waste, and high-efficiency agricultural sector aligned with CE principles and the Sustainable Development Goals.

Conclusion

Armenia should adopt a phased and complementary strategy integrating Circular Economy (CE) and Resource Efficient and Cleaner Production (RECP) to support sustainable agricultural transformation. Drawing on international best practices and adapted to Armenia's socio-economic and institutional realities, the strategy envisions three stages: short-term RECP implementation, mid-term CE infrastructure development, and long-term circular integration and export expansion covering 2026–2040 timeline.

Short-term - Foundation and Capacity Building (2025–2030) which will focus on RECP implementation in key agricultural zones, capacity building (e.g., at ANAU), and targeted incentives for cleaner production through prioritizing the integration of Resource Efficient and Cleaner Production (RECP) practices in Armenia's key agricultural zones, particularly in regions like Ararat Valley, Gegharkunik, and Vayots Dzor. The focus will be on improving input use efficiency, introducing clean technologies, and raising awareness among farmers and agribusinesses. RECP's accessibility and low capital requirements make it ideal for early adoption, especially among smallholders.

Key actions include:

- Launching national and regional RECP demonstration projects in water efficiency, composting, and nutrient management.
- Establishing capacity-building platforms, notably through ANAU and local agricultural extension systems, modeled after Serbia's CE education initiatives.
- Introducing financial incentives—grants, tax reductions, and cost-share schemes—for clean production tools and waste separation infrastructure.
- Drafting and adopting Armenia's first Agricultural Circular Economy Law, establishing institutional mandates and regulatory mechanisms in line with Estonia's CE roadmap.
- Formulating standards for compost, organic fertilizers, and processed agricultural waste that align with Circular Economy principles, in compliance with the ISO 59000 series and relevant European Union directives.

This phase also includes a national assessment of Armenia's

priority organic waste streams—grape pomace, fruit pulp, livestock manure, orchard residues—to inform targeted pilot interventions. Inspired by Italy's AgriWasteValue project and Georgia's winery waste model, Armenia will initiate pilot projects for converting such residues into bio-based products including fertilizers, bioethanol, and bioplastics.

This phase is the most logical and impactful place to formally introduce training and education as a core pillar, which includes launching a National Circular Agriculture Training Initiative, coordinated with ANAU and regional agricultural colleges, to provide foundational knowledge in RECP and CE practices; developing modular training programs; establishing demonstration farms and model pilot sites in priority regions to serve as hands-on learning hubs; and introduce incentive-linked certification schemes, where farmers who complete training modules gain eligibility for CE-related grants, certification discounts, or green financing.

Mid-term - Infrastructure Development and System Integration (2026–2035), which will scale successful RECP practices into CE systems by developing compost-based products, biogas units, and aligning with EU CE policies.

Building on the institutional foundation and early RECP results, the second phase transitions toward scaling Circular Economy systems through infrastructure deployment and systemic integration. The goal is to shift from isolated pilot actions to regionally coordinated circular models, particularly in livestock-rich areas such as Shirak and Tavush, and horticultural centres like Ararat Valley.

Key priorities during this phase include:

- Developing regional composting hubs and nutrient recycling centres for organic fertilizer production, modeled on Moldova's decentralized composting approach.
- Installing biogas units and anaerobic digesters for livestock waste management and renewable energy generation, drawing on Finland's example where over 130 biogas plants support nutrient cycling and energy security.
- Promoting circular regenerative farming practices, including no-till farming, crop-livestock integration, and cover cropping, supported by technical assistance and co-financing.
- Streamlining organic certification processes and introducing partial reimbursement schemes to support farmers transitioning to CE-aligned production, taking lessons from North Macedonia.
- Establishing a CE Investment Facilitation Unit under the Ministry of Economy to coordinate national and international financing, liaise with donors (e.g., GCF, EBRD GEFF), and support PPPs in CE infrastructure.

In addition, a national closed-loop agriculture policy should be introduced to formally recognize circular farming practices and outline policy instruments for nutrient recovery, water recycling, and clean energy use. This policy will support the expansion of precision irrigation systems, greywater reuse, and farm-level composting, particularly in water-stressed regions like Armavir and Aragatsotn. In this phase, training becomes more specialized and operational covering scaling up advanced technical training; training extension officers and local CE specialists to support farmers during infrastructure rollout and integrating CE modules into vocational education and lifelong learning programs.

Long-term - circular maturity, export readiness, and global integration (2026–2004) which should establish full CE loops in half of Armenia's agricultural regions, adopt a national CE law for agriculture, and expand exports of low-emission, CE-certified products.

The final phase envisions the full institutionalization of CE practices across Armenia's agricultural value chains. By this stage, CE should be embedded in law, infrastructure, and market access, with active participation from farmers, cooperatives, academic institutions, and private investors.

Strategic outcomes by 2040 should include, but not limited:

- Establishing full CE loops in at least 50% of Armenia's agricultural regions, enabling efficient waste-to-product pathways for fertilizers, energy, and bio-based goods.
- Achieving a 50% reduction in agricultural waste, by valorizing organic residues through composting, fermentation, and bio-refining.
- Increasing organic fertilizer use by 40% and reducing synthetic fertilizer use by 30%, based on demonstrated outcomes from Finland and Moldova.
- Certifying 25% of Armenia's arable land for organic production, leveraging EU and Russian market demand and Estonia's proven growth path.
- Creating a 15% increase in CE-related jobs in rural areas through composting centers, CE education services, and sustainable farming cooperatives.

This phase will also focus on positioning Armenia in international CE trade networks. Dedicated CE branding, participation in EU green supply chains, and export certification for circular agri-products will help Armenian

producers access premium global markets. Engagement with platforms such as the European Circular Economy Stakeholder Platform and FAO organic networks will strengthen Armenia's global visibility.

Monitoring systems will be operationalized by 2035, using national CE indicators to track GHG reductions, waste recovery rates, soil health improvements, and circular employment growth. Annual progress reviews will ensure policy adaptation and stakeholder feedback loops.

In this phase, education supports institutionalization and export competitiveness including launching the Circular Economy Academy; organizing annual CE innovation forums and promoting CE education in agricultural trade fairs and certification programs.

Through this phased 2026–2040 strategy, Armenia can progressively transform its agricultural sector from a linear, input-intensive system to a circular, regenerative model rooted in efficiency, innovation, and inclusiveness. International experience shows that successful CE implementation requires both top-down policy frameworks and bottom-up engagement from farmers, educators, and local businesses. With careful planning, financing, and learning-by-doing, Armenia can position itself as a regional leader in sustainable, circular agriculture—delivering economic, environmental, and social benefits for decades to come. At the same time, Armenia should act as a pioneer within the EAEU to bring all members' economies into the circular economic models.

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Declarations of interest

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