

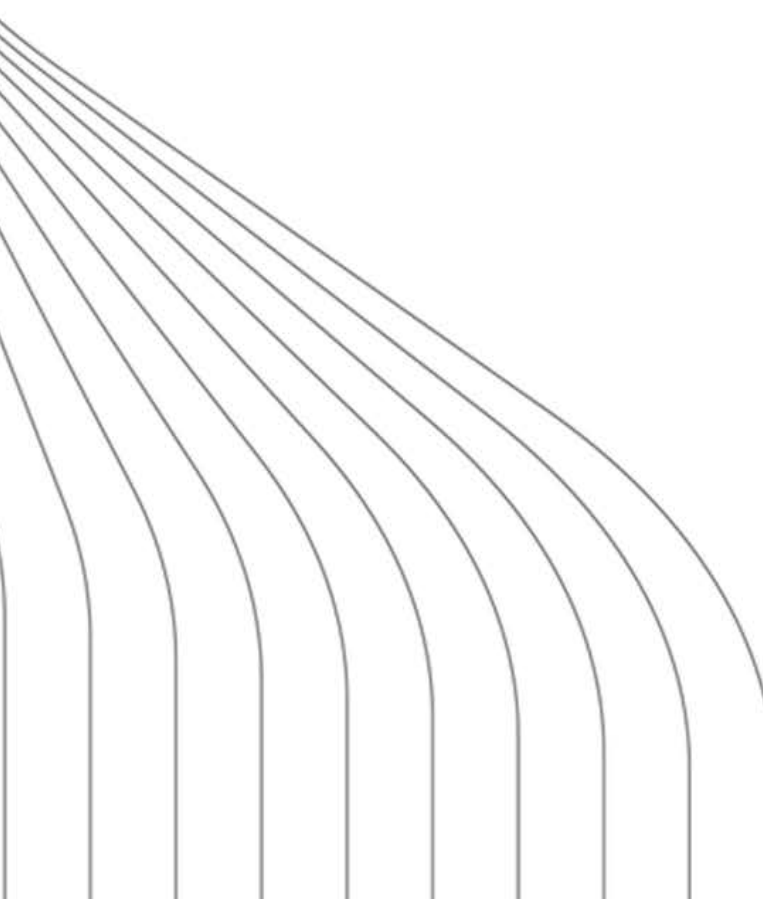
Final Report: Feasibility Study for the Adoption of Sustainable Production & Processing Practices, Climate-Smart Agriculture

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Executive Summary

This final report presents a comprehensive assessment of the feasibility of implementing Climate-Smart Agriculture (CSA) practices in Kosovo's agricultural sector. The study focuses on four key sectors: Non-Wood Forest Products (NWFPs), Medicinal and Aromatic Plants (MAPs), Berries, and Fruit and Vegetable Processing (FVP).

This feasibility study was conducted through a mixed-methods approach, combining desk research, stakeholder consultations, and focus groups. Desk research involved a comprehensive review of existing literature, government reports, and international best practices in climate-smart agriculture. Stakeholder consultations included in-depth interviews with key government officials, agricultural experts, and representatives from NGOs and agricultural associations. Focus groups were conducted with farmers and agribusinesses to assess the current state of agriculture in Kosovo and identify specific challenges and opportunities in four targeted sectors. This multi-faceted approach ensured a thorough understanding of the context and provided valuable insights for developing tailored recommendations.

Key Findings:

- **Significant climate change impacts:** Kosovo's agricultural sector faces increasing challenges due to climate change, including unpredictable weather patterns, extreme temperatures, and water scarcity.
- **Institutional and policy gaps:** While the government has prioritized the climate change agenda, there is a need for more targeted policies and measures for climate adaptation in agriculture.
- **Sector-specific challenges:** Each sector faces unique challenges due to climate change:
 - o NWFPs: Shifting growing areas, unpredictable harvesting seasons, and biodiversity loss.
 - o MAPs: Changes in active compounds, increased pest pressure, and loss of traditional growing areas.
 - o Berries: Reduced chilling hours, increased susceptibility to diseases, and water stress.
 - o FVP: Extreme weather events, water scarcity, and disrupted production cycles.
- **Opportunities for CSA:** There is significant potential for implementing CSA practices in all four sectors, including organic farming, efficient irrigation, renewable energy, and value-added processing.

To address the challenges and opportunities identified in this study, a comprehensive set of recommendations is proposed to enhance the adoption of CSA practices in Kosovo's agricultural sector including:

- Develop a national climate adaptation strategy for agriculture, prioritizing sectors most vulnerable to climate change.
- Mainstream climate-smart technologies within government subsidies and programs.
- Support the development of organic farming in NWFPs and MAPs sectors.
- Invest in efficient irrigation systems and water conservation measures.
- Promote the use of renewable energy in processing facilities.
- Enhance value-added processing of agricultural products.
- Strengthen capacity building and knowledge transfer among farmers and stakeholders.

The following proposed interventions tackle specific challenges and opportunities identified in each sector:

- Tailored interventions: Develop sector-specific interventions based on identified challenges and opportunities, such as agroforestry systems for NWFPs, seed conservation for MAPs, climate-resilient berry varieties, and energy-efficient processing for FVP.
- Pilot projects: Implement five out of six pilot projects to demonstrate the feasibility of CSA technologies, including semi-permanent high tunnels, microclimate management, heat exchangers, solar-powered water heaters, water filters, and smart irrigation systems.

To conclude, this study demonstrates the feasibility of adopting CSA practices in Kosovo's agricultural sector. By implementing the proposed interventions and addressing the identified challenges, Kosovo can enhance agricultural productivity, resilience, and sustainability while contributing to climate change mitigation and adaptation goals.

Introduction

The main goal of this project is to evaluate the feasibility of integrating climate-smart practices and technologies into existing agricultural systems in Kosovo.

This study aims to assess the potential and viability of integrating sustainable and climate-smart practices into Kosovo's agricultural sector. By analyzing the current agricultural landscape, identifying key challenges and opportunities, and developing tailored interventions, this study will provide a roadmap for transitioning towards a more resilient, productive, and environmentally friendly agricultural system.

The study focuses on identifying and evaluating sustainable practices that can be integrated into existing production systems, with a particular emphasis on non-wood forest products (NWFPs), medicinal and aromatic plants (MAPs), fruits, and vegetables. The ultimate goal is to develop a comprehensive strategy that empowers farmers, businesses, and policymakers to adopt and implement climate-smart approaches.

A mixed-methods approach has been employed to gather comprehensive data and insights. This includes desk research, key informant in-depth interviews, and focus group discussions. The study analyzes existing policies, programs, and initiatives related to agriculture and climate change.

By combining quantitative and qualitative data, this study provides a detailed analysis of the current situation, identifies key constraints and opportunities, proposes practical solutions - pilot projects considering Kosovo context and global experiences, and proposes a capacity building framework to support the transition to sustainable and climate-smart agriculture in Kosovo.

To ensure the project's success and accountability, a comprehensive monitoring and evaluation system is proposed for implementation. This will involve setting clear performance indicators, collecting and analyzing data, and using the findings to make necessary adjustments. Regular assessments will track progress towards project goals and measure the impact on farmers, the environment, and the economy.

1.Desk Research

Kosovo has developed a comprehensive framework addressing various agro-environmental issues through several strategic documents. These documents outline the country's approach to integrating climate-smart technologies in agriculture, circular economy, resilient food production, and processing practices.

In sustainable agriculture, organic agriculture plays a significant role in promoting environmental conservation and long-term viability. By integrating organic practices into sustainable agriculture, farmers can enhance soil health, improve water quality, and support ecosystem resilience. This relationship between organic agriculture and sustainable agriculture underscores the importance of environmentally friendly and socially responsible farming practices for a more sustainable future and it also ensures climate resiliency for the sector. Below is an overview of multiple strategic and monitoring documents that provide insights into the current state of the agricultural sector and the strategic orientation needed to enable integration of climate mitigation and adaptation in the sector.

1.1. The National Organic Action Plan (NOAP)

The NOAP aims to promote organic agriculture, emphasizing climate-smart practices that reduce greenhouse gas emissions and enhance soil carbon sequestration while also making the sector more resilient to climate risks (Ministry of Agriculture, Forestry and Rural Development, 2023). Organic farming techniques, such as the use of natural fertilizers and pest control methods, are central to this plan, fostering sustainable food production and long-term soil health. The NOAP aligns with international climate agreements, integrating circular economy principles by encouraging the recycling of organic waste into compost (Ministry of Agriculture, Forestry and Rural Development, 2023).

1.2. The Strategic Plan of the Kosovo Advisory System for Agriculture and Rural Development 2023-2027

This document outlines the goals and strategies for enhancing agricultural productivity and sustainability over five years (Kosovo Advisory System for Agriculture and Rural Development, 2023). It introduces climate-smart agriculture by advocating advanced farming technologies and practices that improve resilience to climate change. Key components include efficient use of water and soil resources, crop rotation, and diversification to promote sustainable food production. Adaptation strategies, such as drought-resistant crops and improved irrigation systems, are emphasized to address climate change (Kosovo Advisory System for Agriculture and Rural Development, 2023). The plan also promotes the reuse of agricultural by-products, aligning with circular economy principles.

1.3. The Strategy for Agriculture and Rural Development

This is an important strategic document that provides a long-term vision for the sector, aligning with national priorities. It integrates climate risk assessments into agricultural planning, emphasizing climate-smart agriculture practices. Sustainable farming practices are promoted to enhance productivity without degrading natural resources. The strategy addresses both mitigation and adaptation measures for climate change, including reducing emissions and enhancing resilience to extreme weather events. Circular economy initiatives are supported through local markets for recycled agricultural products and the use of renewable energy sources in farming.

According to the Strategy for Agriculture and Rural Development 2022-2028, currently, there is a plenty of space for improvement because there is a lack of clear policies and legislation for the sustainable management of agricultural land. The quality of the fertilizers and pesticides is considered low, inadequate

management of manure, irrigation system, water and air pollution with nitrogen compounds constitute the main problems. Kosovo has potential to contribute to climate change mitigation through carbon sequestration measures, such as afforestation of the agricultural land. Kosovo hasn't elaborated projections for GHG emissions and does not have a reference period for possible reductions yet, as it is not yet part of the international conventions. Aiming to increase its livestock and considering the sector's capacity to generate profit to be re-invested, Kosovo finds it challenging to follow the EU target of reducing GHG emissions by 55% until 2050. Regarding renewable energy an important impact in stimulating renewable energy was achieved through the MAFRD grants schemes.

Moreover, for some sectors, the low quality of the planting material (especially in the case of grapes, orchards, soft berries, etc.) is hampering productivity. Level of mechanization also affects productivity. Weak endowments with machinery and outdated machinery are primary obstacles to increasing labor productivity. Quality and safety standards are weakly implemented. Master Plan for Irrigation, prepared by the World Bank in 2020, includes valuable recommendations, but still is not yet included in the financing mechanism of the public administration.

Despite the very high proportion of small farmers and various gaps in the value chain, only a few farmer associations are known. Softwood sector, fruit and vegetables are more active in terms of involvement in organizations or their establishment. The knowledge gap might be the most problematic bottleneck in the modernization of Kosovo's agriculture. There is no rigorous control system that may validate the rules are appropriately respected. The collection of NWFP and MAPs is one of the essential rural businesses. Some concerns are raised over the sustainability of this type of business, as the activity is under weak state control. There is a risk of natural resource depletion due to overharvesting. Sound environmental practices are mainly missing and weakly promoted.

Public or private advisory systems do not promote good practices for climate change adaptation, such as usage of cover crops, no-tillage or minimum tillage, crop diversification, and rotation. Direct payments are not linked to any environmental conditionality, and there is not any agri-environment measure yet in place. The challenge remains in the fact that Kosovo does not have an adequate market for agricultural insurance schemes which would significantly increase farmers' ability to adapt toward climate risks.

Increasing the competitiveness of the agri-food sector and improving the efficiency and sustainability of farm production is one of the strategic objectives that can contribute to climate-smart agriculture. Investing in sustainable farm revenues, enhancing food safety, competitiveness, and market orientation, along with focusing on research, innovation, technology, and digitalization, can indeed have a positive impact. By improving farmers' positions in the value chain through these measures, the adoption of more sustainable practices is enabled. For example, utilizing innovative technologies and digital tools can help farmers monitor and optimize their resource use, leading to more efficient and environmentally friendly farming methods. Additionally, research and innovation can contribute to the development of climate-resilient crops and practices better suited to changing environmental conditions, ultimately promoting sustainable agriculture and mitigating the effects of climate change.

Another strategic objective is the sustainable management of natural resources, including land, forests, and water. By actively participating in efforts to mitigate and adapt to climate change, promoting sustainable land, water, and air management, and prioritizing biodiversity protection, enhanced ecosystem services, and the conservation of habitats and landscapes, we can significantly bolster climate-smart agriculture. These actions help create a more resilient agricultural system that can better withstand the challenges posed by climate change. Sustainable management practices ensure the efficient use of resources, reducing environmental impact while maintaining productivity. Furthermore, by safeguarding biodiversity and ecosystems, we support natural processes that are vital for agricultural productivity and long-term

sustainability. This holistic approach not only benefits the environment but also enhances the overall resilience and success of agricultural practices in the face of a changing climate.

Without first modernizing the agri-food sector, it is hard, if not impossible, to enter market competition with CEFTA and EU countries. There is significant pressure on all farms, especially those that are market oriented. Fruits and vegetables are market-related sectors, and there is a need for extra transitional support income. Moreover, fruits and vegetables, berries, and medicinal and aromatic plants are considered to have more potential for job creation. To support these sectors and the growth of organic farming, it is important to establish young farmers as managers, encourage digitalization, and facilitate access to financial capital. MAPs and NWFPs are export-oriented sectors that need support related to post-harvest facilities and equipment, including dryers and cooling storage. Strengthening monitoring capacities for these two sectors is essential to ensure that over-harvesting is avoided. Advisory services should be more involved in developing awareness campaigns and delivering training sessions regarding climate change adaptation practices.

It is planned to link grants with meeting standards obligations, which is crucial as it ensures that farmers and producers adhere to established guidelines and regulations, promoting sustainable and responsible practices. By tying grants to these standards, farmers are incentivized to adopt environmentally friendly methods, maintain food safety, and comply with ethical and legal requirements. This linkage not only benefits the environment and consumer health but also helps build a more sustainable and resilient agricultural sector in the long run.

1.4. Climate Change Strategy and Action Plan 2019 - 2028

Although the Government of the Kosovo (GoK) has announced that the Climate Change Strategy 2019 – 2028 will be revised into the Climate Change Adaptation Strategy, the current Climate Change Strategy and Action Plan remains in force, and it outlines Kosovo's strategic approach to climate adaptation and mitigation. The Climate Change Strategy and its Action Plan outlines Kosovo's strategic approach to climate adaptation and mitigation, with not such a big focus on the agricultural sector although it points out the sector's vulnerability to climate change. The strategy draws extensively from the Agriculture and Rural Development Plan, FAO reports, and other documents from the Ministry of Agriculture, Forestry, and Rural Development (MAFRD).

The strategy highlights that Kosovo's agricultural sector, although reduced from 25% of GDP in the 1980s to 14.1% in 2011, remains vital, accounting for 35% of total employment and 16% of total export value. The total agricultural land is approximately 470,400 hectares, with 413,635 hectares being arable land and 65,856 hectares classified as pasture. The sector faces several climate-related challenges, including irregular rainfall, droughts, and soil degradation. The sector is predominantly composed of small-scale farms, with about 52% involved in livestock production. Livestock farming is economically significant, promoting related sectors like plant production and processing industries.

According to the greenhouse gas (GHG) emission inventory prepared by the Kosovo Environmental Protection Agency (KEPA) for 2008-2013, the average GHG emissions in Kosovo were about 8.5 million tons of CO₂ equivalent annually. The energy sector is the main source of GHG emissions, accounting for 88% of total emissions, while agriculture contributes 7% or 690 Gg CO₂ eq.

Water management is a critical challenge due to Kosovo's susceptibility to droughts and irregular rainfall. The strategy promotes modern irrigation systems to improve water use efficiency and encourages renewable energy sources, such as solar and wind power, to reduce the agricultural sector's carbon footprint. The strategy identifies several significant challenges that inhibit the agricultural sector's capacity

to adapt to climate change. One major issue is the loss of agricultural land, with an estimated 400 hectares converted to construction land annually due to uncontrolled urban development and inadequate enforcement of land protection legislation. Other challenges include deforestation, quarrying, and waste management.

The strategy outlines three primary measures related to agriculture: **1) improving manure storage, preparation, and application methods; 2) proper application of mineral and organic fertilizers; and 3) promoting organic production.** These measures aim to reduce emissions and enhance the sector's sustainability. Although the Strategy does not go into the details of the primary measures related to agriculture, we can foresee positive impacts of these measures both toward climate mitigation and adaptation within the agricultural sector:

Primary Measures	Strategic	Mitigation	Adaptation
Improving manure storage, preparation, and application methods		From a mitigation perspective, better manure management reduces methane emissions. Proper storage techniques, such as covered manure storage facilities, prevent the uncontrolled release of methane during manure decomposition. Additionally, technologies like anaerobic digestion convert manure into biogas, which can be used as a renewable energy source, replacing fossil fuels and further reducing GHG emissions.	A well-managed manure improves soil health by adding organic matter and essential nutrients, enhancing the soil's ability to retain water and nutrients. This increased soil fertility makes crops more resilient to climate extremes such as droughts and heavy rains.
Proper application of mineral and organic fertilizers		Reduces nitrous oxide emissions significantly, especially compared to energy-intensive artificial fertilizers that are imported. When fertilizers are applied efficiently, using techniques such as precision farming and split applications, plants utilize nutrients more effectively, minimizing the amount of nitrous oxide released into the atmosphere. Furthermore, optimized fertilizer application reduces nutrient runoff and leaching into water bodies, preventing eutrophication and the associated greenhouse gas emissions from aquatic ecosystems.	Ensures that crops receive the right amount and type of nutrients at the appropriate times enhances their growth and resilience to climatic stressors like drought and heat. Proper nutrient management maintains soil health, which is critical for sustaining agricultural productivity under adverse climate conditions.
Promoting organic production	organic	Organic farming practices, such as crop rotations, cover cropping, and reduced tillage, increase soil organic matter and enhance carbon sequestration in the soil. Additionally, organic farming avoids the use of synthetic pesticides and fertilizers, whose production and application are associated with significant GHG emissions. By reducing reliance on these chemical inputs, organic farming lowers the overall carbon footprint of agricultural practices.	Diverse cropping systems in organic farming reduce the risk of pest and disease outbreaks, enhancing the stability and productivity of crops.

1.5. Annual State of the Environment Report, 2021

This report provides a thorough overview of Kosovo's environmental conditions, highlighting various sectors' impacts, including agriculture. The specifics of the report in relation to the agricultural sector pinpoint major pollution concerns both from the agricultural sector and to the agricultural sector. Agriculture is considered a major source of land pollution due to the extensive use of chemical fertilizers and other soil treatment chemicals. Indiscriminate use of pesticides and fertilizers further exacerbates soil degradation and contamination. Additionally, illegal waste dumps, industrial activities, and improper storage of chemicals contribute significantly to land pollution.

Water use data for 2021 indicates that the total production of water distributed by regional companies was 156.4 million m³, with 65.97 million m³ used for drinking water and 77.69 million m³ used for agricultural irrigation. However, water losses are substantial, estimated at approximately 85.61 million m³. Agricultural activities significantly impact water quality, with industrial development, urbanization, and intensive agriculture contributing to water pollution. Chronic health risks are associated with exposure to pollutants such as chromium, lead, nitrates, and ammonia, which are prevalent in agricultural runoffs.

In 2021, Kosovo used 78,976,185 kg of various fertilizers and treated 122,138 hectares of land with pesticides. These inputs are crucial for crop productivity but pose environmental and health risks due to their potential to contaminate soil and water resources. The report underscores the need for better management practices to mitigate these risks.

The report does not address climate adaptation but rather focuses on the impacts of agriculture on pollution. However, it can be concluded that the sources of pollution from agriculture, such as pesticides and fertilizers, if met with climate-friendly or climate-smart initiatives, can not only lower land and water pollution but also contribute to agriculture's resiliency toward climate change. Implementing sustainable agricultural practices, improving water management, and promoting organic farming can mitigate pollution while enhancing the sector's ability to adapt to climate variability and extremes. This dual approach can support both environmental protection and the sustainability of Kosovo's agricultural systems.

1.6. Report of Municipal Waste Management in Kosovo, 2021

This report details the current state, challenges, and improvements in waste management across various municipalities in Kosovo, which directly relates to our study's goals of assessing environmental impacts and proposing sustainable solutions. The report indicates substantial advancements in waste management practices, highlighting an increase in waste collection coverage to 90.2% by 2021. This improvement in waste management is crucial as it reduces environmental pollution and fosters a healthier environment for sustainable agricultural practices. Effective waste management practices mitigate the risks of land and water contamination, which are vital for maintaining productive agricultural land.

The feasibility study will benefit from this robust data, enabling us to tailor our recommendations to the specific needs and conditions of Kosovo's agricultural and environmental landscape. As attained from the Focus Group discussions, climate-smart technologies go together with circular economy concepts, especially when considering treatment of organic waste at the processing facilities. The chapter on different interventions will highlight some of these technologies that contribute to reducing organic waste and ensuring maximum utilization of agricultural products that contribute to a higher financial stability of the agricultural operation thus increasing the agricultural producer's or processing facility's ability to adapt toward unforeseen climate risks.

1.7. Republic of Kosovo: Request for Stand-by Arrangement and an Arrangement Under the Resilience and Sustainability Facility—World Bank Assessment Letter

The World Bank Assessment Letter for the Resilience and Sustainability Facility outlines several projects and initiatives related to climate adaptation and mitigation, with particular attention to the agricultural sector. Climate change poses a significant risk to Kosovo's development progress, given the country's susceptibility to various natural hazards such as droughts, wildfires, landslides, earthquakes, and floods. This will have a direct impact on the agricultural sector, which accounts for 7% of the country's economic value added and provides crucial income security for rural households where poverty is concentrated. Recent floods due to heavy rain have already caused damages amounting to 0.9 percent of GDP, and climate change is expected to exacerbate the risks to the forestry sector with increased wildfire risks, changes in species composition, and soil erosion. Kosovo's population, particularly the poor and vulnerable, is more adversely affected by climatic hazards compared to peer countries. Contributing factors include the use of obsolete industrial technologies, unsustainable water management and agronomic practices, deforestation, mining activities, socio-economic vulnerability due to high poverty rates and limited social protection, and inadequate land use and municipal planning, which increase exposure to hazards.

According to the latest Census, approximately 60 percent of the population lives in rural areas, and nearly two-thirds of the poor and extremely poor in these areas face declining agricultural productivity. Limited economic opportunities due to the unproductive agricultural sector and the increasing threat to natural resources like water and land exacerbate the situation. Key climate impacts, such as crop failure and loss of pasture lands and water resources for livestock, disproportionately affect the most at-risk and poor households.

Currently, household consumption constitutes around 60 percent of demand, followed by public and private services (20 percent) and agriculture and industry (18 percent), and public lighting (2 percent). Agriculture currently holds a lower percentage in energy demand but throughout various focus groups, lack of security of energy supply and the need to be energy efficient was one the highlight of the discussion.

1.8. A Green Recovery in Kosovo

The "Green Recovery in Kosovo" report outlines essential policy priorities for a sustainable recovery by reducing the country's high carbon and energy intensities. During the OECD green recovery peer-learning workshop, Kosovo participants from government, private sector, and civil society highlighted reducing energy consumption by 26% by 2030 as a top priority, primarily through energy efficiency measures. They proposed an action plan with six actions and corresponding targets and measures to complement current policy efforts. Focusing on agriculture, the report discusses the limitations and environmental risks associated with hydropower in Kosovo. The country's rivers have low water flow, and new and existing hydropower plants negatively impact the environment and local communities, contributing to riverbed degradation and the destruction of aquatic ecosystems. Ancillary activities, such as road construction, also threaten biodiversity, contribute to soil erosion, and reduce ground and surface water levels, sometimes depriving local residents of water for drinking and agricultural activities.

1.9. Kosovo's flood risk maps and flood hazard maps

Kosovo is actively addressing the challenges posed by climate change through a multifaceted approach that encompasses both adaptation and mitigation strategies. One significant initiative involves the development of flood risk maps and flood hazard maps for all river basins in Kosovo, with support from the Western Balkans Investment Framework (WBIF) and the German Development Cooperation (GIZ). These maps, set to be completed by June 2024, are integral to understanding and managing flood risks across the country.

The preliminary flood risk assessment, completed with WBIF and GIZ support, has analyzed 834 cadastral zones covering a total area of 7,056 km². Furthermore, the assessment identified 398 areas of potential significant flood risk, categorized based on their level of risk. Importantly, these analyses incorporate multiple scenarios, including different probabilities and climate change scenarios, to ensure comprehensive planning. In addition to addressing flood risks, Kosovo has initiated a vulnerability assessment of its agricultural sector with support from the USAID Climate Adapt Project. This assessment aims to identify specific climate risks that agriculture faces, such as droughts, heatwaves, and unpredictable weather patterns. Moving forward, Kosovo plans to leverage the data and findings from these initiatives to inform the development of its climate change adaptation strategy. This strategy will utilize the best available science and incorporate input from stakeholders across various sectors, with a particular focus on agriculture.

1.10. Kosovo: Agro Activity Climate Risk Management Case Study

This case study focuses on the significant impact of climate risk management (CRM) actions on the agricultural sector in Kosovo. The AGRO (for short) Activity recognized the threats posed by climate risks like water shortages and intense storms and the AGRO team implemented various CRM actions. These included technologies to decrease agricultural water use per unit area and measures to protect crops from extreme weather events. The CRM actions contributed to improved crop yields, water conservation, reduced crop losses, job creation, and increased resilience among partners. The AGRO team's efforts resulted in a 50-300 percent increase in yields for important crops, reduced irrigation water demand by up to 4,000 cubic meters per hectare and avoided crop losses due to early warning systems and crop protection measures. Additionally, CRM actions provided seasonal employment for women, significantly boosting household incomes. Some of the measures included were installing drip irrigation systems, implementing fertigation practices, introducing new crop varieties, developing anti-frost systems, adapting greenhouse production methods, and developing an early warning system. The introduction of drip irrigation and fertigation systems, for example, led to significant yield increases for crops like blueberries, raspberries, gherkins, peppers, industrial strawberries, apples, and sour cherries.

In conclusion the reviewed documents demonstrate a comprehensive approach to integrating climate-smart agriculture, sustainable food production, and climate change mitigation and adaptation into Kosovo's national agricultural framework. Circular economy principles are consistently promoted, emphasizing waste reduction, resource efficiency, and enhanced resilience to environmental challenges. In addition, energy efficiency and its potential to be more integrated in agriculture is highlighted as imperative given Government's strategic orientation toward decarbonization. These strategic plans and reports provide a solid foundation for advancing sustainable agricultural practices in Kosovo, which a focus on application of organic fertilizers and increase of resource and energy efficiency.

Kosovo's strategic documents emphasize the adoption of climate-smart agricultural practices to enhance resilience and productivity. The National Organic Action Plan (NOAP) 2023–2026 and the Strategic Plan of the Kosovo Advisory System for Agriculture and Rural Development 2023–2027 both highlight the importance of reducing greenhouse gas emissions and improving carbon sequestration through organic and sustainable farming practices (Ministry of Agriculture, Forestry and Rural Development, 2023; Kosovo Advisory System for Agriculture and Rural Development, 2023).

The integration of technology in agriculture is a significant focus in Kosovo's strategic plans. The Strategic Plan of the Kosovo Advisory System for Agriculture and Rural Development 2023–2027 and the Strategy for Agriculture and Rural Development 2022–2028 emphasize the use of smart agricultural practices to increase efficiency and productivity (Kosovo Advisory System for Agriculture and Rural Development, 2023; Ministry of Agriculture, Forestry and Rural Development, 2022).

Kosovo's approach to the circular economy in agriculture is reflected in several strategic documents. The National Organic Action Plan (NOAP) 2023–2026 and the Report of Municipal Waste Management in Kosovo 2021 highlight the importance of recycling agricultural waste and promoting sustainable resource use (Ministry of Agriculture, Forestry and Rural Development, 2023; Ministry of Environment and Spatial Planning, 2021).

Food processors in Kosovo are struggling with a lack of information about specific market demands, which can cause problems entering new market segments. Sustainable supply chain partnerships among Kosovo's food processing industry, contractors, franchise businesses, and retailers are crucial for economic growth. To help with improvements, USAID, in partnership with PePeKo, supported the Food Sector Forum. The USAID Kosovo Compete Activity is currently working to support Kosovo's food processors in linking with local and foreign buyers and acquiring the necessary product quality certifications. Moreover, supporting the Food Sector Forum is important because it can help address challenges such as food security, sustainability, and market access, ultimately leading to more informed decision-making and positive outcomes for the food industry as a whole.

A meta-analysis of the scientific output on climate change issues in Kosovo shows that most of the research is focused on environmental science (22.53%), followed by engineering (21.12%), social sciences (19.72%), and energy (15.49%). Despite other sectors, food processing systems and agriculture will be greatly affected by climate change (Caka & Caka, 2022). In recent years, the urban population has grown very fast, and there is a need to strengthen food production and distribution systems to support the needs of urban populations. This can be achieved by developing urban agriculture (Caka, 2022). Urban agriculture plays a crucial role in enhancing food security, promoting sustainability, and fostering community resilience in cities. It involves growing, processing, and distributing food within urban areas, reducing the distance food travels from farm to table. By utilizing spaces like rooftops, vacant lots, and community gardens, urban agriculture increases access to fresh produce, educates communities about food production, and can even contribute to mitigating climate change through carbon sequestration in urban green spaces. Still, it is necessary to produce food that is not only fresh and local but also environmentally sustainable and healthy for consumers.

Transforming to organic farming in Kosovo is a lengthy and challenging process. The sectors of NWFPs and MAPs are considered the most promising organic sectors in Kosovo. The amount of support given is not enough to fulfill all the investments needed (Iliriana Miftari, 2022). Organic products preferred by Kosovar consumers compared to conventional ones, but they are still not willing to pay more for these products (Hoxha & Musliu, 2021). To foster the growth of organic farming in Kosovo, a comprehensive

approach is needed, encompassing policy development, awareness raising, infrastructure development, and financial incentives (Regional Rural Development Standing Working Group in SEE & GFA Consulting Group GmbH, 2022). By raising public awareness and expanding market access, demand for organic products can be increased. Financial incentives, such as subsidies and grants, can help farmers transition to organic production, especially small-scale operators.

2. In Depth Interviews

There were 12 in-depth interviews conducted with stakeholders, including governmental institutions, international organizations, academia, associations and agribusinesses beneficiaries of the SIREN and EREA project. The interviews with key stakeholders in Kosovo's agricultural sector highlight the significant challenges posed by climate change, technological barriers, and financial constraints. However, there are also substantial opportunities for adopting climate-smart agriculture, improving infrastructure, and enhancing market access. Effective government policies, financial support, and continuous training and capacity building are essential to promote sustainable agricultural practices and enhance resilience to climate change.

The list of stakeholders interviewed	
Government institutions	- Ministry of Environment, Spatial Planning and Infrastructure - Ministry of Agriculture, Forestry and Rural Development
International organizations	United Nations Development Programme in Kosovo
Academia	The Faculty of Agriculture and Veterinary Medicine, University of Prishtina
Associations	- AgroDev - IADK - Mjedra e Kosoves - Shoqata Organika - EkoKosWomen - PePeKo
Beneficiaries	- Eurofruti - Hit Flores - Ananas Impex

2.1. Findings from in-depth interviews

The in-depth interviews with key stakeholders in Kosovo's agricultural sector, including governmental institutions, international organizations, academia, associations, and agribusinesses, revealed significant challenges and opportunities. The most significant climate-related changes noticed were variations in precipitation, droughts, floods, and wild forest fires. These climate changes have adversely impacted agricultural productivity and food security, causing damage to crops, especially fruits, due to late frosts and high summer temperatures. Interviewees highlighted the need for advanced climate-smart technologies, such as anti-hail systems and smart irrigation, to mitigate these effects.

Topic	Government Institutions	Associations	Academia	Agribusinesses
The most significant climate-related or environmental changes noticed over the past few years.	Government representatives have noted the effects of climate change on weather patterns, including more extreme weather events. They have observed that winters are starting later and are generally milder, with a rise in the frequency and intensity of floods and droughts. Additionally, there are noticeable increases in air temperatures and heatwaves. The government is actively working on strategies and measures to address and mitigate these climate impacts.	Associations have reported significant changes in precipitation patterns, including more frequent droughts, floods, and wildfires. Hail events have also become more common. There are positive anomalies in climate variables such as air temperature, average precipitation, and snowfall. Additionally, the late onset of winter and reduced water retention in surface water bodies, due to increased evaporation rates from higher air temperatures throughout the year, are major concerns. The associations are advocating for measures to tackle these evolving climate challenges.	Academia has highlighted significant changes in precipitation patterns, leading to more frequent droughts, floods, and wildfires. There are notable changes in average temperatures, reductions in precipitation, and other atmospheric conditions on Earth. These changes result from both natural processes and human-induced alterations. Researchers emphasize the urgent need for comprehensive studies and interventions to address these complex climate issues.	Agribusinesses have reported facing extreme weather conditions, with late winters and early summers becoming more common. They are experiencing a higher frequency of floods and droughts, as well as damage from the sun burning their products. Additionally, milder winters and frequent hailstorms are posing significant challenges. These changes are affecting crop yields and production, prompting agribusinesses to seek adaptive strategies and solutions.
Impact on Agricultural Productivity and Food Security	Government institutions have reported an increase in flash floods and 20- and 100-year floods, significantly impacting agricultural land. Early blooming followed by harsh weather is causing damage to crops, while droughts and insufficient irrigation are exacerbating the challenges faced	Associations have observed that floods and high temperatures are adversely affecting crop development, while late frosts are causing significant damage. The delay in winter impacts agricultural cultures annually, particularly delicate ones that flower in January due to higher	There is no study that explicitly brings evidence on how climate change affects agricultural productivity and hence food security. However, observing the statistics of agricultural output, of vegetables grown in open field it can be observed a negative trend in terms of yield	Agribusinesses have reported early blooming followed by harsh weather, which is damaging crops. They are also struggling with droughts and insufficient irrigation. Additionally, floods, high temperatures, and late frosts are causing significant harm to crops. These challenges are leading to

Topic	Government Institutions	Associations	Academia	Agribusinesses
	by the agricultural sector. These issues highlight the urgent need for effective water management and climate adaptation strategies to protect and sustain agricultural productivity.	temperatures. Crops, especially fruits, suffer damage from late frosts and high summer temperatures, leading to challenges in fruit setting and dehydration of crops. These issues underline the pressing need for adaptive measures and support for farmers to mitigate these impacts.	per ha during the last 5 to 6 years. The decrease in yield can be attributed to climate change, shift in farming calendar and cultivated varieties less adaptive to climate change.	lower productivity and an increase in pests, necessitating the implementation of more resilient agricultural practices and improved irrigation systems.
State of Post-Harvest Technology	There is room for integration of energy efficiency and circular economy projects within this sector.	Associations have noted that the processing sector has seen limited advancements, with some implementation of solar panels for pasteurization and a few adopting solar drying methods. There has been investment in refrigerators and cooling units, and efforts are being made to enhance energy efficiency in processing. Additionally, there is a growing interest in installing solar panels in barns to improve sustainability and reduce energy costs.	Academia has highlighted that there is significant room for improvement in the adoption of sustainable practices. They emphasize the need for increased sensibilization and education to promote these practices effectively.	Agribusinesses are increasingly integrating energy efficiency and circular economy principles into their operations. They have started using solar panels for daily activities, aiming to reduce energy costs and enhance sustainability.
Sources of Information on Climate Change and CSA	- o Hydrometeorological Institute. - o Kosovo Environmental Protection Agency. - o European Environmental Protection Agency.	- o World Bank, Caritas, field observations - o Internet research, European advisory services, international experts - o Agroportal, local observations	o Technical reports, scientific articles, strategic and programming documents.	- o Caritas - o USAID Kosovo - o Internet Research - o Agroportal - o Fairs held outside the country have raised the businesses self-awareness regarding the

Topic	Government Institutions	Associations	Academia	Agribusinesses
	o Different academic and international organizations.	- o Field data, expert consultations - o Technical reports, scientific articles, strategic and programming documents - o Official data and Environmental Agency.		impact of climate change on agriculture.
Sector Challenges Related to Environment and Climate Change	Government institutions acknowledge several challenges related to the environment and climate change. These include limited access to UNFCCC processes and mechanisms for climate adaptation and mitigation, as well as climate finance options like GEF and GCF. There is also a lack of institutional capacity to integrate climate adaptation into sectoral strategies effectively. Furthermore, there is insufficient information on the best climate adaptation measures suited to future climate forecasts and models.	Associations highlight several challenges in addressing climate change. There is a lack of sufficient information and low acceptance of new practices. Basic knowledge is often missing, and high costs and maintenance issues pose significant barriers. Financial constraints and the high costs of adaptation measures further hinder efforts to implement effective solutions.	Academia points out that climate adaptation measures in Kosovo require substantial investments in technology, renewable energy, and capacity building. However, Kosovo faces significant budgetary constraints, making it difficult to allocate the necessary funds for these measures. The challenge is further compounded by the lack of access to international financial mechanisms, such as those provided by the UNFCCC, GEF, and other adaptation funds, which limits Kosovo's ability to effectively address climate issues.	Agribusinesses emphasize that farmers have been hesitant to adopt new practices due to a lack of knowledge about climate change. Additionally, the high cost of adaptation measures poses a significant barrier, making it challenging for farmers to implement necessary changes.
Measures Taken to Address These Challenges	Government institutions have taken several measures to address climate change challenges. These include the functionalization of the Climate Change Council and the	Associations are actively promoting various measures to address climate challenges. These include the promotion of anti-hail systems and smart	The strategic planned measures 2022-2028 include: 1) Introduce good agricultural and environmental practices aimed at improving carbon	Agribusinesses are taking several steps to address climate challenges. They are encouraging the use of anti-hail systems and smart irrigation systems.

Topic	Government Institutions	Associations	Academia	Agribusinesses
	Interministerial Climate Change Secretariat. They have adopted the Climate Change Law and initiated the Climate Change Adaptation Strategy. Budget allocations now include climate adaptation in infrastructural projects. Additionally, climate adaptation is being mainstreamed in sectoral strategies, with sectoral measures on climate mitigation considered through the National Energy and Climate Plan and the voluntary Nationally Determined Contributions (NDC).	irrigation systems. They are investing in solar panels and promoting sustainable practices. Efforts are being made to implement flood management systems and modernize irrigation systems, including conducting feasibility studies for water reservoirs. Associations are also advocating for the use of micro-sprinkler systems and educating farmers on sustainable practices.	sequestration (for example, not burning incinerators); 2) Prioritize grants for farmers with investments in renewable energy; 3) Afforestation of opening areas; 4) Preparing of management plans; 5) Extensive pasture management for high biodiversity lands in areas with proven biodiversity values, such as protected areas; 6) Preparation of guidelines for farmers and pasture users for the use and management of value added pastures. Organic farming - subsidizing / compensating for farmers who follow the rules of organic farming, as their production is usually lower against the ban on chemical fertilizers and pesticides. Alignment of the forestry sector legislation with the EU Acquis. Forested areas covered by long-term management plans. Forest areas covered by multi-purpose integrated forest management plans in five pilot sites. Forest and forest land area inventoried. Regulation of titled holders and owners of	Investments are being made in solar panels promoting sustainable practices. Agribusinesses are also using agrotextiles. Agribusinesses have been active in providing subsidies for berry production to support farmers and enhance resilience against climate impacts.

Topic	Government Institutions	Associations	Academia	Agribusinesses
			public forests and their registration in the cadastre. Identification and registration of usurpations of forests and forest lands, as well as legal property disputes. Registration of forest lands by function. Increase (expansion) of forest areas.	
Perceived Benefits and Barriers of Implementing Climate-Smart Agriculture Policies	Government institutions recognize several benefits and barriers to implementing climate-smart agriculture policies. These policies can help maintain the yield of important crops in Kosovo, reducing the reliance on agricultural imports. They also provide financial security for farmers and rural areas and increase resilience to climate change. However, barriers such as the need for substantial investments, limited knowledge, and the high costs associated with these measures remain challenges that need to be addressed.	Associations identify several benefits and barriers to implementing climate-smart agriculture policies. The high costs and lack of awareness are significant barriers, but the benefits include improved yield and quality of crops. Increased productivity and better quality are also noted as advantages. Renewable energy adoption offers additional financial security. Despite financial barriers and a lack of knowledge, the potential for improved resilience and leadership in production remains a key benefit. Overall, the cost and awareness challenges are offset by the prospects of better productivity and enhanced crop quality.	Perceived benefits relate mainly to improved yields, environmental benefits like improved soil health, water conservation due to efficient use of irrigation systems and reduction in GHG emissions.	Agribusinesses face financial limitations and a lack of awareness as barriers to implementing climate-smart agriculture policies. However, the benefits include better yield and quality of crops. Renewable energy offers extra financial security, and many companies are now operating on renewable energy to enhance sustainability and reduce costs.

Topic	Government Institutions	Associations	Academia	Agribusinesses
Practices or Technologies for CSA Implemented in the Area	N/A	Associations have emphasized various practices and technologies for climate-smart agriculture in the area. These include using solar panels for pasteurization and drying and adopting renewable energy in processing facilities and new orchards. Micro-sprinklers are utilized for irrigation, and efficient drip irrigation systems are in place. Additionally, sustainable farming practices and meteorological stations as warning systems are part of their efforts to enhance resilience and productivity.	There are many farmers that have successfully applied climate-smart technologies e.g. blueberry producers through efficient drip irrigation systems, or grape producers through meteorological stations as warning systems.	Agribusinesses have adopted several climate-smart practices and technologies. They are using agrotextiles and incorporating renewable energy in processing facilities. Smart irrigation systems have also been implemented to enhance water efficiency and crop management.
Additional Financial, Technical, and Political Support Needed	Government institutions recognize the need for additional financial, technical, and political support. Ongoing grants and subsidies for energy efficiency measures for households and SMEs should be expanded to include farmers. There is also a need to integrate climate adaptation and mitigation components into the annual grant and subsidy schemes of the Ministry of Agriculture, Forestry, and Rural Development (MAFRD).	Associations emphasize the need for increased government and donor support, along with financial incentives. They advocate for the provision of climate-friendly tools and guidelines, and call for lower investment costs and easier access to subsidies. Special funds from ministries and municipalities, as well as donor investments, are crucial. Additionally, increased financial	Adaptation of climate-smart practices are costly in terms of technology but also in terms of knowledge. Hence, farmers and agricultural enterprises need financial through well designed policy support schemes and advisory support towards adaptation of climate-smart practices.	Agribusinesses highlight the need for increased government and donor support, along with financial incentives. They emphasize the importance of providing climate-friendly tools and guidelines, particularly for farmers, to help them adopt sustainable practices and improve resilience.

Topic	Government Institutions	Associations	Academia	Agribusinesses
		and technical support through well-designed policy support schemes and advisory services are necessary to promote the adaptation of climate-smart practices. More incentives and government support are essential for successful implementation.		
Engagement of Various Stakeholders in Implementing Sustainable Agricultural Practices	Government institutions stress the importance of engaging various stakeholders in implementing sustainable agricultural practices. Ongoing donor coordination is focused on advancing the climate agenda. The Climate Change Secretariat is undergoing reforms to become more inclusive, yet it has remained highly active over the past two years.	Associations emphasize the need for coordination among donors and local stakeholders to implement sustainable agricultural practices effectively. They highlight the necessity of practical models and investments, as well as integrating the climate change agenda across various ministries. Better coordination and support among different stakeholders are crucial for successful implementation.	There is a lack of coordination between various stakeholders in this matter. Except for the study conducted on climate change on WB countries implemented by SWG and recently the development of NDC report there is no other initiative to put together stakeholders with the aim of addressing SAP and CSA.	Agribusinesses note that there is better coordination with international organizations and donors compared to government institutions. They also emphasize the need for improved coordination and cooperation among farmers to enhance the implementation of sustainable agricultural practices.
Effectiveness of Governmental and Donor Policies in Promoting CSA	There is room for improvement to streamline both mitigation and adaptation specifically for agriculture and forestry.	Associations assess the effectiveness of governmental and donor policies in promoting CSA as limited. They highlight the need for specific projects and targeted actions, along with better coordination and implementation.	There is a lack of coordination body that could enhance engagement of all stakeholders towards this matter.	Agribusinesses have indicated that awareness should be raised and a better implementation of Government policies is required.

Topic	Government Institutions	Associations	Academia	Agribusinesses
		Policies are often made in isolation from farmers and agribusinesses, indicating a need for improved collaboration and focus to enhance their impact.		
Promising Innovations or Technologies for Advancing CSA	Government institutions identify several promising innovations and technologies for advancing CSA. These include smart irrigation systems and crop varieties resilient to anticipated climate changes. Additionally, the implementation of flood management plans is crucial to reducing the risk of flash floods. Proper infrastructure and spatial planning are essential to prevent damage to agricultural lands from flooding.	Associations highlight several promising innovations and technologies for advancing CSA. These include the use of solar panels, minimal tillage, and digitalization in agriculture. Water gathering systems for heavy precipitation and smart irrigation systems are also emphasized. Sustainable farming practices and developing crop varieties resilient to climate change are key areas of focus. Associations also collaborate with agricultural research institutions to identify and develop crop sensitivity modeling.	Academia emphasizes several promising approaches for advancing CSA. These include lifelong learning and education programs for farmers and processors. Additionally, promoting collaboration between academia and agribusinesses is crucial for developing applied research that addresses CSA and SAP related issues.	Agribusinesses highlight several promising innovations and technologies for advancing CSA. These include the use of solar panels and the digitalization of agriculture. Water collection systems for heavy rain and smart irrigation systems are also emphasized. Additionally, they are incorporating electric vehicles for distribution, promoting climate-resilient crop varieties, and using hybrid seeds to enhance agricultural sustainability and productivity.

3.Focus Group Discussions

The focus group discussions conducted in various regions, including Gjilan, Prizren, Podujeva, and Prishtina, provided valuable insights into the local perceptions and challenges related to climate change and agriculture. Participants noted significant climate-related changes such as unpredictable rainfall, increased temperatures during winter and early spring, and extreme weather events. These changes have negatively impacted agricultural productivity, causing issues like late frosts damaging crops and decreased productivity due to increased pest presence. The discussions emphasized the importance of adopting climate-smart practices, such as using solar panels for drying and pasteurization, implementing efficient drip irrigation systems, and promoting sustainable farming practices. Financial and technical support, along with better coordination among stakeholders, were identified as crucial for advancing these practices.

	Location	Date	Number of participants
FGD 1	Gjilan	June 3, 2024	6
FGD 2	Prizren	June 4, 2024	5
FGD 3	Podujevë	June 5, 2024	6
FGD 4	Prishtinë	June 5, 2024	3

3.1. Findings from the focus group discussions

The focus group discussions highlighted several key findings related to climate change's impact on agriculture in Kosovo. One major issue is the late onset of winter, leading to early blooming of crops and subsequent damage from late frosts. This has resulted in decreased agricultural productivity and increased challenges in fruit setting and crop dehydration. Participants also pointed out the lack of modern post-harvest technology and the need for better information and resources to implement CSA. Despite these challenges, there is optimism about the potential benefits of CSA practices, such as improved yield and quality using solar panels and efficient irrigation systems. Enhanced financial support and simplified procedures for adopting renewable energy technologies were seen as essential to encourage wider adoption of these practices.

Topic	Answers from farmers	Answers from businesses
The most significant climate-related or environmental changes noticed over the past few years.	Farmers have observed several significant climate-related changes in recent years. These include changes in precipitation, more frequent droughts and floods, and deforestation. They have also noted higher temperatures during winter and early spring, unpredictable rainfall, extreme summer heat, sudden temperature changes, and new plant diseases. High temperatures have led to early	Businesses have noticed significant climate-related changes impacting their operations. Changes in precipitation, droughts, floods, and deforestation have negatively affected the quality and quantity of produce. Increased temperatures during winter and early spring, unpredictable rainfall, extreme weather events, and high summer temperatures have created challenges. Additionally, late onset of winter, sudden temperature shifts, and the emergence of new diseases have further complicated production, with high temperatures causing early blooming followed by spring frost.

Topic	Answers from farmers	Answers from businesses
	blooming followed by spring frost, disrupting the growing season.	
Impact on Agricultural Productivity and Food Security	Farmers have observed several climate-related impacts on agricultural productivity and food security. Floods and high temperatures are affecting crop development, while late frosts are causing significant damage, especially to fruits. Moderately higher winter temperatures are also noted. Challenges in fruit setting and crop dehydration have become more common, leading to decreased productivity and increased pest presence.	Businesses have observed several climate-related impacts on agricultural productivity and food security. These include reduced yield and lower quality of produce. They are also facing increased sensitivity to postharvest spoilage and greater challenges in pest and disease control.
State of Post-Harvest Technology	There has been improvement regarding post-harvesting methods.	The processing sector has seen some implementation of solar panels for pasteurization and limited adoption of solar drying methods. While some refrigerators and cooling units have been established, there is still a need for further investment in this area.
Sources of Information on Climate Change and CSA	Farmers rely on various sources of information regarding climate change and CSA. These include field observations and data, guidance from donors such as the World Bank, Caritas, and USAID, as well as resources from Agroportal and expert consultations.	Businesses gather information on climate change and climate-smart agriculture (CSA) from several sources. They rely on insights from farmers and partners, guidance from donors like the World Bank, Caritas, and USAID, news on the internet, and social media platforms.
Sector Challenges Related to Environment and Climate Change	Farmers face several sector challenges related to the environment and climate change. These include a lack of sufficient information, low acceptance of new practices, and a general lack of basic knowledge. High costs and maintenance issues, financial constraints, and budgetary barriers further complicate matters. Floods remain a significant problem with limited mitigation actions. Other challenges include the senescence of raspberry seedlings, a lack of hail protection measures, late spring frosts,	Businesses face several sector challenges related to the environment and climate change. These include a lack of information and education, financial constraints, and inadequate implementation of quality assurance standards in food processing units, leading to increased food waste and losses. Additionally, there is instability in electricity supply and a shortage of processing units to close the value chain and reduce waste. The absence of state advisory bodies on agri-food processing further exacerbates these challenges.

Topic	Answers from farmers	Answers from businesses
	insufficient modern collection points, unstable electricity supply, and the use of potable and polluted water for irrigation.	
Measures Taken to Address These Challenges	Farmers have taken several measures to address environmental and climate challenges. They are promoting anti-hail systems and smart irrigation systems and investing in solar panels to support sustainable practices. The adoption of micro-sprinkler systems and modernization of irrigation systems are also underway. Farmers are adjusting agricultural activity timelines and transitioning production to protected environments, such as greenhouses, particularly for vegetables. Additionally, efforts are being made to minimize processing losses by using waste for other products, with better technologies and composting methods converting waste into useful fertilizers and sellable products.	Businesses have taken several measures to address environmental and climate challenges. These include limited investments in training and education, as well as investing in eco-friendly technology. There have been investments in implementing Total Quality Management Systems (TQMS) and promoting sustainable practices. Efforts also include educating farmers, conducting soil analyses, and the rational use of pesticides and fertilizers.
Perceived Benefits and Barriers of Implementing Climate-Smart Agriculture Policies	Farmers perceive both benefits and barriers to implementing climate-smart agriculture policies. High costs and a lack of awareness or knowledge are significant barriers. However, the benefits include improved yield, quality, productivity, resilience, and leadership in production. Financial barriers remain a challenge, but the potential for better overall outcomes makes the investment worthwhile.	Businesses perceive high investment costs, lack of awareness, and financial constraints as the main barriers to implementing climate-smart agriculture policies. However, the benefits include lower operational costs and reduced negative environmental impacts.
Practices or Technologies for CSA Implemented in the Area	Farmers have implemented several practices and technologies for CSA in the area. These include minimal tillage, crop rotation, and the use of solar panels. Additionally, micro-sprinklers and efficient drip irrigation systems are utilized for	Businesses have implemented the use of solar panels for pasteurization and drying as part of their climate-smart agriculture practices.

Topic	Answers from farmers	Answers from businesses
	irrigation. Sustainable farming practices and meteorological stations as warning systems are also part of their efforts.	
Additional Financial, Technical, and Political Support Needed	Farmers need additional financial, technical, and political support to implement climate-smart agriculture practices effectively. This includes more government and donor support, financial incentives, and special funds from ministries and municipalities. Grants should prioritize new, climate-resilient crops to help farmers adapt and maintain productivity. Increased financial and technical support is essential, and procedures for adopting renewable energy need to be simplified. There is also a need for better control over the quality of fertilizers and easier access to organic options. Well-designed policy support schemes and advisory services are crucial for adapting to climate-smart practices.	Businesses need additional financial, technical, and political support to advance climate-smart agriculture. This includes more government and donor support, financial incentives, and special funds from ministries and municipalities. Grants should be more inclusive and prioritize the green economy and resilient food processing. Increased financial and technical support is essential for implementing these practices effectively.
Engagement of Various Stakeholders in Implementing Sustainable Agricultural Practices	Farmers emphasize the need for coordination among donors and local stakeholders in implementing sustainable agricultural practices. Practical models and investments are also essential for effective implementation.	Businesses highlight the necessity for improved coordination between donors and local stakeholders in advancing sustainable agricultural practices. Additionally, they emphasize the need for practical models and increased investment to ensure successful implementation.
Effectiveness of Governmental and Donor Policies in Promoting CSA	Farmers find governmental and donor policies in promoting climate-smart agriculture (CSA) to have limited effectiveness, needing more specific projects and better awareness and implementation. Comprehensive guidelines covering water availability, wind speed, and other environmental conditions, including flood risk maps, are essential and should be provided by the government or relevant authorities. Overall, the policies	Businesses view governmental and donor policies for promoting climate-smart agriculture (CSA) as moderately effective but believe there is a need for more coordination and targeted actions to enhance their impact.

Topic	Answers from farmers	Answers from businesses
	require more focus and coordination to be effective.	
Promising Innovations or Technologies for Advancing CSA	Farmers see several promising innovations and technologies for advancing CSA. These include the use of solar panels, minimal tillage, and digitalization in agriculture. Smart irrigation systems and sustainable farming practices are also being adopted. Developing and promoting climate-resilient crop varieties, collaborating with agricultural research institutions for crop sensitivity modeling, and providing certified, resistant seedlings are crucial steps. Other measures include opening private wells, accessing "green" loans, agricultural insurance, and installing protective films and nets. Additionally, reviewing and adapting university curricula, composting organic waste, and obtaining organic certification are important for advancing CSA.	Businesses see several promising innovations and technologies for advancing climate-smart agriculture (CSA). These include the use of solar panels and improvements in energy-efficient technology. They are also adopting sustainable agri-food processing practices and promoting the valorization of industry by-products or the use of agri-food sector waste as input for other products to prevent food losses. Additionally, Total Quality Management training and certification are being implemented to enhance overall efficiency and sustainability.

The comprehensive assessment of Kosovo's agricultural sector, conducted during task 2 through desk research, in-depth interviews, and focus group discussions, revealed several critical challenges and opportunities for implementing climate-smart agriculture (CSA):

- **Climate Change Impacts:** Stakeholders reported significant changes in weather patterns, including unpredictable rainfall, increased temperatures, and more frequent extreme weather events. These changes have adversely affected agricultural productivity, particularly in fruit setting and crop dehydration.
- **Policy and Institutional Framework:** While Kosovo has developed strategic documents addressing agro-environmental issues, there is a lack of clear policies and legislation for sustainable management of agricultural land. The implementation of climate-smart practices is hindered by insufficient government support and weak state control, especially in sectors like Non-Wood Forest Products (NWFPs) and Medicinal and Aromatic Plants (MAPs).
- **Technological Gaps:** Farmers expressed a strong need for advanced climate-smart technologies, such as anti-hail systems, smart irrigation, and renewable energy solutions. However, high costs and lack of technical knowledge remain significant barriers to adoption.
- **Organic Farming Potential:** The NWFPs and MAPs sectors are identified as the most promising for organic farming, but financial and professional support is needed to ensure a stable market for organic products.

- **Knowledge and Capacity Building:** A significant knowledge gap was identified as a major bottleneck in modernizing Kosovo's agriculture. There is a pressing need for education and training in climate-smart agricultural practices.
- **Financial Constraints:** Both farmers and agribusinesses highlighted the need for increased financial support, including grants, subsidies, and simplified procedures for adopting renewable energy technologies.
- **Circular Economy and Resource Efficiency:** Stakeholders recognized the potential of circular economy principles in agriculture, particularly in waste management and the use of renewable energy sources.
- **Sector-Specific Needs:** The assessment identified specific needs in the berries, fruits, vegetables, and MAPs sectors, including improved post-harvest facilities, better monitoring to prevent over-harvesting, and support for young farmers.

These findings highlight the urgent need for targeted interventions that address both the technological and knowledge gaps while providing adequate financial support to enable the transition to climate-smart agriculture in Kosovo. In the next sections we present the challenges and opportunities emerged from the previous tasks, as well as a more detailed analysis of the specific challenges faced by the selected sectors, namely: Non-Wood Forest Products (NWFPs), Medicinal and Aromatic Plants (MAPs), Berries and Fruit and Vegetable Processing (FVP).

4. Identified Challenges and Potential Solutions

4.1 Identified Climate Institutional and Policy Challenges and Opportunities

The in-depth interviews with key stakeholders carried out in, revealed several critical challenges and opportunities within Kosovo's agricultural sector. Institutional stakeholders such as the Ministry of Environment, Spatial Planning and Infrastructure (MESPI) and the Ministry of Agriculture, Forestry and Rural Development (MAFRD) emphasized that at the national level the climate change agenda is a priority for the Government. This has been demonstrated through the functioning of the National Climate Change Council and Secretariat as well as the entry into force of the Climate Change Law. Although much has been done in the mitigation aspect of the climate agenda, much is left to be done for climate adaptation. MESPI will start drafting the National Adaptation Strategy in 2024 and numerous parallel processes that will feed into the strategy have already finished, namely the climate vulnerability assessment and the hazardous flood risk maps. Both institutions acknowledge that the government has not prioritized climate adaptation for agriculture as the most vulnerable sector when it comes to climate risks in Kosovo. The Ministries acknowledge the necessity of mainstreaming climate technologies within their subsidies and programs, but such a decision has not been considered. Most of the interventions that were proposed by key institutions in the climate change agenda such as the Ministries and UNDP in Kosovo range from the integration of renewable energy systems in agriculture to major infrastructural projects on water reservoirs for irrigation for which the government already finished feasibility studies.

The literature review reveals that national strategies such as the climate change strategy and the national organic action plan highlight a couple of policies and measures to increase climate resiliency and integrate mitigation potential for the agricultural sector. The Climate Change Strategy 2019 – 2028 and Action Plan outlines three primary measures related to agriculture: 1) improving manure storage, preparation, and application methods; 2) proper application of mineral and organic fertilizers; and 3) promoting organic production. These measures aim to reduce emissions and enhance the sector's sustainability. The National

Organic Action Plan (NOAP) focuses on promoting organic farming techniques to reduce greenhouse gas emissions and enhance soil carbon sequestration. The Annual State of the Environment Report identifies major pollution concerns from agriculture and underscores the need for climate-friendly practices to reduce environmental impact and enhance agricultural resilience.

4.2 Specific challenges faced by the NWFPs, MAPs, FVP, and Berries sectors in Kosovo

Kosovo's agricultural sector, encompassing Non-Wood Forest Products (NWFPs), Medicinal and Aromatic Plants (MAPs), Fruits and Vegetables (FVP), and Berries, is a vital component of the national economy. However, these sectors face significant vulnerabilities due to climate change, including shifts in suitable growing areas, impacts of extreme weather events, and changes in water availability. This section provides an analysis of key climate-related challenges faced by the selected sectors.

- **NWFPs:** Kosovo's changing climate, marked by shifting precipitation patterns and rising temperatures, has profoundly affected the growth and distribution of wild plants. Unpredictable rainfall and higher temperatures are altering natural habitats, leading to shifts in the geographical distribution of these plants. This unpredictability complicates the harvesting seasons, making it challenging for communities to determine the optimal times for collection. As a result, harvesting at inopportune times can diminish the potency and market value of these products. The loss of biodiversity is another significant concern, as many wild plant species struggle to adapt to the rapid climate changes, leading to their decline or extinction.
- **MAPs:** Climate change is impacting the active compounds in medicinal plants in Kosovo, potentially reducing their efficacy. The chemical composition of these plants is highly sensitive to specific environmental conditions. Variations in temperature and precipitation can alter the concentrations of these active compounds, affecting the therapeutic value of the plants. Additionally, warmer temperatures increase pest pressure, creating favorable conditions for pests and diseases. Traditional growing areas may also become unsuitable, forcing farmers to seek new locations, which can further disrupt the ecosystem.
- **FVP:** Extreme weather events such as heatwaves, droughts, and unseasonable frosts are significantly impacting fruit and vegetable production in Kosovo. Heatwaves and droughts lead to water scarcity, a critical issue for crops needing consistent moisture. Changes in crop phenology, such as altered flowering and fruiting times, disrupt production cycles, resulting in lower yields and quality. These extreme conditions also increase pest and disease pressure, as stressed plants are more susceptible to infestations and infections. Unseasonable frosts can devastate crops, wiping out entire harvests and affecting farmers' livelihoods.
- **Berries:** Berry production in Kosovo faces specific challenges, including reduced chilling hours essential for certain varieties to set fruit properly. Higher humidity levels associated with increased temperatures make berries more susceptible to fungal diseases, threatening entire crops. Water stress due to prolonged drought or insufficient irrigation affects berry size and quality, making them less marketable. These factors pose significant threats to the sustainability of berry farming in the region, necessitating adaptive strategies and resilient practices to mitigate the adverse effects of climate change.

Adapting to these challenges through innovative practices, efficient resource management, and climate-resilient strategies is essential for sustaining these sectors and ensuring long-term agricultural productivity and economic stability. In the following sub-section, we present practical solutions derived from interviews, literature reviews, and focus group discussions conducted in previous tasks. Additionally, in Section 4, we showcase case studies featuring innovative solutions implemented across various geographic and climatic regions to address similar challenges.

4.3 Identified Solutions

The findings from interviews, literature reviews, and focus group discussions (FGDs) all highlight practical solutions to address both climate adaptation and mitigation in Kosovo's agricultural sector. These solutions vary widely, from simple changes in agricultural practices like composting to highly digitalized and complex technologies. However, these solutions identified range from very simple changes in agricultural practices such as composting to highly digitalized and complex technologies. When cross-checking the findings from focus groups, we notice there is a lack of emphasis on these measures in national strategies. In fact, strategic documents are overall lacking in sufficient policies and measures that address adaptation and most of them fail to acknowledge how these measures are feasible to the Kosovo context. Yet, the common denominator between all the findings are measures in 1) energy efficiency 2) efficient water-use 3) organic practices 4) circular economy and 5) awareness or information availability for climate preparedness.

Participants from various FGDs highlighted the challenges posed by late-onset winters, unpredictable rainfall, and increased temperatures. They expressed interest in practical solutions like anti-hail netting, smart irrigation systems, and the use of organic fertilizers. The FGDs also emphasized the importance of financial and technical support for adopting renewable energy technologies as well access to better information that will enable them to adapt better toward a changing climate. A detailed analysis of the unique challenges each selected sector faces due to climate change is provided below.

Based on comprehensive primary and secondary research, as well as international benchmarking, we have developed the following interventions and pilot projects. Initially, we aimed to propose five pilot projects; however, to provide a broader range of options, we have included six. These pilot projects have been designed to offer diverse and innovative solutions. The final selection of pilot projects will be made in close collaboration with the client, ensuring alignment with their strategic goals and preferences.

5. Identification of Tailored Interventions

This document outlines a comprehensive plan for implementing climate-smart agriculture (CSA) interventions in Kosovo, focusing on four key sectors: Non-Wood Forest Products (NWFPs), Medicinal and Aromatic Plants (MAPs), Berries, and Fruit and Vegetable Processing (FVP). The plan is based on findings from previous assessments and aims to address the challenges faced by Kosovo's agricultural sector due to climate change.

Key findings from the assessment include:

1. Significant climate change impacts agricultural productivity, particularly affecting fruit setting and crop dehydration.
2. Lack of clear policies and legislation for sustainable management of agricultural land.
3. Strong need for advanced climate-smart technologies and knowledge among farmers.
4. Financial constraints limiting the adoption of new technologies and practices.
5. Potential for organic farming, particularly in the NWFPs and MAPs sectors.

The document proposes a series of tailored interventions for each sector, including:

1. Efficient drip irrigation systems
2. Organic fertilizers and mulching techniques
3. Anti-hail netting and frost protection systems
4. Solar-powered water pumps and cold storage
5. Agroforestry systems and biochar production
6. Precision farming technologies and smart monitoring systems

Additionally, the plan below presents a portfolio of six small-scale pilot projects to demonstrate and evaluate innovative CSA technologies, allowing selection of five most suitable five based on the sector, which were designed based on the most pressing needs on the ground:

1. Semi-Permanent High Tunnels for Berry Production
2. Microclimate Management System for Berry Production
3. Heat Exchangers for Pasteurizers in Fruit and Vegetable Processing Sector
4. Solar-Powered Water Heaters for Fruit and Vegetable Processing
5. Water Filters for Reuse in Fruit and Vegetable Processing
6. Smart Irrigation System for Fruits, MAPs, and Vegetables

These pilot projects are designed to be implemented over 12 months, with budgets of approximately €10,000 each. They aim to showcase the potential of these technologies in Kosovo's agricultural context and provide valuable data for scaling up successful interventions.

The document also provides general recommendations for enhancing the feasibility, adoption, and scaling-up of these interventions, including capacity building, leveraging existing infrastructure, promoting farmer-to-farmer learning, developing flexible financing models, and fostering public-private partnerships. In Task 4, we will develop a detailed capacity building strategy and knowledge dissemination channels to ensure the effective uptake and utilization of the recommended interventions.

Further, in the annex 3 of this report we have attached four innovative CSA pilot project ideas that may be of interest in the future.

Overall, this plan presents a comprehensive approach to introducing climate-smart agriculture practices in Kosovo, addressing both immediate needs and long-term sustainability goals in the face of climate change challenges.

5.1 Tailored interventions

5.1.1 Berries

Kosovo's climate and soil conditions are well-suited for the cultivation of a variety of berry crops, offering significant potential for export and domestic consumption. By investing in sustainable production practices and value-added processing, the berry sector can contribute to rural development and food security.

Drip irrigation systems:

- Implementing efficient drip irrigation systems to reduce water wastage and improve crop yields.
- Using sensors to monitor soil moisture and optimize irrigation schedules.

Integrated pest management:

- Adopting biological control methods and using natural pest repellents.
- Monitoring pest populations and applying pesticides only when necessary.

Cold storage facilities:

- Investing in cold storage infrastructure to preserve product quality and extend shelf life.
- Implementing energy-efficient cooling systems to reduce operational costs.

The berry sector has the potential to become a significant driver of economic growth in Kosovo. By focusing on sustainable production, efficient water management, and market development, the sector can contribute to the country's agricultural diversification and export earnings.

5.1.2 Medicinal and Aromatic Plants

Kosovo's diverse flora provides a rich source of medicinal and aromatic plants with significant economic and medicinal potential. By adopting sustainable cultivation practices and promoting value-added processing, the MAP sector can contribute to rural development and export diversification.

Organic cultivation:

- Implementing organic farming practices to reduce chemical inputs and improve product quality.
- Promoting the use of organic fertilizers and pest control methods.

Seed production and conservation:

- Establishing seed banks to preserve genetic diversity.
- Developing local seed production capabilities to ensure the availability of high-quality seeds.

Market development:

- Identifying new markets for MAP products, both domestically and internationally.
- Collaborating with pharmaceutical companies and herbal medicine manufacturers.

The development of a vibrant MAP sector requires a coordinated effort to promote organic cultivation, establish seed banks, and develop new markets. By investing in this sector, Kosovo can leverage its natural resources to create sustainable livelihoods and improve public health.

5.1.3 Non-Wood Forest products

Kosovo's rich forest resources offer significant potential for sustainable economic development through the production and utilization of non-wood forest products (NWFPs). By implementing appropriate interventions, the NWFP sector can be transformed into a more resilient and profitable industry, such as:

Agroforestry systems:

- **Alley cropping:** Planting trees in between rows of agricultural crops to provide shade, improve soil fertility, and increase biodiversity.
- **Forest gardens:** Creating diverse agroforestry systems that mimic natural ecosystems, incorporating fruit trees, medicinal plants, and timber species.

Forest conservation:

- Implementing sustainable harvesting practices to ensure the long-term viability of forest resources.
- Promoting community-based forest management to empower local communities in decision-making.

Value-added processing:

- Establishing local processing facilities for products like mushrooms, honey, and medicinal herbs.
- Developing new products and markets for NWFPs, such as herbal teas, cosmetics, and pharmaceuticals.

The development of a vibrant NWFP sector requires a coordinated effort to promote sustainable forest management, invest in value-added processing, and develop new markets. By harnessing Kosovo's forest

resources, the country can create sustainable livelihoods, promote biodiversity conservation, and contribute to a more resilient and diversified economy.

5.1.4 Fruit and Vegetable Processing

Kosovo's agricultural sector produces a wide range of fruits and vegetables, offering opportunities for value-added processing and export diversification. By investing in modern processing facilities and adopting sustainable practices, the sector can enhance its competitiveness and contribute to rural development.

Energy-efficient processing technologies:

- Upgrading processing facilities with solar-powered equipment or other renewable energy sources.
- Implementing energy-efficient practices, such as reducing waste and optimizing production processes.

Waste reduction and recycling:

- Implementing composting and organic waste management systems.
- Developing value-added products from food waste.

Quality control and certification:

- Implementing quality assurance standards and obtaining certifications to improve market access and consumer confidence.

The development of a robust fruit and vegetable processing sector can create new employment opportunities, reduce food waste, and improve the livelihoods of rural communities. By focusing on quality control, innovation, and market diversification, Kosovo can establish a strong position in the regional and global markets.

The proposed interventions outlined in this section offer a comprehensive approach to promoting sustainable and climate-smart agriculture in Kosovo's NWFP, MAP, berry, and FVP sectors. By implementing these measures, farmers can enhance their productivity, resilience, and profitability while contributing to environmental conservation and rural development.

To gain a deeper understanding of the specific interventions, their associated costs, and potential benefits, please refer to the detailed table provided in the following section.

5.2 Proposed Small-Scale Pilot Projects

To demonstrate the practical application of climate-smart technologies and practices in Kosovo's agricultural sector, a series of small-scale pilot projects have been proposed in this section. These six pilots will serve as real-world case studies, providing valuable insights into the feasibility, effectiveness, and scalability of innovative interventions. By focusing on a diverse range of technologies and sectors, the pilot projects aim to showcase the potential of climate-smart agriculture in addressing the challenges faced by Kosovo's farmers and promoting sustainable development.

5.2.1 Semi-Permanent High Tunnels for Berry Production in Kosovo

Rationale

Kosovo's agricultural sector faces significant challenges due to climate change, including unpredictable weather patterns, extreme temperature fluctuations, and increased frequency of severe weather events. These factors particularly affect berry production, which is a crucial part of Kosovo's agricultural economy.

The implementation of semi-permanent high tunnels with automated green net coverage presents an innovative and effective solution to these challenges, offering numerous benefits:

- **Climate Resilience:** High tunnels create a controlled microclimate that protects crops from extreme weather events, reducing the vulnerability of raspberry production to climate variability.
- **Extended Growing Season:** By providing protection from early and late frosts, high tunnels can extend the growing season by up to 2-3 months, allowing for earlier planting and later harvests. This extension is particularly valuable in Kosovo's continental climate.
- **Improved Yield and Quality:** Studies have shown that raspberries grown in high tunnels can produce yields up to 30% higher than field-grown crops. The controlled environment reduces plant stress and optimizes growing conditions, resulting in higher quality fruit.
- **Disease Management:** By controlling humidity levels and reducing foliage moisture, high tunnels significantly decrease the incidence of fungal diseases common in raspberry production, such as Botrytis fruit rot.
- **Water Conservation:** The enclosed structure of high tunnels reduces water loss through evaporation and allows for more efficient irrigation practices, addressing water scarcity issues that are becoming more prevalent due to climate change.
- **Economic Benefits:** The combination of higher yields, better quality fruit, and extended harvest seasons can significantly increase the profitability of small-scale raspberry farms in Kosovo.
- **Technological Innovation:** The integration of automated green net coverage based on microclimate conditions represents a step towards precision agriculture, optimizing resource use and crop protection.
- **Scalability and Replicability:** This project serves as a pilot that can be easily scaled up or replicated in other small farms across Kosovo, potentially transforming the country's approach to climate-smart berry production.

By implementing this project, we aim to demonstrate a sustainable, climate-adaptive approach to raspberry cultivation that can enhance the resilience and productivity of small-scale farmers in Kosovo. This solution can also be adapted and applied to other crops, including various types of berries, fruits, and vegetables. While the basic structure remains the same, specific aspects of the system can be customized for different crops:

- Adjusting irrigation systems for crop-specific water needs.
- Modifying climate control parameters for optimal temperature and humidity levels.
- Adapting trellising or support systems for different plant growth habits.

Objectives

Overall Objective: To demonstrate a sustainable, climate-adaptive approach to raspberry cultivation that enhances the resilience and productivity of small-scale farmers in Kosovo

Specific Objectives:

- 1: Increase berry crop resilience to climate change impacts
- 2: Improve yield and quality of berry production
- 3: Demonstrate the effectiveness of automated climate control in high tunnels
- 4: Enhance economic viability of small-scale raspberry farming

Expected Results:

- 1.1: Enhanced protection against extreme weather conditions

- 2.1:** Optimized growing conditions within high tunnels
- 3.1:** Fully integrated and operational automated control system
- 4.1:** Established market channels for premium berry products

Implementation Plan

The implementation plan provides a roadmap for upgrading existing 200m² raspberry farms with climate-smart high tunnel systems. Each activity is designed to address specific aspects of the climate-smart agriculture approach, focusing on the physical structure, technological components, and knowledge transfer.

Activity 1: High Tunnel Construction

- Construction of high tunnel frame over existing 200m² planted area
- Installation of polyethylene covering and green net
- Installation of automated retraction system for shade cloth

Activity 2: Climate Control System Implementation

- Installation of environmental sensors
- Setup of ventilation system
- Configuration of automated control system
- Integration with shade net automation

Activity 3: Training and Capacity Building

- Development of training materials
- Conducting on-site workshops
- Hands-on training sessions
- Preparation of operation manual

Activity 4: Monitoring and Evaluation

- Establishment of monitoring protocols
- Regular data collection and analysis
- Comparative analysis with open-field production
- Preparation of progress reports and final evaluation

Action Plan and budget

Activity/Cost Category	Timeline	Budget (€)
Direct Costs		11,000.00
1. High Tunnel Construction	Month 1-2	4,000
- Site preparation	Week 1	250
- Frame assembly	Week 2-3	2,000
- Polyethylene covering and green net installation	Week 4	1,200
- Automated retraction system for shade cloth	Week 5-6	550
2. Automation System Implementation	Month 2-3	2,000
- Environmental sensors	Week 1-2	500

- Ventilation system setup	Week 3	400
- Control system configuration	Week 4-5	700
- Integration with shade net automation	Week 6	400
3. Raspberry Plants and Soil Preparation	Month 3	800
- Soil testing and amendment	Week 1	250
- Procurement and planting of raspberry canes	Week 2-3	550
4. Labor Costs	Month 1-12	2,000
- Construction labor	Month 1-2	1,000
- Planting and initial crop management	Month 3-4	300
- Ongoing system maintenance and optimization	Month 5-12	700
5. Training and Capacity Building	Month 4-5	700
- Training material development	Week 1-2	200
- On-site workshops (2 sessions)	Week 3-4	300
- Hands-on training sessions	Week 5-6	200
6. Monitoring Equipment	Month 5	500
- Data loggers and sensors	Week 1-2	300
- Soil testing kit and misc. tools	Week 3-4	200
7. Harvest and Market Testing	Month 8-10	1,000
- Harvest equipment and materials	Month 8	400
- Quality assessment tools	Month 9	250
- Market testing and transportation	Month 10	350
Indirect Costs		1,300.00
Subtotal (Direct + Indirect Costs)		12,300.00
Contingency (1.6%)		200
Total Project Budget		12,500.00

Cost-Benefit Analysis

Summary of Costs and Benefits

Item	Amount (€)
Costs	
Direct Costs	11,000.00
Indirect Costs	1,300.00
Contingency	200
Total Costs	12,500.00
Benefits	
Increased Berry Yield Value	3,800.00

Extended Season Revenue	1,600.00
Water Savings	600.00
Total Annual Benefits	6,000.00
Financial Metrics	
Net Present Value (NPV)	15,500.00
Internal Rate of Return (IRR)	Undefined*
Benefit-Cost Ratio (BCR)	0.48**
Simple Payback Period	2.08 years

* IRR is undefined as there is no initial negative cash flow for the farmer due to grant funding.

** BCR is from the grant provider's perspective.

This Cost-Benefit Analysis reflects a scenario where all initial costs (€12,500) are covered by a grant. The farmer begins to realize benefits immediately without any upfront investment. Annual benefits of €6,000 are expected, primarily from increased yield value and extended season revenue. The Net Present Value over 5 years is positive at €15,500, indicating the project is financially beneficial. The Simple Payback Period of 2.08 years represents the time it would take for the benefits to equal the initial grant investment. The Benefit-Cost Ratio of 0.48 is from the grant provider's perspective, suggesting that for every euro invested, 0.48 euros in direct financial benefits are generated annually. However, this doesn't account for broader economic, social, and environmental benefits that may justify the investment.

Contribution to Climate Change Adaptation and Mitigation

Adaptation	Mitigation
Water Management: The precision irrigation system reduces water usage by 30-40%, enhancing resilience to drought conditions. Resilient Infrastructure: High tunnels protect crops from extreme weather events, reducing crop losses by up to 80-90% compared to open-field cultivation.	Reduced Energy Use: High tunnels use 40-50% less energy compared to traditional heated greenhouses, lowering CO2 emissions. Sequestration: Improved soil management practices enhance soil organic matter, increasing carbon sequestration. Decreased Transportation Emissions: Extended local production reduces the need for imported berries, cutting transportation-related emissions.

International Experiences and Market Suppliers

Case Studies of Similar Projects

1. Farmer Perceptions of Tunnels for Berry Production (United States):

- **Positive Experiences:** Farmers in states like California and Oregon saw improved yields and fruit quality. High tunnels extended the growing season and protected crops from adverse weather, reducing losses.
- **Challenges:** Pest management was difficult due to higher pest populations in enclosed spaces. Nutrient management required careful monitoring.

Link: <https://journals.ashs.org/horttech/view/journals/horttech/28/6/article-p706.xml>

2. Small Fruit Production in High Tunnels (United States and Europe):

- **Positive Experiences:** High tunnels created a favorable microclimate for strawberries, raspberries, blackberries, and blueberries, leading to higher yields and better-quality fruits. Reduced disease incidence was another benefit.
- **Challenges:** Certain pests thrived in the controlled environment, necessitating integrated pest management strategies.

Link: <https://journals.ashs.org/horttech/view/journals/horttech/19/1/article-p50.xml>

3. TunnelBerries Project (United States)

- **Positive Experiences:** High tunnels created a favorable microclimate for strawberries, raspberries, blackberries, and blueberries, leading to higher yields and better-quality fruits. Reduced disease incidence was another benefit.
- **Challenges:** Certain pests thrived in the controlled environment, necessitating integrated pest management strategies.

Link: https://www.scientia.global/wp-content/uploads/TunnelBerries/TunnelBerries_Project.pdf

Market Suppliers for Equipment and Technology

When selecting suppliers, consider factors such as compatibility with local conditions, after-sales support, and alignment with project goals for climate resilience and sustainability. For specific pricing, please contact suppliers directly through their websites.

Supplier	Products	Cost	Strengths
1. Haygrove Ltd (UK) www.haygrove.com	High tunnel structures, automated ventilation systems	Contact for quotes	Extensive experience in berry production, innovative designs
2. Netafim (Israel/Europe) www.netafim.com	Precision irrigation systems, climate control technology, environmental sensors	€500 - €2,000 per kit	Global leader in drip irrigation, strong focus on water efficiency
3. Priva (Netherlands) www.priva.com	Climate control systems, automation software	€2,000 - €5,000	Advanced AI-driven climate management, energy-efficient solutions
4. Ludvig Svensson (Sweden) www.ludvigsvensson.com	Climate screens, energy-saving fabrics	Contact for quotes	High-quality materials, focus on energy conservation
5. Filclair Greenhouse (France) www.filclair.com	High Tunnel Frame	Custom quotes; generally €60 per m ²	Renowned for customizable, durable high tunnel frames suitable for various climatic conditions
6. Ginegar Plastic Products (Israel/Europe) www.ginegar.com	Polyethylene Covering and Green Net	€0.15 - €0.25 per m ² for polyethylene	Industry leader in advanced polyethylene and netting materials, offering superior light diffusion and climate control properties

7. Rovero (Netherlands) www.rovero.eu	Automated Retraction System	€3,000 - €6,000	Specializes in innovative, energy-efficient automated systems for greenhouse climate control
8. Richel Group (France) www.richel.fr	Ventilation System	€1,500 - €3,500	Provides state-of-the-art ventilation solutions with a focus on optimizing crop environments in diverse climates
9. HortiMaX (Netherlands) www.hortimax.com	Shade Net Automation Integration	€1,000 - €2,000	Offers cutting-edge, integrated automation systems with user-friendly interfaces for precise greenhouse management

Innovative Aspects of the Project

1. **Semi-Permanent High Tunnel Design:** Combines benefits of greenhouses with flexibility and cost-effectiveness of high tunnels.
2. **Automated Green Net Coverage:** Optimizes light exposure and temperature control based on microclimate conditions.
3. **Integrated Climate Control:** Raspberry Pi-based controller with custom software for automated climate management.
4. **Precision Agriculture Techniques:** Soil moisture sensors, smart irrigation controllers, and environmental monitoring systems.
5. **Multi-Faceted Sustainability Approach:** Combines water conservation, energy efficiency, and climate resilience.
6. **Adaptive Management System:** Comprehensive monitoring and data collection for continuous improvement.
7. **Knowledge Transfer Model:** Strong focus on training and capacity building for local farmers.

Conclusion

This high tunnel raspberry project in Kosovo makes significant contributions to both climate change adaptation and mitigation. It enhances the resilience of raspberry production to extreme weather events and changing climatic patterns while simultaneously reducing greenhouse gas emissions through improved energy efficiency, reduced pesticide use, and integration of renewable energy. The project serves as a model for climate-smart agriculture, demonstrating how innovative technologies and practices can be leveraged to create more sustainable and resilient food production systems. By implementing this project, Kosovo takes a significant step towards climate-resilient agriculture and contributes to global efforts in combating climate change.

The approach, focusing on upgrading existing 200m² farms, ensures that the benefits of climate-smart agriculture are directly applicable to current farmers. This not only enhances the project's immediate impact but also increases its potential for wider adoption across Kosovo's agricultural sector. By combining traditional farming knowledge with cutting-edge technology, this project paves the way for a more resilient, productive, and sustainable future for Kosovo's raspberry farmers. The success of this pilot project could serve as a catalyst for transforming small-scale agriculture across the region, ultimately contributing to improved food security, economic stability, and environmental sustainability.

5.2.2 Microclimate Management System for Berry Production in Kosovo

Rationale

Kosovo's berry sector faces significant challenges due to climate change, including unpredictable weather patterns and extreme temperature fluctuations. The implementation of a microclimate management system with integrated sprinkler irrigation presents an innovative and effective solution to these challenges, offering numerous benefits:

- **Climate Resilience:** The system protects crops from extreme weather events and extends the growing season.
- **Water Efficiency:** Sprinkler systems with low precipitation rates prevent water run-off and soil compaction, optimizing water use.
- **Yield Improvement:** Precise microclimate control can increase berry yields by 20-25%.
- **Quality Enhancement:** Uniform water distribution and cooling benefits improve fruit quality.
- **Resource Optimization:** The system promotes efficient use of water and energy resources.

This project aims to demonstrate a sustainable, climate-adaptive approach to berry production that can enhance the resilience and productivity of Kosovo's growing berry sector while contributing to resource conservation goals.

Objectives

Overall Objective: To evaluate and demonstrate the effectiveness of a microclimate management system in optimizing growing conditions, enhancing berry production, and improving climate resilience on a small-scale farm in Kosovo.

Specific Objectives:

1. Increase berry yield by 20-25% within the first growing season after installation.
2. Extend the production season by 2-3 weeks compared to conventional methods.
3. Reduce water use by 20-25% while maintaining optimal soil moisture levels within 12 months.
4. Improve crop quality and resilience to climate variability, as measured by fruit size, color, and shelf life.

Expected Results:

- **Result 1.1:** 20-25% increase in berry yield for both strawberries and raspberries.
- **Result 2.1:** Production season extended by 2-3 weeks.
- **Result 3.1:** 20-25% reduction in water consumption for irrigation.
- **Result 4.1:** Improved fruit quality metrics (size, color, shelf life) compared to control plot.

Implementation Plan

Activity 1: System Design and Procurement

- Design microclimate management system with integrated sprinkler irrigation
- Procure necessary equipment (sensors, sprinklers, control unit)

Activity 2: Installation and Integration

- Install microclimate sensors, automated misting/shading system, and sprinklers on a 500 m² plot
- Set up solar-powered control unit
- Establish a conventional production system on an adjacent 500 m² plot as control

Activity 3: System Development

- Develop machine learning algorithm for microclimate prediction
- Create mobile app for monitoring and control
- Integrate sprinkler system with microclimate management controls

Activity 4: Training and Capacity Building

- Develop training materials on system operation and maintenance
- Conduct 2-day intensive training session for the farmer and local experts

Activity 5: Monitoring and Evaluation

- Establish baseline data for crop yield, water use, and quality metrics
- Implement continuous monitoring of microclimate conditions, crop growth, and resource use
- Conduct regular comparative analysis between managed and control plots

Activity 6: Knowledge Dissemination

- Organize a field day for other farmers to observe and learn
- Develop case study and best practice guidelines

Action Plan and Budget

Activity/Cost Category	Timeline	Budget (€)
Direct Costs		9,300
1. System Design and Procurement	Month 1	2,000
2. Installation and Integration	Month 2	3,500
3. System Development	Month 2-3	2,500
4. Training and Capacity Building	Month 3	500
5. Monitoring and Evaluation	Month 1-12	500
6. Knowledge Dissemination	Month 12	300
Indirect Costs		1,000
Subtotal		10,300
Contingency (1.9%)		200
Total Project Budget		10,500

Cost-Benefit Analysis

Summary of Costs and Benefits

Item	Amount (€)
Costs	
Total Project Costs (Grant-funded)	10,000
Benefits (Annual)	
Increased Berry Yield Value	3,500
Extended Season Revenue	1,500
Water Savings	500
Energy Savings	300
Total Annual Benefits	5,800
Financial Metrics	
Net Present Value (NPV) over 5 years	18,500
Internal Rate of Return (IRR)	Undefined*
Benefit-Cost Ratio (BCR)	0.55**
Simple Payback Period	1.81 years

*IRR is undefined as there is no initial negative cash flow for the processor due to grant funding.

**BCR is from the grant provider's perspective.

This Cost-Benefit Analysis reflects a scenario where all initial costs (€10,500) are covered by a grant. The farmer begins to realize benefits immediately without any upfront investment. Annual benefits of €5,800 are expected, primarily from increased yield value and extended season revenue. The Net Present Value over 5 years is positive at €18,500, indicating the project is financially beneficial. The Simple Payback Period of 1.81 years represents the time it would take for the benefits to equal the initial grant investment. The Benefit-Cost Ratio of 0.55 is from the grant provider's perspective, suggesting that for every euro invested, 0.55 euros in direct financial benefits are generated annually. However, this doesn't account for broader economic, social, and environmental benefits that may justify the investment.

Contribution to Climate Change Adaptation and Mitigation

Adaptation:	Mitigation:
• Extends growing season, reducing vulnerability to seasonal climate variations • Enhances crop resilience to extreme weather events and temperature fluctuations	• Reduces water consumption, lowering energy use for pumping and associated emissions • Optimizes resource use, minimizing overall environmental impact of berry production

International Experiences and Market Suppliers

Case Studies of Similar Projects

1. Advanced Microclimate Management in California Berry Farms

- Driscoll's achieved 30% water savings and 15% yield increase

- Link: <https://www.driscolls.com/about/sustainability>

2. High-Tech Greenhouse Berry Production in the Netherlands

- Extended growing season by 6 weeks and reduced energy use by 40%
- Link: <https://www.wur.nl/en/research-results/research-institutes/plant-research/greenhouse-horticulture.htm>

Market Suppliers for Equipment and Technology

Supplier	Products	Cost Range (€)
Farm 21 www.farm21.com	Advanced sensor technology	Custom quotes
30MHz www.30mhz.com	ZENSIE dashboard and sensors	Starter kit: 2,500
Monnit www.monnit.com	IoT sensors	130 - 260 per sensor
Sensoterra www.sensoterra.com	Soil moisture sensors	230 per sensor
Davis Instruments www.davisinstruments.com	Weather stations	450 - 1,000

These suppliers offer solutions suitable for small-scale berry production. The farmer should request detailed quotes and consider factors such as compatibility with local conditions, scalability, and after-sales support when making the final selection.

Innovative Aspects

- Integration of machine learning for predictive microclimate management
- Combination of sprinkler irrigation with sensor-based climate control
- Development of a user-friendly mobile app for remote monitoring and control
- Use of solar power for system operation, enhancing Sustainability

Conclusion

This pilot project introduces a climate-smart solution to Kosovo's berry sector through the implementation of an advanced microclimate management system with integrated sprinkler irrigation. By optimizing growing conditions, extending the production season, and improving resource efficiency, the project addresses key climate change challenges while enhancing productivity and fruit quality. The positive

financial indicators and potential for scalability make this an attractive investment in sustainable berry production. Successful implementation could serve as a model for wider adoption across Kosovo's growing berry sector, contributing to the country's agricultural resilience and economic development.

The project demonstrates how precision agriculture technologies can significantly impact small-scale farming operations, paving the way for a more sustainable and competitive berry industry in Kosovo. By combining traditional sprinkler irrigation with cutting-edge sensor and control technologies, this initiative not only conserves precious resources but also sets a new standard for climate-smart berry production in the region. The knowledge generated and disseminated through this project has the potential to transform berry cultivation practices, making the sector more resilient to climate variability and economically viable for small-scale farmers.

5.2.3 Heat Exchangers for Pasteurizers in Kosovo's Fruit and Vegetable Processing Sector

Rationale

Kosovo's fruit and vegetable processing sector faces significant challenges due to climate change, including increasing energy costs and water scarcity. The implementation of heat exchangers in pasteurizers presents an innovative and effective solution to these challenges, offering numerous benefits:

- **Energy Efficiency:** Heat exchangers can reduce energy consumption in pasteurization processes by up to 60%, significantly lowering greenhouse gas emissions.
- **Water Conservation:** Closed-loop systems recycle water, addressing water scarcity issues that are becoming more prevalent due to climate change.
- **Cost Reduction:** Lower energy and water usage translate to reduced operational costs for processors.
- **Product Quality:** Improved temperature control enhances product quality and safety.
- **Climate Resilience:** By reducing resource dependency, processors become more resilient to climate-related supply disruptions.

This project aims to demonstrate a sustainable, climate-adaptive approach to fruit and vegetable processing that can enhance the resilience and productivity of Kosovo's food industry.

Objectives

Overall Objective: To demonstrate an energy-efficient and water-conserving approach to fruit and vegetable pasteurization that enhances the climate resilience of Kosovo's food processing sector.

Specific Objectives:

1. Reduce energy consumption in pasteurization processes by 50% within 12 months of implementation.
2. Decrease water usage in pasteurization by 40% within the first year of operation.
3. Improve product quality and safety through more precise temperature control within 6 months.

4. Enhance the economic viability of participating processors by reducing operational costs by 30% within 18 months.

Expected Results:

- **Result 1.1:** 50% reduction in energy consumption for pasteurization processes.
- **Result 2.1:** 40% decrease in water usage for pasteurization.
- **Result 3.1:** 20% improvement in product quality metrics (e.g., shelf life, nutrient retention).
- **Result 4.1:** 30% reduction in operational costs for participating processors.

Implementation Plan

Activity 1: System Design and Procurement

- Conduct energy and water audits of existing pasteurization systems
- Design heat exchanger systems tailored to the facility
- Procure necessary equipment and materials

Activity 2: Installation and Integration

- Install heat exchangers in the existing pasteurizer system
- Integrate with current process control system
- Conduct system tests and calibrations

Activity 3: Training and Capacity Building

- Develop training materials on system operation and maintenance
- Conduct on-site workshops for staff
- Provide ongoing technical support

Activity 4: Monitoring and Evaluation

- Establish baseline data for energy use, water consumption, and product quality
- Implement continuous monitoring systems
- Conduct regular performance evaluations and adjustments

Action Plan and Budget

Activity/Cost Category	Timeline	Budget (€)
Direct Costs		8,800
1. System Design and Procurement	Month 1	4,000
2. Installation and Integration	Month 2	3,500
3. Training and Capacity Building	Month 3	1,750
4. Monitoring and Evaluation	Month 1-6	900

Indirect Costs		1,200
Subtotal		11,350
Contingency (1.3%)		150
Total Project Budget		11,300

Cost-Benefit Analysis

Summary of Costs and Benefits

Item	Amount (€)
Costs	
Total Project Costs (Grant-funded)	11,350
Benefits (Annual)	
Energy Savings	3,000
Water Savings	1,000
Improved Product Quality	1,500
Total Annual Benefits	5,500
Financial Metrics	
Net Present Value (NPV) over 5 years	16,000
Internal Rate of Return (IRR)	Undefined*
Benefit-Cost Ratio (BCR)	0.48**
Simple Payback Period	2.09 years

*IRR is undefined as there is no initial negative cash flow for the processor due to grant funding.

**BCR is from the grant provider's perspective.

This Cost-Benefit Analysis reflects a scenario where all initial costs (€11,500) are covered by a grant. The processor begins to realize benefits immediately without any upfront investment. Annual benefits of €5,500 are expected, primarily from energy and water savings, and improved product quality. The Net Present Value over 5 years is positive at €16,000, indicating the project is financially beneficial. The Simple Payback Period of 2.09 years represents the time it would take for the benefits to equal the initial grant investment. The Benefit-Cost Ratio of 0.48 is from the grant provider's perspective, suggesting that for every euro invested, 0.48 euros in direct financial benefits are generated annually. However, this doesn't account for broader economic, social, and environmental benefits that may justify the investment.

Contribution to Climate Change Adaptation and Mitigation

Adaptation:	Mitigation:
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-
- | | |
|---|---|
| <ul style="list-style-type: none"> • Enhances resilience to water scarcity through efficient water use • Improves food security by extending product shelf life | <ul style="list-style-type: none"> • Decreases water usage, reducing strain on water treatment facilities and associated emissions • Reduces energy consumption, lowering greenhouse gas emissions by an estimated 100 tons CO₂e annually per facility |
|---|---|
-

International Experiences and Market Suppliers

Case Studies of Similar Projects

1. Heat Exchanger Helps Produce Carrot Powder (UK)

Huntapac is a family-owned grower and supplier of root crops, established in 1942 in UK. The company, which initially grew a variety of crops, decided to focus exclusively on carrots and parsnips a few years ago.

Challenges: Huntapac faced the challenge of utilizing the 5% of carrots that were unsuitable for sale, which amounted to a significant volume given their large-scale operations.

Solution: To add value to these surplus carrots, Huntapac developed a process to convert them into carrot powder. This involves pureeing the carrots, heating the puree with rotary scraped surface heat exchangers, and then drying and milling it into powder. The pre-heating step reduces energy consumption and increases efficiency.

Results: Since early 2021, Huntapac's carrot powder production line has been producing 60 kg of powder per hour, which is used in animal feed and reduces waste while enhancing the efficiency of their operations.

Link: www.hrs-heatexchangers.com/case-study/heat-exchanger-helps-produce-carrot-powder/

2. Heat Exchangers and Thermal Fluids in Food Processing (2021)

Summary: Heat exchangers are essential in the food processing industry for tasks such as pasteurization, sterilization, and ultra-high temperature processing. These devices transfer heat between fluids, which helps in reducing microbial presence and extending shelf life. They also improve energy efficiency, potentially recovering up to 50% of wasted heat.

Challenges: The selection of appropriate heat transfer fluids is crucial to ensure safe and effective operation. Fluids must comply with food safety regulations to avoid contamination, particularly when in contact with food products.

Solution: Heat exchangers use two main mechanisms for heat transfer: conduction and convection. Conduction involves heat transfer between materials in direct contact, while convection involves heat transfer through fluid movement. By selecting the correct food-safe heat transfer fluids, like HT1 food-grade fluids, manufacturers ensure both safety and efficiency in food processing.

Results: The use of heat exchangers and appropriate thermal fluids in the food industry has significantly improved product safety and extended shelf life, while also reducing energy costs and resource use. Ensuring the use of FDA-approved, food-safe fluids prevents contamination and maintains consumer safety.

Link: thermtest.com/heat-exchangers-and-thermal-fluids-in-the-food-processing-industry

Market Suppliers for Equipment and Technology

Supplier	Products	Cost Range (€)
HRS Heat Exchangers (UK/Spain) www.hrs-heatexchangers.com	Compact plate heat exchangers	3,000 - 5,000
Tetra Pak (Sweden, Switzerland, Kosovo) www.tetrapak.com	Small-scale pasteurization units	4,000 - 7,000
Fischer Maschinen- und Apparatebau GmbH https://www.fischer-heatexchanger.com/en/	Modular heat exchange systems	3,500 - 6,000
ProFruit Machinery (Lithuania) https://pro-fruit.com/product/tube-in-tube-heat-exchanger/	Tube-in-tube heat exchanger for heating or cooling products with medium to high viscosity, such as mash and berries.	Quotes on demand

The processors should request detailed quotes and consider factors such as compatibility with existing systems, energy efficiency, and after-sales support when making their final selection.

Innovative Aspects

- Integration of IoT sensors for real-time monitoring and optimization
- Use of advanced materials for improved heat transfer efficiency
- Development of a modular design for easy scalability and replication

Conclusion

This pilot project introduces a climate-smart solution to Kosovo's fruit and vegetable processing sector through the implementation of heat exchangers in pasteurization processes. By significantly reducing energy consumption and water usage, the project addresses key climate change challenges while improving operational efficiency and product quality. The strong financial indicators and potential for scalability make this an attractive investment in sustainable food processing. Successful implementation could serve as a model for wider adoption across Kosovo's food industry, contributing to the country's climate resilience and economic development.

5.2.4 Solar-Powered Water Heaters for Fruit and Vegetable Processing in Kosovo

Rationale

Kosovo's fruit and vegetable processing sector faces significant challenges due to climate change, including rising energy costs and increasing pressure to reduce carbon emissions. The implementation of

solar-powered water heaters presents an innovative and effective solution to these challenges, offering numerous benefits:

- **Energy Efficiency:** Solar water heaters can reduce energy consumption for water heating by up to 70%, significantly lowering greenhouse gas emissions.
- **Cost Reduction:** Lower energy usage translates to reduced operational costs for processors.
- **Climate Resilience:** By reducing dependency on the grid, processors become more resilient to power outages and energy price fluctuations.
- **Renewable Energy Integration:** This project promotes the adoption of renewable energy in the agri-food sector.
- **Scalability:** The technology can be easily scaled up or replicated in other processing facilities.

This project aims to demonstrate a sustainable, climate-adaptive approach to fruit and vegetable processing that can enhance the resilience and productivity of Kosovo's food industry while contributing to national renewable energy goals.

Objectives

Overall Objective: To demonstrate an energy-efficient and low-carbon approach to water heating in fruit and vegetable processing that enhances the climate resilience of Kosovo's food processing sector.

Specific Objectives:

1. Reduce energy consumption for water heating by 60% within 12 months of implementation.
2. Decrease carbon emissions related to water heating by 70% within the first year of operation.
3. Improve energy independence of the processing facility by meeting 50% of its hot water needs through solar energy within 6 months.
4. Enhance the economic viability of the participating processor by reducing water heating costs by 50% within 18 months.

Expected Results:

- **Result 1.1:** 60% reduction in energy consumption for water heating processes.
- **Result 2.1:** 70% decrease in carbon emissions related to water heating.
- **Result 3.1:** 50% of hot water needs met through solar energy.
- **Result 4.1:** 50% reduction in water heating costs for the participating processor.

Implementation Plan

Activity 1: System Design and Procurement

- Conduct energy audit of existing water heating system
- Design solar water heating system tailored to the facility
- Procure necessary equipment and materials

Activity 2: Installation and Integration

- Install solar collectors, storage tank, and heat transfer system
- Integrate with current water heating system
- Conduct system tests and calibrations

Activity 3: Training and Capacity Building

- Develop training materials on system operation and maintenance
- Conduct on-site workshops for staff
- Provide ongoing technical support

Activity 4: Monitoring and Evaluation

- Establish baseline data for energy use and costs
- Implement monitoring system for energy production and consumption
- Conduct regular performance evaluations and adjustments

Action Plan and Budget

Activity/Cost Category	Timeline	Budget (€)
Direct Costs		7,900
1. System Design and Procurement	Month 1	3,200
2. Installation and Integration	Month 2	3,300
3. Training and Capacity Building	Month 3	700
4. Monitoring and Evaluation	Month 4-12	700
Indirect Costs		950
Subtotal		8,850
Contingency (1.7%)		850
Total Project Budget		9,000

Cost-Benefit Analysis

Summary of Costs and Benefits

Item	Amount (€)
Costs	
Total Project Costs (Grant-funded)	9,000
Benefits (Annual)	
Energy Savings	2,500
Carbon Emission Reduction Value	500
Maintenance Cost Savings	300
Total Annual Benefits	3,300
Financial Metrics	
Net Present Value (NPV) over 5 years	7,500
Internal Rate of Return (IRR)	Undefined*

Benefit-Cost Ratio (BCR)	0.37**
Simple Payback Period	2.73 years

*IRR is undefined as there is no initial negative cash flow for the processor due to grant funding.

**BCR is from the grant provider's perspective.

This Cost-Benefit Analysis reflects a scenario where all initial costs (€9,000) are covered by a grant. The processor begins to realize benefits immediately without any upfront investment. Annual benefits of €3,300 are expected, primarily from energy savings and reduced carbon emissions. The Net Present Value over 5 years is positive at €7,500, indicating the project is financially beneficial. The Simple Payback Period of 2.73 years represents the time it would take for the benefits to equal the initial grant investment. The Benefit-Cost Ratio of 0.37 is from the grant provider's perspective, suggesting that for every euro invested, 0.37 euros in direct financial benefits are generated annually. However, this doesn't account for broader economic, social, and environmental benefits that may justify the investment.

Contribution to Climate Change Adaptation and Mitigation

Adaptation:	Mitigation:
- Improves energy security for food processing operations - Enhances resilience to energy price fluctuations and grid instability	Promotes the adoption of renewable energy in the agri-food sector Reduces energy consumption from fossil fuel sources, lowering greenhouse gas emissions by an estimated 5 tons CO2e annually

International Experiences and Market Suppliers

Case Studies of Similar Projects

1. Solar Heating and Cooling Applications in Agriculture and Food Processing

Summary: This 2022 case study from Västerås, Sweden, explores the use of solar energy technologies in the agricultural and food processing sectors to improve sustainability and energy efficiency.

Challenges:

- High energy consumption in agriculture and food processing, especially for heating and cooling, poses sustainability challenges.
- Conventional energy sources contribute significantly to greenhouse gas emissions and climate change.

Solutions:

- Implementation of various solar energy systems, including solar air heaters, water heaters, cooling systems, and integrated solar solutions.
- Use of solar-powered systems to provide necessary thermal energy for drying, dehydration, heating, and cooling processes, as well as maintaining greenhouse climates.

Results:

- Solar technologies can significantly reduce energy consumption from non-renewable sources, aiding climate mitigation.
- Enhanced energy flexibility and resilience in agriculture and food processing, contributing to sustainable rural development and environmental goals.

Link: <https://mdh.diva-portal.org/smash/get/diva2:1712897/SUMMARY01.pdf>

2. Decentralized Solar-Powered Cooling Systems (2023)

Summary: The case study explores the use of decentralized solar-powered cooling systems to reduce post-harvest losses of fruits and vegetables in developing regions, supporting smallholder farmers.

Challenges:

- **High Post-Harvest Losses:** Up to 50% of produce is lost due to inadequate storage.
- **Lack of Infrastructure:** Insufficient cold storage facilities in rural areas with unstable electricity.
- **Economic Barriers:** High costs and limited resources prevent adoption.
- **Knowledge Gaps:** Low awareness and technical skills for solar cooling technologies.

Solutions:

- **Solar-Powered Systems:** Off-grid solar cooling units on farms.
- **Low-Tech Cooling:** Cost-effective methods like evaporative cooling.
- **Financial Access:** Improved financing for technology adoption.

Results:

- **Reduced Losses:** Better storage extends produce shelf life.
- **Economic Gains:** Increased income for farmers.
- **Environmental Benefits:** Lower carbon footprint.
- **Rural Development:** Enhanced food security and local employment.

Link: <https://academic.oup.com/ce/article/7/3/635/7174941?login=false>

3. Solar PV-Powered Evaporative Cooling System

Summary: This case study explores the development of a solar PV-powered evaporative cooling system designed for cooling fruits and vegetables in tropical climates. The system features dual cooling chambers using different biomass pads (wood shavings and polyurethane foam) to achieve varying cooling effects.

Challenges:

- High temperatures in tropical regions increase the demand for effective cooling systems.
- Conventional cooling methods are energy-intensive and often unreliable in rural areas due to power shortages.
- Lack of affordable, energy-efficient cooling solutions that prevent chilling injuries to produce.

Solutions:

- The system uses solar energy to power fans and water pumps, enhancing cooling performance without relying on the grid.
- Dual chambers allow for different cooling settings, optimizing preservation for various types of produce.
- Use of locally available biomass materials as cooling pads provides a sustainable and cost-effective alternative to exotic materials.

Results:

- The cooling system achieved temperature reductions ranging from 0.22 to 10.94°C, depending on the type of biomass pad and conditions.
- Cooling efficiency varied between 3.62% and 96.42%, with higher performance observed using polyurethane foam.
- The system demonstrated a higher coefficient of performance (COP) than traditional solar-powered chillers, indicating superior energy efficiency.
- Economically, the system showed a low levelized cost of energy (0.043–0.045 USD/kWh) and a positive net present value, making it a viable option for smallholder farmers in rural Nigeria.
- Significant potential for CO₂ mitigation was also noted, contributing to environmental sustainability goals.

Link: www.mdpi.com/2624-7402/6/3/149

Market Suppliers for Equipment and Technology

Supplier	Products	Cost Range (€)
Viessmann (UK) www.viessmann.co.uk	Solar thermal collectors and systems	3,000 - 6,000
Dimas Solar (Greece) https://dimas-solar.gr/	Integrated solar water heating solutions	2,500 - 5,000
Wagner Solar (France) www.wagner-solar.com	Custom solar thermal systems	3,500 - 7,000

These suppliers offer solutions suitable for small-scale processing facilities. The processor should request detailed quotes and consider factors such as efficiency, integration capabilities, and after-sales support when making the final selection.

Innovative Aspects

- Integration of smart controls for optimized energy management
- Use of high-efficiency evacuated tube collectors for improved performance in varied weather conditions
- Development of a modular design for easy scalability and replication in other facilities

Conclusion

This pilot project introduces a climate-smart solution to Kosovo's fruit and vegetable processing sector through the implementation of solar-powered water heaters. By significantly reducing energy consumption and carbon emissions associated with water heating, the project addresses key climate

change challenges while improving operational efficiency and energy independence. The positive financial indicators and potential for scalability make this an attractive investment in sustainable food processing. Successful implementation could serve as a model for wider adoption across Kosovo's food industry, contributing to the country's climate resilience, renewable energy goals, and economic development. The project demonstrates how small-scale interventions can have significant impacts, paving the way for a more sustainable and competitive agri-food sector in Kosovo

5.2.5 Water Filters for Reuse in Fruit and Vegetable Processing in Kosovo

Rationale

- Kosovo's fruit and vegetable processing sector faces significant challenges due to climate change, including increasing water scarcity and pressure to reduce water consumption. The implementation of water filtration and reuse systems presents an innovative and effective solution to these challenges, offering numerous benefits:
- **Water Conservation:** Filtration systems can reduce freshwater consumption by up to 70%, addressing water scarcity issues.
- **Cost Reduction:** Lower water usage and wastewater treatment needs translate to reduced operational costs for processors.
- **Environmental Impact:** Reduced wastewater discharge minimizes environmental pollution and protects local water resources.
- **Climate Resilience:** By reducing dependency on freshwater sources, processors become more resilient to drought conditions.
- **Resource Efficiency:** This project promotes a closed-loop water cycle, maximizing resource efficiency in the agri-food sector.

This project aims to demonstrate a sustainable, climate-adaptive approach to water management in fruit and vegetable processing that can enhance the resilience and productivity of Kosovo's food industry while contributing to water conservation goals

Objectives

Overall Objective: To demonstrate a water-efficient and sustainable approach to water management in fruit and vegetable processing that enhances the climate resilience of Kosovo's food processing sector.

Specific Objectives:

1. Reduce freshwater consumption by 60% within 12 months of implementation.
2. Decrease wastewater discharge by 50% within the first year of operation.
3. Improve water independence of the processing facility by meeting 40% of its water needs through recycled water within 6 months.
4. Enhance the economic viability of the participating processor by reducing water-related costs by 40% within 18 months.

Expected Results:

- **Result 1.1:** 60% reduction in freshwater consumption for processing.
- **Result 2.1:** 50% decrease in wastewater discharge.
- **Result 3.1:** 40% of water needs met through recycled water.
- **Result 4.1:** 40% reduction in water-related costs for the participating processor.

Implementation Plan

Activity 1: System Design and Procurement

- Conduct water audit of existing processing system
- Design water filtration and reuse system tailored to the facility
- Procure necessary equipment and materials

Activity 2: Installation and Integration

- Install filtration system, storage tanks, and distribution network
- Integrate with current water system
- Conduct system tests and calibrations

Activity 3: Training and Capacity Building

- Develop training materials on system operation and maintenance
- Conduct on-site workshops for staff
- Provide ongoing technical support

Activity 4: Monitoring and Evaluation

- Establish baseline data for water use and costs
- Implement monitoring system for water quality and consumption
- Conduct regular performance evaluations and adjustments

Action Plan and Budget

Activity/Cost Category	Timeline	Budget (€)
Direct Costs		6,100
1. System Design and Procurement	Month 1	2,400
2. Installation and Integration	Month 2	2,600
3. Training and Capacity Building	Month 3	600
4. Monitoring and Evaluation	Month 1-6	500
Indirect Costs		800
Subtotal		6,900
Contingency (1.4%)		100
Total Project Budget		7,000

Cost-Benefit Analysis

Summary of Costs and Benefits

Item	Amount (€)
Costs	
Total Project Costs (Grant-funded)	7,000
Benefits (Annual)	
Energy Savings	2,000
Carbon Emission Reduction Value	800
Maintenance Cost Savings	200
Total Annual Benefits	3,000
Financial Metrics	
Net Present Value (NPV) over 5 years	8,000
Internal Rate of Return (IRR)	Undefined*
Benefit-Cost Ratio (BCR)	0.43**
Simple Payback Period	2.33 years

*IRR is undefined as there is no initial negative cash flow for the processor due to grant funding.

**BCR is from the grant provider's perspective.

This Cost-Benefit Analysis reflects a scenario where all initial costs (€7,000) are covered by a grant. The processor begins to realize benefits immediately without any upfront investment. Annual benefits of €3,000 are expected, primarily from water savings and reduced wastewater treatment costs. The Net Present Value over 5 years is positive at €8,000, indicating the project is financially beneficial. The Simple Payback Period of 2.33 years represents the time it would take for the benefits to equal the initial grant investment. The Benefit-Cost Ratio of 0.43 is from the grant provider's perspective, suggesting that for every euro invested, 0.43 euros in direct financial benefits are generated annually. However, this doesn't account for broader economic, social, and environmental benefits that may justify the investment.

Contribution to Climate Change Adaptation and Mitigation

Adaptation:	Mitigation:
- Improves water security for food processing operations - Enhances resilience to water scarcity and drought conditions	- Decreases pressure on local water resources, contributing to ecosystem preservation - Reduces energy consumption for water pumping and treatment, lowering greenhouse gas emissions

International Experiences and Market Suppliers

Case Studies of Similar Projects

1. Water Efficiency in Fruit and Vegetable Processing

Summary : This guide discusses various methods to treat and reuse water in fruit and vegetable processing, including ultrafiltration and nanofiltration to remove contaminants and reuse water for irrigation.

Challenges:

- High water consumption and production of liquid waste (effluent) in fruit and vegetable processing.
- Financial costs associated with water use and effluent treatment.
- Resistance to adopting new water-saving practices and equipment due to initial costs and staff habits.

Solutions:

- **Water Reduction:** Implementing measures like removing solid waste before cleaning, using spray systems for processing, choosing water-efficient equipment, and using physical methods (brushes, squeegees) to clean areas to minimize water use.
- **Water Reuse:** Reusing water through various methods such as treating water used in waste conveyance, filtering out contaminants for reuse in rinsing, using advanced filtration technologies (ultrafiltration and nanofiltration), storing water for irrigation, and adopting multi-stage rinsing processes.

Results:

- **Cost Savings:** Reducing water usage lowers costs associated with water supply and effluent treatment.
- **Environmental Benefits:** Less water usage and improved water recycling contribute to more sustainable operations and reduced environmental footprint.
- **Improved Efficiency:** Systematic water management enhances operational efficiency, supports regulatory compliance, and promotes sustainable business practices in the fruit and vegetable processing industry.

Link: www.nibusinessinfo.co.uk/content/fruit-and-vegetable-processing-water-efficiency

2. Early-Stage Water Purification in Food Processing

Summary: This project by VAM WaterTech based in The Netherlands focuses on treating water in the initial phase of the washing process for fresh produce. It includes technologies for filtration, sand and soil removal, sludge dewatering, and disinfection. The systems aim to enhance food safety, reduce water usage, and lower costs by treating water at the beginning of the washing process.

Challenges:

- Foodborne illnesses due to contaminated wash water can cause widespread outbreaks and product recalls.
- Conventional water purification methods often occur at the end of the processing line, which is less efficient.
- Concerns over water scarcity and strict regulations require high-quality recycled water.
- The cost and inefficiency of replacing process water with drinkable water are significant.

Solutions:

- VAM WaterTech developed custom water purification systems that treat water at the first stage of washing, removing contaminants like sand, silt, leaves, and stones.
- The purification process includes filtration, sedimentation, sludge dewatering, and advanced disinfection using AOP (Advanced Oxidation Process) technology, which combines ozone and UV light.
- By continuously treating and reusing water, the systems minimize water loss and maintain high hygiene standards.

Results:

- Significant reduction in water usage, with only 3-4% of the total volume lost in the process.
- Enhanced food safety and extended shelf life due to the effective removal of bacteria, fungi, and pesticides.
- Cost savings from reduced water usage and lower waste management expenses.
- Improved operational efficiency with cleaner equipment and fewer downtimes, contributing to a better working environment and employee satisfaction.

Link: <https://produceprocessing.net/article/early-stage-produce-processing-water-purification-reduce-usage-costs/>

3. Effective Solid Removal Technologies for Wash-Water Treatment:

Summary: This study investigated treatments for wash-water from fresh-cut fruit and vegetable (FCFV) processing facilities to enable water reuse. Two facilities were studied - one processing carrots and one processing various fruits and vegetables. It evaluates the use of dissolved air flotation (DAF) and centrifuge technologies for solids removal, followed by ultraviolet (UV) disinfection, to enable water reuse in the fresh-cut fruit and vegetable industry

Challenges:

- High levels of suspended solids and organic matter in wash-water
- Need for effective solids removal to allow further treatment and potential reuse
- Limited information available on treating FCFV wash-water

Solutions tested:

- Dissolved air flotation (DAF)
- Centrifugation
- Membrane filtration
- UV disinfection

Key Results:

- Both DAF and centrifugation achieved ~95% turbidity reduction
- DAF removed more dissolved solids and BOD than centrifugation
- Filtration after DAF/centrifugation achieved very low turbidity (<4 NTU)
- UV disinfection effective after filtration at doses of 10 mJ/cm² or less
- Treatment train of DAF/centrifuge + filtration + UV showed potential for water reuse

[Link](#) to the study.

Market Suppliers for Equipment and Technology

Supplier	Products	Cost Range (€)
Xylem www.xylem.com	Water filtration and reuse systems	3,000 - 6,000
Veolia Water Technologies www.veoliawatertechnologies.com	Custom water treatment solutions	2,500 - 5,000
Ecolab www.ecolab.com	Water filtration and management systems	3,500 - 7,000
VAM WaterTech www.vam-watertech.com	Agrofood water purification systems including a closed-cycle process, which allows to save up to 95% on agrofood process water use, and can purify product up to 100%.	Prices on demand

These suppliers offer solutions suitable for small-scale processing facilities. The processor should request detailed quotes and consider factors such as filtration efficiency, integration capabilities, and after-sales support when making the final selection.

Innovative Aspects

- Integration of IoT sensors for real-time water quality monitoring
- Use of advanced membrane filtration technology for improved water purification
- Development of a modular design for easy scalability and replication in other facilities

Conclusion

This pilot project introduces a climate-smart solution to Kosovo's fruit and vegetable processing sector through the implementation of water filtration and reuse systems. By significantly reducing freshwater consumption and wastewater discharge, the project addresses key climate change challenges while improving operational efficiency and water independence. The positive financial indicators and potential for scalability make this an attractive investment in sustainable food processing. Successful implementation could serve as a model for wider adoption across Kosovo's food industry, contributing to the country's water conservation goals, climate resilience, and economic development. The project demonstrates how small-scale interventions can have significant impacts, paving the way for a more sustainable and competitive agri-food sector in Kosovo. By creating a closed-loop water cycle, this initiative not only conserves precious water resources but also sets a new standard for resource efficiency in the region's food processing industry.

5.2.6 Smart Irrigation System for Fruits, MAPs, and Vegetables in Kosovo

Rationale

Kosovo's agricultural sector, particularly in fruits, Medicinal and Aromatic Plants (MAPs), and vegetables, faces significant challenges due to climate change, including water scarcity and unpredictable weather

patterns. The implementation of a smart irrigation system presents an innovative and effective solution to these challenges, offering numerous benefits:

- **Water Efficiency:** Smart irrigation can reduce water consumption by up to 50%, addressing water scarcity issues.
- **Crop Yield Improvement:** Precise irrigation can increase crop yields by 20-30% by providing optimal water conditions.
- **Climate Resilience:** By adapting to real-time weather and soil conditions, crops become more resilient to climate variability.
- **Resource Optimization:** This project promotes efficient use of water resources across multiple crop types.
- **Cost Reduction:** Optimized water usage translates to reduced operational costs for farmers.

This project aims to demonstrate a sustainable, climate-adaptive approach to irrigation that can enhance the resilience and productivity of Kosovo's diverse agricultural sectors while contributing to water conservation goals.

Objectives

Overall Objective: To demonstrate a water-efficient and climate-smart approach to irrigation in fruit, MAP, and vegetable cultivation that enhances the climate resilience of Kosovo's agricultural sector.

Specific Objectives:

1. Reduce water consumption for irrigation by 40% within 12 months of implementation.
2. Increase crop yields by 20% within the first growing season after installation.
3. Improve water use efficiency by achieving 90% accuracy in irrigation needs prediction within 6 months.
4. Enhance the economic viability of participating farmers by reducing water-related costs by 30% within 18 months.

Expected Results:

- **Result 1.1:** 40% reduction in water consumption for irrigation.
- **Result 2.1:** 20% increase in crop yields across fruits, MAPs, and vegetables.
- **Result 3.1:** 90% accuracy in predicting irrigation needs based on sensor and weather data.
- **Result 4.1:** 30% reduction in water-related costs for participating farmers.

Implementation Plan

Activity 1: System Design and Procurement

- Conduct site assessment and water requirement analysis for each crop type
- Design smart irrigation system tailored to the multi-crop setup
- Procure necessary equipment (sensors, data loggers, controllers)

Activity 2: Installation and Integration

- Install soil humidity sensors at various depths for each crop type
- Set up weather station and data logger

- Integrate sensors with irrigation control system
- Conduct system tests and calibrations

Activity 3: Software Development and Data Analysis

- Develop algorithm for irrigation needs prediction
- Create user interface for data visualization and system control
- Integrate automation for irrigation start/stop based on sensor readings

Activity 4: Training and Capacity Building

- Develop training materials on system operation and maintenance
- Conduct on-site workshops for staff
- Provide ongoing technical support

Activity 5: Monitoring and Evaluation

- Establish baseline data for water use, crop yields, and costs
- Implement continuous monitoring system
- Conduct regular performance evaluations and systems adjustments

Action Plan and Budget

Activity/Cost Category	Timeline	Budget (€)
Direct Costs		8,800
1. System Design and Procurement	Month 1	3,300
2. Installation and Integration	Month 2	2,700
3. Software Development and Data Analysis	Month 2-3	1,400
4. Training and Capacity Building	Month 3	750
5. Monitoring and Evaluation	Month 1-6	650
Indirect Costs		1,000
Subtotal		9,800
Contingency (2%)		200
Total Project Budget		10,000

Cost-Benefit Analysis

Summary of Costs and Benefits

Item	Amount (€)
Costs	
Total Project Costs (Grant-funded)	10,000
Benefits (Annual)	

Water Savings	2,000
Increased Crop Yield Value	3,000
Energy Savings from Reduced Pumping	500
Total Annual Benefits	5,500
Financial Metrics	
Net Present Value (NPV) over 5 years	17,000
Internal Rate of Return (IRR)	Undefined*
Benefit-Cost Ratio (BCR)	0.55**
Simple Payback Period	1.82 years

*IRR is undefined as there is no initial negative cash flow for the processor due to grant funding.

**BCR is from the grant provider's perspective.

This Cost-Benefit Analysis reflects a scenario where all initial costs (€10,000) are covered by a grant. The farmers begin to realize benefits immediately without any upfront investment. Annual benefits of €5,500 are expected, primarily from water savings and increased crop yields. The Net Present Value over 5 years is positive at €17,000, indicating the project is financially beneficial. The Simple Payback Period of 1.82 years represents the time it would take for the benefits to equal the initial grant investment. The Benefit-Cost Ratio of 0.55 is from the grant provider's perspective, suggesting that for every euro invested, 0.55 euros in direct financial benefits are generated annually. However, this doesn't account for broader economic, social, and environmental benefits that may justify the investment.

Contribution to Climate Change Adaptation and Mitigation

Adaptation:	Mitigation:
- Enhances resilience to water scarcity and drought conditions - Improves crop resilience to variable weather patterns	- Reduces energy consumption for water pumping, lowering greenhouse gas emissions - Optimizes water use, reducing pressure on water resources and associated energy-intensive water treatment

International Experiences and Market Suppliers

Case Studies of Similar Projects

1. SMART Irrigation System Using Microcontroller (2024)

Summary: This project introduces a Smart Irrigation System designed to optimize water usage in agricultural fields by leveraging microcontroller technology. It aims to enhance water management efficiency.

Challenges: Traditional irrigation wastes water and requires manual labor.

Solutions: System uses soil moisture, temperature and humidity sensors to monitor conditions. Microcontroller analyzes data and controls irrigation pump automatically.

Results: Automated system optimizes water usage based on real-time soil and environmental conditions. Reduces water waste and labor while improving crop health.

Link: <https://rjpn.org/ijnti/papers/IJNTI2404013.pdf>

2. Automatic Plant Irrigation System Using Arduino (India, 2023)

Summary: This project presents a solution for efficient water management in agriculture using copper electrode soil sensors, a microcontroller, and a DC pumping motor.

Challenges: Manual irrigation is labor-intensive and often leads to water wastage.

Solutions: System uses soil moisture, temperature and humidity sensors connected to Arduino microcontroller (open-source electronics platform based on easy-to-use hardware and software). Controls water pump based on soil moisture levels.

Results: Successfully automated irrigation process, activating pump when soil moisture is low and deactivating when sufficient. Reduced water waste and labor requirements while promoting optimal plant growth.

Link:

https://www.irjmets.com/uploadedfiles/paper/issue_6_june_2023/42129/final/fin_irjmets1686837853.pdf

3. Smart Irrigation Systems in Agriculture: A Systematic Review (2023)

Summary: This systematic review covers various smart irrigation systems using artificial intelligence techniques in both urban and rural agriculture. It identifies systems currently in use or adaptable for urban agriculture, focusing on soil crops

Description: A systematic literature review of smart irrigation systems using artificial intelligence techniques like machine learning, fuzzy logic, and IoT.

Challenges: Need for more efficient irrigation to conserve water and improve crop yields.

Solutions: Review of systems using AI techniques like machine learning for predicting soil moisture, fuzzy logic for irrigation control, and IoT for data collection and remote monitoring.

Results: Found increasing research interest in smart irrigation, with IoT and fuzzy logic being most common technologies. Identified potential for applying rural agriculture solutions to urban farming.

Link: <https://www.mdpi.com/2073-4395/13/2/342>

Market Suppliers for Equipment and Technology

Supplier	Products	Cost Range (€)
Netafim (Israel) www.netafim.com	Smart irrigation systems and sensors	2,500 - 5,000
Rain Bird (USA/Europe) www.rainbird.com	Automated irrigation controllers	1,000 - 3,000

Davis Instruments www.davisinstruments.com	(USA)	Weather stations and data loggers	500 - 1,500
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These suppliers offer solutions suitable for small-scale, multi-crop setups. Farmers should request detailed quotes and consider factors such as compatibility with local conditions, scalability, and after-sales support when making the final selection.

Innovative Aspects

- Integration of multi-depth soil sensors for precise water management across different crop types
- Use of machine learning algorithms for predictive irrigation scheduling
- Development of a user-friendly mobile app for remote monitoring and control
- Cross-sector applicability, demonstrating versatility across fruits, MAPs, and vegetables

Conclusion

This pilot project introduces a climate-smart solution to Kosovo's fruit and vegetable processing sector through the implementation of water filtration and reuse systems. By significantly reducing freshwater consumption and wastewater discharge, the project addresses key climate change challenges while improving operational efficiency and water independence. The positive financial indicators and potential for scalability make this an attractive investment in sustainable food processing. Successful implementation could serve as a model for wider adoption across Kosovo's food industry, contributing to the country's water conservation goals, climate resilience, and economic development. The project demonstrates how small-scale interventions can have significant impacts, paving the way for a more sustainable and competitive agri-food sector in Kosovo. By creating a closed-loop water cycle, this initiative not only conserves precious water resources but also sets a new standard for resource efficiency in the region's food processing industry.

5.3 General recommendations to enhance feasibility, adoption and scaling-up of pilot projects

The successful implementation and scaling of the proposed pilot projects require a holistic approach that addresses various aspects of technology adoption, capacity building, and systemic support. The following recommendations are designed to enhance the feasibility, adoption, and scaling-up of these pilot projects in Kosovo's agricultural context. These suggestions take into account the unique challenges and opportunities present in Kosovo's farming sector, including the predominance of small-scale farms, the need for modernization, and the importance of aligning with national agricultural policies and EU standards. By following these recommendations, stakeholders can create a more conducive environment for the successful integration of climate-smart technologies and practices in Kosovo's agriculture. In Task 4, we will develop a comprehensive strategy for capacity building and knowledge dissemination to ensure the effective uptake and utilization of the recommended interventions.

Recommendations:

- Build local capacity:

- o Establish partnerships with local universities and technical schools to develop training programs.
 - o Create a "train-the-trainer" program to build a network of local experts.
 - o Develop user-friendly manuals and guidelines in local languages.
- Leverage existing infrastructure:
 - o Partner with local agricultural cooperatives to use their facilities for demonstrations.
- Promote farmer-to-farmer learning:
 - o Organize field days and farmer exchange visits to showcase successful implementations.
 - o Establish a network of demonstration farms across different regions.
- Develop flexible financing models:
 - o Work with local banks to create tailored loan products for climate-smart agriculture investments.
 - o Explore pay-as-you-save models for energy-efficient technologies.
 - o Implement cost-sharing mechanisms between farmers, government, and private sector.
- Enhance market linkages:
 - o Connect farmers adopting climate-smart practices with premium markets.
 - o Develop certification schemes for climate-smart produce.
- Foster public-private partnerships:
 - o Engage local agribusinesses in technology dissemination and support.
 - o Collaborate with input suppliers to bundle climate-smart technologies with their products.
- Integrate with existing government programs:
 - o Align pilot projects with national agricultural and climate change strategies.
 - o Incorporate successful pilots into existing extension services.
- Implement adaptive management:
 - o Establish robust monitoring and evaluation systems.
 - o Regularly review and adjust project design based on feedback and results.
- Address gender and youth inclusion:
 - o Design interventions that specifically target women and young farmers.
 - o Ensure training and technology access is equitable.
- Develop supportive policies:
 - o Work with policymakers to create incentives for climate-smart technology adoption.
 - o Advocate for regulations that support innovative agricultural practices.

5.4 List of detailed tailored interventions for adoption of climate-smart technologies and techniques

5.4.1 Berries

Intervention	Description	Rough Estimated Cost	Climate Mitigation Potential	Climate Adaptation Potential	Scalability	Alignment with Kosovo's Context
Efficient Drip Irrigation Systems	- For 0.1 hectare: 1000-1500 meters of drip lines 1 water pump (0.5-1 HP) 1 filter system 1 small fertilizer injector - System design considers soil type, berry variety, and plant spacing - Typically requires 2-4 emitters per plant, depending on berry type	€500-€1,000 per hectare	Reduces water and energy use	Ensures efficient water use during droughts	High	High; water scarcity and inefficient irrigation are issues in Kosovo
Mulching	- For 0.1 hectare: 1000-1500 kg of organic mulch (e.g., straw, wood chips) or 100-150 m² of plastic mulch - Application thickness: 5-10 cm for organic mulch - Mulch type depends on soil type and berry variety	€200-€500 per hectare	Increases soil carbon sequestration	Reduces soil evaporation, maintains soil moisture	High	High; applicable to various crop types

Anti-Hail Netting	7. For 0.1 hectare: 7. 1000-1200 m² of anti-hail net 8. Support structure: 20-30 poles 9. Anchoring system 8. Net specifications depend on local hail risk and berry type	€9,600 per 3,000 m ²	Prevents crop loss	Protects crops from hail damage, ensuring stable yields	Medium	High; aligns with recent hailstorm impacts
Solar-Powered Water Pumps	9. For 0.1 hectare: 10. 1 solar pump system (0.5-1 HP) 11. 2-4 solar panels (depending on pump size and sunlight availability) 12. 1 controller 13. 1 battery bank (optional, for consistent operation)	€1,500-€3,000	Reduces reliance on fossil fuels	Provides reliable water supply during power outages	High	High; renewable energy is a priority
Cover Crops	10. For 0.1 hectare: 14. 5-10 kg of cover crop seeds (varies by species) 11. Species selection based on soil type, climate, and primary crop needs	€100-€300 per hectare	Enhances soil organic matter	Improves soil health, reduces erosion	High	High; promotes sustainable farming practices
Organic Fertilizers	12. For 0.1 hectare: 15. 500-1000 kg of compost or 16. 200-400 kg of specialized organic fertilizer	€200-€500 per hectare	Reduces emissions from synthetic fertilizers	Enhances soil health, improves crop resilience	High	High; aligns with organic farming promotion

	13. Application rates vary by soil type, berry variety, and existing soil fertility. 14. This measure can be utilized in the fruit and vegetable processing facilities too given that the rate of organic waste generated there is high.					
Rainwater Harvesting Systems	15. For 0.1 hectare: 17. 1 collection surface (often greenhouse roof) 18. Gutters and downspouts 19. 1 storage tank (5000-10000 liters) 20. 1 small pump and filtration system	€500-€1,000 per system	Reduces water extraction energy use	Provides water during dry periods	High	High; mitigates water scarcity issues
Biodiversity Planting	16. For 0.1 hectare: 21. 50-100 m² dedicated to biodiversity strips 22. Mixture of 10-20 plant species (flowers, herbs, shrubs) 17. Species selection based on local ecosystem and target beneficial insects	€100-€300 per hectare	Enhances ecosystem carbon sequestration	Increases resilience to pests and diseases	High	High; supports agro-biodiversity
Soil Moisture Sensors	18. For 0.1 hectare: 23. 3-5 soil moisture sensors 24. 1 data logger or wireless transmission system	€200-€400 per system	Optimizes water use, reduces energy consumption	Ensures efficient water use, improves plant health	High	High; supports precision agriculture

	19. Sensor placement considers soil variability and irrigation zones					
Frost Protection Systems	20. For 0.1 hectare: 25. 1 frost protection fan (3-5 m tall, covering about 0.4-0.5 hectares, so one unit is sufficient) 26. Alternative: 1000-1200 m² of frost protection fleece or row covers 27. 1 frost alarm system with 2-3 temperature sensors 21. System choice depends on local climate, frequency of frost events, and berry type 22. Fan system includes: 28. 1 tower with fan unit 29. 1 automated control system 30. Fuel tank or electrical connection depending on power source 23. Fleece system includes: 31. Support hoops: 100-150 units 32. Anchoring pegs: 200-300 units 24. Requires weather monitoring station for optimal operation	€2,000-€5,000 per hectare	Low	Protects crops from late spring frosts	Medium	High; addresses increasing frost risk due to climate change

5.4.2 Medicinal and Aromatic Plants (MAPs)

Intervention	Description	Rough Estimated Cost	Climate Mitigation Potential	Climate Adaptation Potential	Scalability	Alignment with Kosovo's Context
Efficient Drip Irrigation Systems	Similar to berries, but with adjustments for plant spacing and water needs of specific MAPs	€500-€1,000 per hectare	Reduces water and energy use	Ensures efficient water use during droughts	High	High; water scarcity and inefficient irrigation are issues in Kosovo
Organic Fertilizers	Similar to berries, but with specific formulations for MAPs	€200-€500 per hectare	Reduces emissions from synthetic fertilizers	Enhances soil health, improves crop resilience	High	High; aligns with organic farming promotion
Rainwater Harvesting Systems	Similar to berries	€500-€1,000 per system	Reduces water extraction energy use	Provides water during dry periods	High	High; mitigates water scarcity issues
Biodiversity Planting	Similar to berries, but with focus on plants that attract pollinators beneficial to MAPs	€100-€300 per hectare	Enhances ecosystem carbon sequestration	Increases resilience to pests and diseases	High	High; supports agro-biodiversity
Soil Moisture Sensors	Similar to berries	€200-€400 per system	Optimizes water use, reduces energy consumption	Ensures efficient water use, improves plant health	High	High; supports precision agriculture
Agroforestry Systems	25. For 0.1 hectare:	€500-€1,000 per hectare	Increases carbon sequestration,	Diversifies income, improves resilience	High	High; promotes multifunctional landscapes

	33. 10-20 trees or shrubs integrated with MAPs 34. Species selection based on compatibility with MAPs and local conditions		reduces emissions			
Mycorrhizal Inoculation	26. For 0.1 hectare: 35. 1-2 kg of mycorrhizal inoculant 27. Application method depends on product form (liquid, powder, granules)	€200-€500 per hectare	Enhances soil carbon storage	Improves plant health and drought resistance	Medium	Medium; supports sustainable forest management
Composting Units	28. 1 small composting unit (1-2 m³) 29. Suitable for processing plant residues from 0.1 hectare 30. Suitable for a collaboration between farmers and their corresponding partners such as fruits or vegetable processing facilities.	€1,000-€2,000 per unit	Reduces methane emissions from waste	Enhances soil fertility, reduces need for synthetic fertilizers	High	High; promotes circular economy
Shade Nets for Temperature Control	31. For 0.1 hectare: 36. 1000-1200 m² of shade netting 37. Support structure: 20-30 poles 32. Shade percentage chosen based on specific MAP light requirements	€300-€700 per hectare	Reduces heat stress on crops	Protects plants from extreme temperatures	High	High; suitable for MAPs that are sensitive to temperature fluctuations
Solar Drying Systems	33. For 0.1 hectare:	€1,000-€3,000 per unit	Reduces energy use for drying	Reduces energy use for drying	High	High; supports value addition and

	38. 1 solar dryer unit (2-3 m² drying area) 39. Capacity: 50-100 kg of fresh herbs per batch 34. Components: 40. Solar collector: 2-3 m² 41. Drying chamber with 3-5 trays 42. Small fan for air circulation 43. Temperature and humidity sensors: 2-3 units 35. Design considers specific drying requirements of different MAPs 36. Includes basic packaging equipment for dried products					quality preservation
Precision Seeding Equipment	37. For 0.1 hectare: 44. 1 small-scale precision seeder (hand-pushed or small tractor-mounted) 45. Seed hoppers: 2-3 units for different seed sizes 46. Interchangeable seeding plates: 5-10 units for various MAP species 47. Row markers: 2-3 units 38. Capable of adjusting seed spacing and depth 39. Includes calibration tools for different seed types	€2,000- €5,000	Optimizes resource use	Improves crop establishment	Medium	Medium; suitable for larger MAP operations

	40. May include GPS guidance system for very precise planting patterns					
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5.4.3 Non-Wood Forest Products (NWFPs)

Intervention	Description	Rough Estimated Cost	Climate Mitigation Potential	Climate Adaptation Potential	Scalability	Alignment with Kosovo's Context
Forest Management for Carbon Sequestration	41. For 1 hectare: 48. Selective thinning or planting of 100-200 trees 49. Species selection based on carbon sequestration potential and NWFP production 42. Includes creation of a detailed forest management plan 43. May involve establishing 2-3 permanent sample plots for long-term carbon monitoring	€100-€300 per hectare	Enhances carbon storage in forests	Improves forest health and resilience	Medium	High; aligns with forest conservation efforts
Mycorrhizal Inoculation	44. For 1 hectare: 50. 10-20 kg of mycorrhizal inoculant 45. Application methods: 51. Direct soil application: 10-20 g per tree 52. Seedling treatment: 5-10 g per seedling for new plantings	€200-€500 per hectare	Enhances soil carbon storage	Improves plant health and drought resistance	Medium	Medium; supports sustainable forest management

	46. Inoculation strategy considers existing soil mycorrhizal populations and target NWFP species					
Agroforestry Systems	47. For 1 hectare: 53. 100-200 trees or shrubs integrated with other NWFPs or crops 54. Tree spacing typically 5-10 meters, depending on species and system design 48. Includes a mix of 3-5 tree species and 2-3 NWFP or crop species 49. Design considers light requirements, root interactions, and harvest logistics	€500- €1,000 per hectare	Increases carbon sequestration, reduces emissions	Diversifies income, improves resilience	High	High; promotes multifunctional landscapes
Composting Units	50. For 1 hectare: 55. 1-2 larger composting units (5-10 m³ each) 51. Capable of processing 5-10 tons of organic matter annually 52. Includes turning equipment and monitoring tools (thermometer, pH meter)	€1,000- €2,000 per unit	Reduces methane emissions from waste	Enhances soil fertility, reduces need for synthetic fertilizers	High	High; promotes circular economy
Soil Moisture Sensors	53. For 1 hectare forest area: 56. 10-15 soil moisture sensors	€200-€400 per system	Optimizes water use, reduces	Ensures efficient water use,	High	High; supports precision agriculture

	57. 1 central data logger or wireless transmission system 54. Sensor placement considers soil variability, topography, and different NWFP zones		energy consumption	improves plant health		
Sustainable Harvesting Techniques	55. Equipment for 5-10 harvesters: 58. 5-10 sets of pruning shears, collection baskets, and protective gear 59. 1-2 portable field weighing scales 56. Includes development of species-specific harvesting guidelines 57. Implementation of a rotational harvesting plan to ensure sustainability	€300-€500 per hectare	Maintains biodiversity, reduces over-exploitation	Ensures long-term availability of NWFPs	High	High; supports sustainable forest and land management
Biochar Production	58. 1 medium-sized biochar kiln (2-5 m³ capacity) 59. Processes 5-10 tons of woody waste annually 60. Includes storage area for feedstock and finished biochar 61. Basic testing equipment for biochar quality assessment	€500-€1,000 per unit	Sequesters carbon, improves soil health	Enhances soil fertility, reduces water needs	Medium	Medium; promotes soil health and sustainable agriculture
Community-Based Forest Management	62. For 1 hectare (often part of a larger community forest):	€1,000-€2,000 per program	Enhances local engagement in conservation	Improves forest resilience,	High	High; aligns with community-based resource

	60. Training program for 20-30 community members 61. Development of comprehensive management plan 62. Establishment of a community forest committee (5-7 members) 63. Includes basic equipment for forest inventory and monitoring			supports livelihoods		management practices
Low-Impact Logging Equipment	64. For 1 hectare operations: 63. 1 small forestry tractor or skidder 64. 1 portable winch system 65. 2-3 chainsaws 66. 5-10 sets of personal protective equipment 65. Includes equipment for establishing skid trails and log landings	€2,000-€5,000	Reduces soil compaction, maintains forest structure	Supports sustainable forest operations	Medium	Medium; suitable for small-scale forest operations
Wild Edible Plant Cultivation	66. For 1 hectare: 67. Seeds or seedlings for 5-10 wild edible plant species 68. Basic cultivation tools (hand tools, small tiller)	€300-€700 per hectare	Promotes biodiversity, reduces pressure on wild populations	Ensures sustainable harvest, supports local diets	High	High; aligns with cultural and dietary practices in rural areas

	69. Small irrigation system if needed (similar to drip irrigation for berries, scaled appropriately) 67. Includes fencing materials to protect from wildlife if necessary 68. Establishment of 2-3 demonstration plots for different species or cultivation methods					
GPS Mapping for Sustainable Harvesting	69. Equipment: 70. 2-3 handheld GPS units (rugged, forestry-grade) 71. 1 base station for differential GPS if high precision is required 72. Software package for data processing and map creation 70. Mapping components: 73. Resource inventory: Mapping of 50-100 individual NWFP-producing trees or patches 74. Creation of 10-20 permanent sampling plots	€500-€1,000 per system	Helps maintain forest carbon stocks	Supports sustainable resource management	High	High; enhances sustainable harvesting practices

	75. Mapping of sensitive areas, water sources, and access routes 71. Includes training for 5-10 community members in GPS use and data collection 72. Development of digital maps and harvesting schedules based on GPS data					
Value-Addition Processing Units	73. For 1 hectare, assuming mixed NWFP production: 76. 1 multi-purpose processing facility (50-100 m²) 74. Equipment: 77. Cleaning and sorting table: 1-2 units 78. Drying racks or small dehydrator: 5-10 m² total drying area 79. Grinding/milling machine: 1 unit with interchangeable screens 80. Packaging equipment: 1 small-scale unit 81. Cold storage: 1 small unit (5-10 m³) 75. Specialized equipment based on primary NWFPs:	€5,000- €10,000 per unit	Reduces transportation emissions	Diversifies income sources	High	High; supports local economic development

	82. For nuts: 1 small cracking and sorting machine 83. For berries: 1 small pulping or juicing machine 84. For medicinal plants: 1 small essential oil distillation unit 76. Includes basic quality control equipment (moisture meter, scales) 77. Workspace designed for proper product flow and hygiene 78. Includes training program for 5-10 operators on processing techniques and food safety					
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Additional considerations for NWFPs:

- **Zoning:** The hectare might be divided into different management zones based on site conditions and NWFP types.
- **Access:** Development of access paths or small roads within the hectare for management and harvesting.
- **Water Management:** May include small-scale water management interventions like contour trenches or check dams, depending on the topography.
- **Biodiversity Conservation:** Deliberate setting aside of 10-20% of the area for strict conservation to enhance overall forest health and NWFP sustainability.
- **Monitoring System:** Establishment of a more comprehensive monitoring system with permanent plots for tracking NWFP productivity, forest health, and biodiversity.
- **Value Addition:** At this scale, basic processing equipment for NWFPs might be considered, such as drying racks, simple extraction equipment, or packaging materials.
- **Storage:** Development of proper on-site storage facilities for harvested NWFPs before transportation or processing.
- **Certification:** At 1 hectare, pursuing sustainable forest management certification might become viable, which could include additional documentation and management practices.

5.4.4 Fruits and Vegetables Processing (FVP)

Intervention	Description	Rough Estimated Cost	Climate Mitigation Potential	Climate Adaptation Potential	Scalability	Alignment with Kosovo's Context
Energy-Efficient Processing Equipment	79. Typically includes washers, cutters, dryers, and packaging machines. - For a small 0.1 hectare operation (processing about 1-2 tons per day): 85.1 energy-efficient washer 86.1-2 cutting/slicing machines 87.1 small-scale dryer 88.1 packaging machine - Equipment is adaptable to different fruit and vegetable types.	€10,000-€50,000 per unit	High; reduces energy consumption and associated emissions	Medium; improves resilience to energy price fluctuations	Medium	High; aligns with energy efficiency goals and modernization efforts
Solar-Powered Cold Storage	- For 0.1 hectare production (about 5-10 tons storage capacity): 89. Solar panel system: 10-15 kW 90. Battery storage: 20-30 kWh 91. Cold storage unit: 20-30 m³ - System size depends on local solar irradiation and specific	€15,000-€40,000 per unit	High; reduces reliance on grid electricity and associated emissions	High; ensures product quality during power outages and heat waves	Medium	High; leverages Kosovo's solar potential and addresses unreliable power supply

	cooling needs of different fruits and vegetables.					
Water Recycling and Treatment Systems	- For a small processing facility (1-2 tons per day): 92. 1 filtration system 93. 1 UV disinfection unit 94. Storage tanks: 2000-5000 liters - System design considers water quality requirements for different processing stages and crop types.	€5,000-€20,000 per system	Medium; reduces water consumption and wastewater emissions	High; enhances water security in processing operations	High	High; addresses water scarcity issues in Kosovo
Biogas Digesters for Organic Waste	- For 0.1 hectare operation (assuming 20-30% waste): 95. 1 small-scale digester (10-20 m³) 96. 1 gas storage unit 97. 1 small generator (if electricity production is desired) - Digester design considers the mix of fruit and vegetable waste types.	€20,000-€100,000 per unit	High; reduces methane emissions and produces renewable energy	Medium; provides alternative energy source	Medium	Medium; supports waste management and renewable energy goals
Smart Monitoring and Control Systems	- For a small processing line: 98. 5-10 IoT sensors (temperature, humidity, pH, etc.) 99. 1 central control unit 100. Software for data analysis and process control	€5,000-€15,000 per system	Medium; optimizes resource use and reduces waste	High; improves product quality and shelf life	High	Medium; requires technical expertise but enhances competitiveness

	- System is customizable based on the types of fruits and vegetables being processed.					
Eco-friendly Packaging Solutions	- For small-scale operation: 101. 1 biodegradable film wrapping machine 102. 1 cardboard box forming machine - Packaging materials and sizes are adaptable to different produce types.	€1,000-€5,000 for equipment	Medium; reduces plastic waste and associated emissions	Low; minimal direct adaptation benefits	High	High; aligns with EU standards and consumer preferences
Precision Sorting and Grading Technology	- For small-scale operation: 103. 1 biodegradable film wrapping machine 104. 1 cardboard box forming machine - Packaging materials and sizes are adaptable to different produce types.	€10,000-€30,000 per unit	Medium; reduces food waste and associated emissions	High; improves product consistency and market access	High	Medium; requires investment but enhances export potential
Heat Recovery Systems	- For small processing facility: 105. 1 heat exchanger 106. Insulated piping system 107. 1 small storage tank for recovered heat (if applicable) - System design depends on the specific processes generating waste heat.	€10,000-€30,000 per unit	High; reduces energy consumption for heating/cooling	Medium; improves energy efficiency in variable climate conditions	Medium	High; supports energy efficiency in processing facilities

Pulsed Electric Field (PEF) Processing	- For small-scale operation: 108. 1 PEF treatment chamber 109. 1 pulse generator 110. Pumps and piping system - Treatment parameters are adjustable for different fruits and vegetables.	€50,000- €150,000 per unit	Medium; reduces energy use compared to thermal processing	High; improves product quality and shelf life	Low	Medium; advanced technology suitable for larger operations
Lean Manufacturing Implementation	- This is a management approach rather than a specific technology. - For a small facility: 111. Training for all staff (5-10 people typically) 112. Implementation of visual management tools 113. Reorganization of workspace layout - Approach is customized based on specific processing lines and produce types.	€5,000- €20,000 for consulting and training	Medium; optimizes resource use and reduces waste	High; improves operational efficiency and adaptability	High	High; enhances competitiveness and resource efficiency

General considerations for FVP:

1. **Scalability:** Most of these interventions are modular and can be scaled up or down based on the size of the operation. The examples given are for small-scale operations processing the output from approximately 0.1 hectare.
2. **Crop Types:** The processing equipment and systems are generally adaptable to various fruit and vegetable types. However, specific settings or attachments might be needed for different produce (e.g. different cutting blades for soft fruits vs. hard vegetables).

3. **Energy and Water Use:** The actual energy and water consumption will vary greatly depending on the types of fruits and vegetables being processed, their water content, and the specific processing methods used.
4. **Integration:** These systems often work best when integrated. For example, the smart monitoring system can optimize the energy-efficient equipment, cold storage, and water recycling systems.
5. **Training and Maintenance:** All these systems require proper training for operators and regular maintenance. This should be factored into the overall implementation plan.
6. **Regulatory Compliance:** Especially for food processing, all equipment and processes must comply with local food safety regulations.

6 Strategies for Capacity Building

In the wake of increasing climate variability and the pressing need for sustainable agricultural practices, this capacity-building strategy aims to empower stakeholders in Kosovo to adopt and implement Climate-Smart Agriculture (CSA). This strategy, designed with the needs of farmers, agribusinesses, government agencies, and NGOs in mind, will equip stakeholders with the knowledge and skills necessary for sustainable agricultural development. By focusing on training programs, tutorial videos, manuals, extension services, awareness campaigns, and knowledge transfer channels, this comprehensive approach will foster resilience and promote sustainable practices across the agricultural sector.

This strategy is based on extensive investigations and findings from our desk research, in-depth interviews, and focus group discussions, as detailed in our initial project phases. Our comprehensive review of strategic documents such as the National Organic Action Plan, the Strategy for Agriculture and Rural Development, and the Climate Change Strategy and Action Plan has highlighted the need for better management practices, advanced climate-smart technologies, and increased financial and technical support to promote sustainable agriculture. The insights gathered from these investigations have informed the development of this strategy, ensuring it is tailored to the specific needs and challenges faced by stakeholders in Kosovo.

We conducted 12 interviews with key stakeholders including government institutions, international organizations, academia, associations, and agribusinesses. These interviews revealed significant climate-related changes such as extreme weather events, droughts, and floods, which adversely impacted agricultural productivity and food security. Stakeholders emphasized the need for advanced climate-smart technologies, better financial and technical support, and the importance of sustainable practices. Key challenges included financial constraints, lack of information, and high costs of adaptation measures.

Focus group discussions held in regions such as Gjilan, Prizren, Podujeva, and Prishtina provided valuable insights into local perceptions and challenges. Participants noted significant climate-related changes, including unpredictable rainfall, increased temperatures, and extreme weather events, which negatively impacted agricultural productivity. There was a strong emphasis on the need for modern post-harvest technology, financial and technical support, and better coordination among stakeholders to adopt CSA practices effectively.

Based on the findings from Task 2, we identified high-impact agricultural value chains and proposed targeted interventions focusing on Non-Wood Forest Products (NWFPs), Medical and Aromatic Plants (MAPs), Berries, and Fruit and Vegetable Processing. The planned small-scale pilot projects aim to enhance sustainability, improve climate resilience, and increase economic viability for smallholders. Examples of pilot projects include the implementation of smart pollination management system to improve climate resilience for berries and MAPs, biochar production and application system to improve soil health etc.

The main Objectives of our proposed CBS are the following:

1. Develop strategies for capacity building and knowledge transfer to empower stakeholders in adopting and implementing climate-smart technologies and practices.
2. Identify training needs, extension services, and knowledge dissemination channels to ensure effective uptake and utilization of recommended interventions.

The Data Analysis findings detailed under Task 2, provide valuable insights into challenges and opportunities for implementing Climate-Smart Agriculture (CSA) in Kosovo. The identified gaps in policy, technology, knowledge and financial resources emphasize the need for long-term interventions in the following key areas:

Policy and Institutional Strengthening:

- Understanding climate change policies and their implications for agriculture
- Policy development and implementation to support CSA
- Strengthen the capacity of government agencies to implement and enforce climate-smart policies

Technology Transfer and Adoption:

- Showcase the benefits of climate-smart technologies through field demonstrations and pilot projects
- Provide financial support for farmers and businesses to adopt climate-smart technologies
- Offer technical assistance for installation, operations and maintenance of climate-smart technologies
- Equip farmers and extension services with the skills to operate and manage new technologies

Knowledge and Skills Development:

- Periodic needs assessment to identify specific knowledge and skills gaps among different stakeholders
- Develop and deliver training programs to address identified needs
- Strengthen extension services to provide ongoing support and advice
- Create or use existing platforms to share information and best practices

Financial Resources and Market Development:

- Promote and advocate for grants or subsidies to support CSA investments
- Identify market opportunities for climate-smart products

This holistic approach would empower farmers, agribusinesses, extension services, and policymakers to build a resilient and sustainable agricultural sector capable of thriving in the face of climate change.

a. Specific Interventions

To effectively promote CSA and create conducive environment for implementation of CSA small scale pilot projects proposed and described under Task 3 - Revised Targeted Interventions, the following are specific interventions proposed by the Expert team for implementation, a combination of theoretical and hands-on experience:

- Interventions to address attitudes and overall skills gap hindering CSA Adoption
- Interventions linked to implementation of CSA small pilot projects

i. Interventions to address attitudes and overall skills gap hindering CSA Adoption:

- **Workshops:** To effectively foster a supportive environment for Climate-Smart Agriculture (CSA), comprehensive workshops need to be conducted targeting farmers, businesses, community leaders, and local agricultural extension services. These workshops will delve deeper into the specific climate change impacts relevant to the region, such as altered rainfall patterns, increased temperatures, and more frequent extreme weather events.

By providing concrete examples and case studies, participants will gain a clear understanding of how these changes are affecting agricultural production, livelihoods, and the overall ecosystem. The workshops will emphasize the urgency of adapting to these challenges and highlight the role of CSA in building resilience.

Below is a workshop proposal outlining a comprehensive plan to equip stakeholders with the knowledge and skills necessary to implement CSA practices. The workshop will provide a platform for participants to learn about the latest CSA technologies and practices, network with experts and peers, and develop strategies for implementing these approaches in their communities. Through interactive sessions, case

studies, and practical exercises, participants will gain valuable insights and skills that can be applied to their work.

Workshop: Climate-Smart Agriculture for Sustainable Development in Kosovo

Objectives:

- To enhance understanding of climate change impacts on agriculture in Kosovo.
- To equip stakeholders with knowledge and skills for implementing CSA practices.
- To foster collaboration and knowledge sharing among stakeholders.

Target Audience: Farmers, Agribusinesses, Extension Services, Community Leaders

Workshop Outline:

Day 1: Climate Change Impacts and CSA Principles	Day 2: CSA Practices and Technologies	Day 3: Policy and Institutional Framework
• Climate change trends and impacts in Kosovo • Understanding CSA concepts and benefits • Case studies of successful CSA implementation	• Soil health and nutrient management • Water conservation and efficient irrigation • Sustainable crop and livestock management • Renewable energy applications in agriculture • Precision agriculture and digital technologies	• Climate-smart policies and regulations • Role of government agencies in promoting CSA • Financial incentives and support mechanisms • Public-private partnerships for CSA development

Workshop Format:

- A mix of presentations, group discussions, case studies, and hands-on activities.
- Expert speakers from government agencies, research institutions, and NGOs.
- Opportunities for networking and collaboration among participants.

Workshop Logistics:

While a non-residential workshop format is certainly feasible, there are several compelling reasons to consider a residential workshop for this initiative such as: enhanced focus and engagement, stronger networking opportunities, team building and community building, hands-on experience, opportunities for informal learning.

By providing this workshop, stakeholders will be given an opportunity to gain valuable insights into climate-smart agriculture and develop the skills necessary to implement sustainable practices in their communities

- **Tutorial Videos:** The objective of the tutorial video series is to provide accessible, on-demand learning resources that empower farmers and agribusinesses to implement CSA practices. Below is a proposal for tutorial videos on the most pressing needs for four targeted sectors and their recommended content.

Berries

- **Topic 1: Climate-Resilient Berry Cultivation in Kosovo**

- o **Focus:** Highlight the selection of berry varieties that are adapted to changing climate conditions, such as drought-tolerant and heat-resistant cultivars.
- o **Content:** Discuss strategies for managing heat stress, water scarcity, and late frosts in berry production.
- o **Visuals:** Showcase berry farms that have successfully adapted to climate change, including irrigation systems, protective netting, and climate-resilient varieties.

Medicinal and Aromatic Plants (MAPs)

- **Topic 2: Organic Cultivation of MAPs for Domestic and Export Markets**

- o **Focus:** Provide practical guidance on organic farming techniques, including soil preparation, pest control, and harvesting methods.
- o **Content:** Showcase successful examples of organic MAP production in Kosovo, highlighting the benefits of reduced chemical inputs and improved product quality.
- o **Visuals:** Include footage of organic farms, demonstrations of cultivation techniques, and interviews with organic farmers.

Non-Wood Forest Products (NWFPs)

- **Topic 3: Community-Based Forest Management for Sustainable NWFP Production**

- o **Focus:** Demonstrate successful examples of community-based forest management initiatives in Kosovo.
- o **Content:** Cover topics such as participatory forest planning, sustainable harvesting practices, and benefit-sharing mechanisms.
- o **Visuals:** Include footage of community meetings, forest inventories, and sustainable harvesting techniques.

Fruit and Vegetable Processing

- **Topic 4: Energy-Efficient Processing Technologies for FVP**

- o **Focus:** Demonstrate innovative technologies that can reduce energy consumption and emissions in FVP facilities.
- o **Content:** Cover topics such as solar-powered equipment, waste heat recovery systems, and energy-efficient processing methods.
- o **Visuals:** Showcase successful implementations of energy-efficient technologies in FVP facilities in Kosovo.

Format of the tutorial video:

- **Expert-led demonstrations:** Showcasing practical techniques step-by-step, using clear and concise language.
- **Visual aids:** Incorporating high-quality visuals, such as diagrams, animations, and real-world footage, to enhance understanding.
- **Subtitles:** Providing subtitles in Albanian and/or Serbian to ensure accessibility.
- **Call to action:** Encouraging viewers to try out the techniques demonstrated in the videos and share their experiences with others.

Distribution:

- **Online platform:** Uploading the videos to an existing online platform such as agroportal.com, accessible to all stakeholders.
- **Social media promotion:** Sharing videos on social media platforms, such as facebook and Instagram where farmers and agribusinesses are active.
- **Collaboration with partners:** Partnering with agricultural organizations and online platforms to increase the reach of the videos.

By focusing on practical skills and techniques, the tutorial video series will empower farmers and agribusinesses to take action and implement CSA practices effectively. These videos will serve as valuable resources for learning and inspiration, contributing to a more sustainable and resilient agricultural sector in Kosovo.

Complementary Learning Resources:

To complement the tutorial video series and workshops, it is recommended that the project develops a range of additional learning resources to support farmers and agribusinesses in adopting CSA practices. These resources could provide comprehensive information, guidance, and tools for implementing CSA interventions, ensuring that stakeholders have access to a variety of learning opportunities:

- **Incorporating CSA concepts into existing farmer training programs:** The project should aim to integrate modules on CSA practices with existing training programs.
- **Partnerships with local organizations/agricultural cooperatives and community leaders:** Collaboration with local organizations will allow for targeted outreach and dissemination of information about CSA practices in rural communities.
- **Manuals and Guides:** Detailed, step-by-step manuals and guides should be developed, providing in-depth information on implementing various CSA practices. These resources could be made available online and distributed through partner organizations.
- **CSA Handbook:** A comprehensive handbook covering all aspects of CSA, including efficient water use, soil health improvement, and renewable energy use, is recommended to be created. This handbook will serve as a valuable reference for farmers, researchers, and policymakers.

ii. Interventions linked to implementation of CSA small pilot projects

Based on the proposed CSA initiatives, here are some potential training programs, in addition to interventions in the previous section:

1. Training on Climate-Smart Raspberry Production in Kosovo

Training Objectives:

- To introduce farmers to the benefits of semi-permanent high tunnels for raspberry cultivation.
- To provide hands-on training on high tunnel construction, irrigation, and climate control.
- To showcase the potential for increased yield, quality, and economic returns.

Target Audience: Small-scale raspberry farmers, extension services

Training Outline:

Day 1: Introduction to High Tunnel Technology	Day 2: High Tunnel Construction and Installation	Day 3: Irrigation and Soil Management	Day 4: Monitoring, Evaluation, and Scaling Up (optional)
Benefits of high tunnels for raspberry production	Site selection and preparation	Drip irrigation system design and installation	Data collection and analysis
Climate resilience and extended growing season	High tunnel frame construction	Soil preparation and planting techniques	Measuring the impact of high tunnels on yield, quality, and profitability
Improved yield and quality	Installation of polyethylene covering and green net	Nutrient management and fertilization	Scaling up the technology to larger areas
Disease management and water conservation	Automated climate control system setup		

Training Format:

- A combination of lectures, demonstrations, and hands-on activities.
- Expert speakers and experienced farmers sharing their knowledge.
- Site visits to a demonstration high tunnel.

By participating in this training, farmers will gain the knowledge and skills necessary to implement climate-smart raspberry production using high tunnels. This innovative approach can help to enhance the resilience and profitability of small-scale farms in Kosovo.

2. Training on Microclimate Management System in Berry Production

Training Objectives:

- Understand the principles of microclimate management and its benefits for berry production.
- Learn how to operate and manage the installed microclimate management system, including:
 - o Using the mobile app for monitoring and control.
 - o Interpreting data from microclimate sensors.
 - o Adjusting sprinkler irrigation schedules based on real-time data.
- Gain practical skills in maintaining the system components (sensors, sprinklers, control unit).
- Appreciate the potential environmental and economic benefits of microclimate management.

Target Audience: small-scale berry farmers, extension services

Training Outline:	
Day 1:	Day 2:
Introduction to microclimate management: concepts, components, and benefits. Overview of the installed system (sensors, sprinklers, control unit, mobile app). Hands-on training on using the mobile app for monitoring: • Real-time microclimate data visualization. • Viewing historical data and trends. Practical demonstration of system operation: • Setting up sprinkler irrigation schedules. • Adjusting misting and shading systems based on microclimate data.	In-depth session on interpreting microclimate data: • Understanding the relationship between microclimate factors and berry growth. • Identifying optimal microclimate conditions for berry production. System maintenance procedures: • Sensor cleaning and calibration. • Troubleshooting common issues with the sprinkler system and control unit. Discussion on data collection and analysis: • Importance of recording data for future reference. • Evaluating the effectiveness of the system based on yield, quality, and resource use data.

Training Format:

- A combination of lectures, demonstrations, and hands-on activities
- Training manual with clear explanations, diagrams, and illustrations.
- Video tutorials demonstrating mobile app functionalities and system operation procedures.

By providing a comprehensive and hands-on training program, this project can equip participants with the necessary knowledge and skills to operate and manage the microclimate management system effectively.

3. Training on Heat Exchangers for FVP Sector

Training Objectives:

- Understand the principles of heat exchangers and their benefits for energy efficiency and water conservation in pasteurization.
- Learn how to operate and maintain the installed heat exchanger system.
- Gain practical skills in troubleshooting and optimizing the system.
- Appreciate the potential environmental and economic benefits of heat exchangers.

Target Audience: small-scale FVP farmers, extension services

Training Outline:	
Day 1:	Day 2:
Introduction to heat exchangers: concepts, types, and benefits. Overview of the installed heat exchanger system in the facility. Hands-on training on system operation and maintenance: • Checking and adjusting temperature settings. • Cleaning and maintaining the heat exchanger surface. • Troubleshooting common issues.	In-depth session on energy efficiency and water conservation: • Understanding the principles of heat transfer and energy recovery. • Calculating energy savings and water reduction potential. Case studies of successful heat exchanger implementations in FVP. Discussion on potential challenges and solutions for adopting heat exchangers in Kosovo.

Training Format:

- A combination of lectures, demonstrations, and hands-on activities
- Training manual with clear explanations, diagrams, and illustrations.
- Video tutorials demonstrating system operation and maintenance procedures.

By providing a comprehensive and hands-on training program, this project can equip facility staff with the necessary knowledge and skills to operate and maintain the heat exchanger system effectively.

4. Training on Solar-Powered Water Heaters in FVP Sector**Training Objectives:**

- Understand the principles of solar water heating and its benefits for energy efficiency and environmental sustainability.
- Learn how to operate and maintain the installed solar water heating system.
- Gain practical skills in troubleshooting and optimizing the system.
- Appreciate the potential environmental and economic benefits of solar energy in FVP.

Target Audience: small-scale FVP farmers, extension services

Training Outline:	
Day 1:	Day 2:
Introduction to solar water heating: concepts, components, and benefits. Overview of the installed solar water heating system in the facility. Hands-on training on system operation and maintenance: • Checking and adjusting solar collector angles. • Inspecting and cleaning the solar collectors. • Monitoring the storage tank temperature and adjusting settings.	In-depth session on energy efficiency and environmental benefits: • Calculating energy savings and carbon emissions reduction. • Discussing the potential for integrating solar water heating with other renewable energy sources. Case studies of successful solar water heating implementations in FVP. Discussion on potential challenges and solutions for adopting solar energy in Kosovo.

Training Format:

- A combination of lectures, demonstrations, and hands-on activities
- Training manual with clear explanations, diagrams, and illustrations.
- Video tutorials demonstrating system operation and maintenance procedures

By providing a comprehensive and hands-on training program, this project can equip FVP facility staff with the necessary knowledge and skills to operate and maintain the solar water heating system effectively.

5. Training on Water Filtration and Reuse in FVP Sector**Training Objectives:**

- Understand the principles of water filtration and reuse and their benefits for water conservation and environmental sustainability.
- Learn how to operate and maintain the installed water filtration and reuse system.
- Gain practical skills in troubleshooting and optimizing the system.
- Appreciate the potential environmental and economic benefits of water conservation in FVP.

Target Audience: small-scale FVP farmers, extension services

Training Outline:	
Day 1:	Day 2:
Introduction to water filtration and reuse: concepts, components, and benefits. Overview of the installed water filtration and reuse system in the facility. Hands-on training on system operation and maintenance: • Checking and cleaning filters. • Monitoring water quality parameters. • Adjusting system settings.	In-depth session on water conservation and environmental benefits: • Calculating water savings and reduced wastewater discharge. • Discussing the potential for integrating water reuse with other sustainability initiatives. Case studies of successful water filtration and reuse implementations in FVP. Discussion on potential challenges and solutions for adopting water conservation measures in Kosovo.

Training Format:

- A combination of lectures, demonstrations, and hands-on activities
- Training manual with clear explanations, diagrams, and illustrations.
- Video tutorials demonstrating system operation and maintenance procedures.

By providing a comprehensive and hands-on training program, this project can equip facility staff with the necessary knowledge and skills to operate and maintain the water filtration and reuse system effectively.

6. Training on Smart Irrigation System

Training Objectives:

- Understand the principles of smart irrigation and its benefits for water conservation and crop productivity.
- Learn how to operate and manage the installed smart irrigation system.
- Gain practical skills in troubleshooting and optimizing the system.
- Appreciate the potential environmental and economic benefits of smart irrigation.

Target Audience: small-scale farmers cultivating fruits, MAPs, or vegetables, extension services

Training Outline:	
Day 1:	Day 2:
Introduction to smart irrigation: concepts, components, and benefits. Overview of the installed smart irrigation system in the demonstration farm. Hands-on training on using the mobile app or control panel: • Viewing real-time soil moisture and weather data. • Setting up irrigation schedules based on sensor readings. • Adjusting irrigation parameters.	In-depth session on irrigation scheduling and water management: • Understanding crop water needs at different growth stages. • Calculating irrigation requirements based on sensor data. • Optimizing irrigation efficiency to minimize water waste. System maintenance procedures: • Sensor cleaning and calibration. • Troubleshooting common issues with the irrigation system. Discussion on data collection and analysis: • Importance of recording data for future reference. • Evaluating the effectiveness of the system based on yield, water use, and economic performance.

Training Format:

- A combination of lectures, demonstrations, and hands-on activities
- Training manual with clear explanations, diagrams, and illustrations.
- Video tutorials demonstrating mobile app functionalities and system operation procedures.
- Quick reference guide for troubleshooting common issues.

By providing a comprehensive and hands-on training program, this project can equip farmers with the necessary knowledge and skills to operate and manage the smart irrigation system effectively.

NOTE: Trainings should be conducted by experienced professionals with expertise in relevant fields, e.g., precision agriculture, IoT technology, irrigation systems, renewable energy etc. Trainers should have a strong understanding of the local agricultural context, and the specific challenges faced by farmers in Kosovo. They have to be equipped with the necessary skills to deliver engaging and informative training sessions.

b. Extension Services Capacity Building

Extension services are the critical link between farmers and research institutions. Equipping them with the necessary skills is paramount for effective adoption of CSA and knowledge transfer. Therefore, throughout all capacity building activities it is recommended to involve the extension services to equip them with the knowledge to assist farmers in adopting CSA practices. These workers will act as local champions, providing on-the-ground support and guidance.

c. Knowledge Transfer Channels

Effective knowledge transfer is essential for widespread adoption of CSA practices. Following are some of the effective channels for disseminating information and knowledge that will contribute to capacity building of involved stakeholders:

Online Portal: Developing an online portal or utilizing an already existing one (e.g. www.agroportali.com) where stakeholders can access training materials, tutorial videos, manuals, and other resources regarding CSA. The portal will also feature a discussion forum where users can share experiences and ask questions. The portal should be updated regularly with new content and resources to keep it relevant and engaging.

Partnerships with Educational Institutions: Collaborating with universities and agricultural colleges to integrate CSA topics into their curricula. Through these partnerships there can be internships and practical training opportunities for students to gain hands-on experience in CSA. These partnerships will ensure a continuous flow of knowledge and innovation, benefiting both current and future generations of farmers. Furthermore, a joint research project on CSA implemented by collaboration of academia, association and agribusinesses, this will foster the collaboration and networking between the three.

d. Implementation Plan

A validation workshop is a first and crucial step in ensuring the relevance and effectiveness of proposed interventions. By gathering feedback from key stakeholders, such as farmers, agribusinesses, extension services, policymakers, will help to refine the strategy, build consensus among stakeholders on the proposed interventions, generate ideas/recommendations for improvement, and prioritize resources to address the most pressing needs and gaps.

After the validation workshop, the training materials and other needed resources should be developed/prepared. The training materials will include the videos, manuals and guides. The content will be relevant, up-to-date and accessible to all stakeholders. The development of the training materials will include experts and practitioners to ensure accuracy and practical relevance.

Once the training materials are developed, organizing and delivering training programs, workshops and field demonstrations will be the next step. The training, to reach a wider audience will be a mix of in-person and online formats, using the local language and appropriate materials to enhance understanding and engagement.

To assess the effectiveness of the capacity-building strategies, establishing a monitoring and evaluation framework will be beneficial. Additionally, using feedback from stakeholders to improve and adapt the training programs is crucial to ensure that the participants will benefit from the training.

Further considerations:

- Tailor interventions to the needs of different farmer groups (e.g., small-scale, large-scale, women farmers)
- Establish strong relationships with farmers to build trust and credibility.
- Collaborate with government agencies, NGOs, research institutions, and private sector organizations to leverage resources and expertise
- Integrate gender-responsive approaches throughout the implementation.
- Involve young people in the design and implementation of activities.
- Sustained efforts are necessary to achieve lasting change. Facilitate knowledge sharing among farmers through peer-to-peer learning networks.

e. Expected Outcomes

- Increased knowledge and skills: Stakeholders will have the knowledge and skills to implement CSA practices effectively, leading to increased productivity and sustainability.
- Higher adoption rates: A higher number of stakeholders will adopt CSA practices, resulting in more sustainable agricultural practices and enhanced climate resilience.
- Improved collaboration: Strengthened collaboration and communication among stakeholders will foster a supportive environment for implementing CSA practices.

- Enhanced resilience: The agricultural sector in Kosovo will become more resilient to climate change, ensuring long-term sustainability and food security.

7. Monitoring and Evaluation Framework for Tailored Interventions and Pilot Projects

7.1 Purpose and Scope of the M&E Framework

The purpose of this Monitoring and Evaluation (M&E) Framework is to systematically track the progress, measure the impact, and assess the effectiveness of climate-smart agriculture interventions and pilot projects under the Empowering Rural Economies in Agriculture (EREA) program in Kosovo. This M&E framework aims to ensure that interventions are implemented effectively, provide data for adaptive management, and inform continuous improvement efforts. The scope of the plan encompasses a range of interventions designed to enhance agricultural productivity, resilience, and sustainability in the face of climate change.

7.2 Overview of the FAO Module and Its Relevance to the EREA Program

The [Food and Agriculture Organization \(FAO\) module on Climate-Smart Agriculture \(CSA\) program and project monitoring and evaluation](#) provide a comprehensive framework for assessing the effectiveness of CSA interventions. It outlines best practices for designing, implementing, and evaluating CSA projects, ensuring that interventions are not only effective but also sustainable and scalable.

The relevance of the FAO module to the EREA program lies in its emphasis on adaptive management, stakeholder engagement, and continuous learning. By adopting the FAO's CSA M&E framework, the EREA program can ensure that its climate-smart agriculture interventions are systematically monitored and evaluated, allowing for data-driven decision-making and iterative improvements. This alignment with international standards and practices will enhance the program's ability to achieve its objectives and demonstrate its impact on agricultural productivity, resilience, and sustainability in Kosovo.

3. To Provide Data for Adaptive Management and Continuous Improvement

This M&E Plan is designed to generate reliable data that can be used for adaptive management. By collecting and analyzing data on a regular basis, the plan facilitates informed decision-making, allowing for the timely adjustment of strategies and actions. This continuous feedback loop promotes learning and innovation, leading to improved intervention performance and greater overall impact.

4. To Assess the Impact of Interventions on Productivity, Resilience, and Sustainability

A key objective of the M&E framework is to evaluate the impact of the interventions on key areas such as agricultural productivity, resilience to climate change, and environmental sustainability. By assessing these impacts, the plan provides valuable insights into the effectiveness of the interventions, highlighting successes and identifying areas for improvement. This comprehensive assessment ensures that the interventions contribute positively to the overarching goals of the EREA program and align with the principles of climate-smart agriculture.

7.4 Design of Monitoring and Evaluation

The design of the Monitoring and Evaluation (M&E) framework is structured to ensure comprehensive tracking and assessment of climate-smart agriculture interventions and pilot projects. The design is divided into four key phases: **Conceptualization, Preparation and Appraisal, Implementation, and Evaluation.**

1. Conceptualization

The first step in the M&E process involves conducting a thorough initial situation analysis based on climate impact assessments and options appraisals. It is important to note that the initial situation analysis is largely considered complete, having been addressed during the previous phases and tasks of the project. The data collection efforts already implemented can be utilized for setting baselines and providing a solid foundation for the M&E framework. This analysis identifies the current challenges and opportunities within the agricultural sector in Kosovo, particularly concerning climate change impacts, and informs the design of potential interventions and pilot projects.

2. Preparation and Appraisal

During this preparation phase, detailed planning is undertaken to set the groundwork for effective monitoring and evaluation. Key activities include:

- **Setting Baselines** – conducting a baseline study for establishing baseline data for key indicators and also utilizing the data collected during previous project phases. This provides a reference point for measuring progress and impact.
- **Identifying Indicators** - selecting relevant output and outcome indicators that align with the objectives of the interventions and pilot projects. [CCAFS Climate-smart Agriculture Programing and Indicator Tool](#) has been utilized in this regard.
- **Developing a Results-Based Framework** – concluding a results-based framework exercise that outlines the expected results, indicators, and data collection methods. This framework ensures that all interventions are aligned with the program's goals and provides a clear roadmap for M&E activities.

3. Implementation

The implementation phase involves the continuous monitoring of progress and resource use to ensure that interventions and pilot projects are on track. Key activities include:

- **Progress Tracking** - regularly collecting data on output and outcome indicators to monitor the implementation of activities.
- **Resource Use Monitoring** - tracking the use of resources (financial, human, and material) to ensure efficiency and effectiveness.
- **Data Collection Methods** - utilizing various data collection methods such as surveys, field visits, interviews, and observations to gather accurate and reliable information.

4. Evaluation

Mid-Cycle and End-of-Project Evaluations - the evaluation phase includes both mid-cycle and end-of-project evaluations to assess the outcomes and impacts of the interventions and pilot projects. Key activities include:

- **Mid-Cycle Evaluation** - Conduct an interim evaluation to review progress, identify any challenges or issues, and make necessary adjustments to improve implementation.
- **End-of-Project Evaluation** - performing a comprehensive evaluation at the conclusion of the project to assess the overall effectiveness, sustainability, and impact of the interventions. This evaluation provides valuable insights into what worked well and what could be improved for future initiatives.

5. Key Components and Adaptable Monitoring and Evaluation Matrix

The Monitoring and Evaluation (M&E) Plan includes key components that form the foundation of the M&E framework. These components are adaptable and can be refined during the detailed planning phase, which includes setting baselines, identifying indicators, and developing a results-based framework.

- **Objective** - This component outlines the primary goal of the pilot projects and interventions. It defines the overarching purpose of the intervention and what it aims to achieve in terms of climate-smart agriculture. For example, objectives may focus on enhancing water use efficiency, improving post-harvest quality, reducing reliance on chemical inputs, or increasing crop resilience to climate variability.
- **Outputs** - Outputs are the immediate, tangible products or services delivered by the project/intervention. These include activities such as the installation of systems or units, the development of management plans, and training provided to farmers. Outputs are essential steps that contribute directly to achieving the project's objectives.
- **Output Indicators** - Output indicators measure the extent to which the project has delivered its planned outputs. They provide quantitative data on activities completed, such as the number of systems installed, the number of units implemented, or the number of farmers trained. These indicators help track progress and ensure that the project is on track to deliver its planned activities.
- **Outcomes** - Outcomes are the effects or changes resulting from the project's outputs. These changes may include improvements in water use efficiency, reductions in post-harvest losses, enhancements in soil health, or increases in crop resilience. Outcomes reflect the benefits experienced by beneficiaries as a result of the project.
- **Outcome Indicators** - Outcome indicators measure the extent to which the project/intervention outcomes have been achieved. They provide quantitative or qualitative data on changes in practices, behaviors, or conditions resulting from the project. Examples include percentage improvements in water use efficiency, reductions in chemical pesticide use, or increases in crop yields.

- **Baseline Data** - Baseline data represents the initial conditions or metrics collected before the project begins/intervention is implemented. This data provides a reference point against which future changes and impacts can be measured. Baseline data is critical for evaluating the effectiveness of the project and understanding the starting point of key indicators.
- **Frequency** - This component outlines how often monitoring and evaluation activities will take place. It includes the schedule for data collection, progress reporting, and impact assessments. Frequencies may be monthly, quarterly, annually, or at the end of the project, depending on the specific requirements of each indicator and the project timeline.
- **Data Collection Methods** - This component describes the methods and tools used to collect data for monitoring and evaluation. It includes techniques such as surveys, field visits, observations, interviews, soil tests, and usage records. Data collection methods ensure that accurate and reliable information is gathered to assess progress and impact.
- **Timelines** - Timelines provide a detailed schedule for implementing the pilot project. They outline the duration of each phase, from assessment and planning to installation, training, and monitoring. Timelines help manage the project's progress and ensure that activities are completed within the specified timeframe.

7.4.1 Monitoring and Evaluation Matrix for Pilot Projects

This matrix provides a comprehensive overview of the monitoring and evaluation plan for each pilot project, ensuring detailed tracking of outputs and outcomes through specific indicators, baseline data, frequency of monitoring, and relevant data collection methods. As detailed planning progresses, the matrix will be refined and adapted to reflect specific targets, timelines, and indicators.

1. Semi-Permanent High Tunnels for Berry Production

Component	Details
Objective	To demonstrate a sustainable, climate-adaptive approach to raspberry cultivation that enhances the resilience and productivity of small-scale farmers in Kosovo.
Outcomes	- Increase in climate-resilient agricultural practices adopted by farmers in the region - Improvement in overall productivity and income of small-scale raspberry farmers
Outcome Indicators	- % increase in adoption of climate-smart practices by local farmers within 2 years of project completion - % average increase in income for participating farmers
Baseline Data	- Regional agricultural surveys, Farmer income records
Frequency	Monthly monitoring, Comparative analysis at months 6 and 12, End of project evaluation
Data Collection Methods	Regional surveys, Regular monitoring.

2. Microclimate Management System for Berry Production

Component	Details
Objective	To evaluate and demonstrate the effectiveness of a microclimate management system in optimizing growing conditions, enhancing berry production, and improving climate resilience on a small-scale farm in Kosovo
Outcomes	- Increase in berry yield (kg/ha) - Extension of production season (days or weeks) - Reduction in water use (cubic meters (m³), liters (L), or percentage (%))

	- Improvement in crop quality and resilience (subjective metrics such as grading scores or indices, or objective metrics like sugar content (°Brix), firmness (N), or disease resistance ratings)
Outcome Indicators	- % yield increase - # of weeks longer season - % water reduction
Baseline Data	Baseline yield, production and water consumption data
Frequency	Quarterly monitoring, Comparative analysis at months 6 and 12, End of project evaluation
Data Collection Methods	Regular monitoring, survey with beneficiaries

3. Heat Exchangers for Pasteurizers in Fruit and Vegetable Processing Sector

Component	Details
Objective	To demonstrate an energy-efficient and water-conserving approach to fruit and vegetable pasteurization that enhances the climate resilience of Kosovo's food processing sector.
Outcomes	- Reduced energy consumption in pasteurization processes by 50% within 12 months of implementation. - Decreased water usage in pasteurization by 40% within the first year of operation. - Reduced operational costs by 30% within 18 months
Outcome Indicators	- % reduction in energy consumption for pasteurization processes. - % decrease in water usage for pasteurization. - % reduction in operational costs for participating processors.
Baseline Data	Baseline data on energy consumption, water usage and operational costs
Frequency	Monthly monitoring, Comparative analysis at months 6 and 12, End of project evaluation
Data Collection Methods	Regular monitoring, survey with beneficiaries

4. Solar-Powered Water Heaters for Fruit and Vegetable Processing

Component	Details
Objective	To demonstrate an energy-efficient and low-carbon approach to water heating in fruit and vegetable processing that enhances the climate resilience of Kosovo's food processing sector.
Outcomes	- Reduced energy consumption for water heating by 60% within 12 months of implementation.

	- Decreased carbon emissions related to water heating by 70% within the first year of operation. - Improved energy independence of the processing facility by meeting 50% of its hot water needs through solar energy within 6 months. - Reduced water heating costs by 50% within 18 months.
Outcome Indicators	- % reduction in energy consumption for water heating processes. - % decrease in carbon emissions related to water heating - % of hot water needs met through solar energy. - % reduction in water heating costs for the participating
Baseline Data	Baseline data on energy consumption, carbon emission, solar energy produced, water heating costs
Frequency	Quarterly monitoring, Comparative analysis at months 6 and 12, End of project evaluation
Data Collection Methods	Regular monitoring, survey with beneficiaries.

5. Water Filters for Reuse in Fruit and Vegetable Processing

Component	Details
Objective	To demonstrate a water-efficient and sustainable approach to water management in fruit and vegetable processing that enhances the climate resilience of Kosovo's food processing sector.
Outcomes	- Reduced freshwater consumption by 60% within 12 months of implementation. - Decreased wastewater discharge by 50% within the first year of operation. - Improved water independence of the processing facility by meeting 40% of its water needs through recycled water within 6 months.
Outcome Indicators	- % reduction in freshwater consumption for processing. - % decrease in wastewater discharge. - % of water needs met through recycled water
Baseline Data	Baseline data on freshwater consumption in processing, wastewater.
Frequency	Monthly monitoring, Comparative analysis at months 6 and 12, End of project evaluation.
Data Collection Methods	Regular monitoring, survey with beneficiaries.

6. Smart Irrigation System for Fruits, MAPs, and Vegetables

Component	Details
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Objective	To demonstrate a water-efficient and climate-smart approach to irrigation in fruit, MAP, and vegetable cultivation that enhances the climate resilience of Kosovo's agricultural sector.
Outcomes	- Reduction in water consumption (in Cubic meters (m³) or liters (L)) - Increase in crop yields (in Kilograms per hectare (kg/ha)) - Improvement in water use efficiency (in Kilograms of crop per cubic meter of water (kg/m³) or percentage (%)) - Reduction in water-related costs(€/year)
Outcome Indicators	- % decrease in freshwater consumption - % of wastewater reduction - % water reuse - % reduced in water-related cost
Baseline Data	Baseline data of freshwater consumption and cost
Frequency	Monthly monitoring, Comparative analysis at months 6 and 12, End of project evaluation
Data Collection Methods	Regular monitoring, survey with beneficiaries

7.4.2 Monitoring and Evaluation Matrix for Suggested Climate-Smart Interventions

The Monitoring and Evaluation (M&E) Matrix for Suggested Climate-Smart Interventions is designed to provide a general framework for tracking progress and evaluating the impact of suggested climate-smart agricultural interventions. These interventions are currently conceptual and intended for potential future implementation. As such, the matrix does not include specific targets or timelines. Instead, it offers a flexible and adaptable structure that allows for detailed tracking and assessment if and when these interventions are implemented. As detailed planning progresses, the matrix will be refined and adapted to reflect specific targets, timelines, and indicators.

The purpose of this M&E Matrix is to ensure that, once the interventions are put into practice, there is a robust system in place to monitor their progress and measure their effectiveness. The matrix covers a range of interventions for different agricultural sectors, including Berries, Medicinal and Aromatic Plants (MAPs), and Non-Wood Forest Products (NWFPs). Each intervention is described in terms of its objectives, expected outputs, outcomes, indicators, baseline data requirements, frequency of monitoring, and data collection methods.

Using the Intervention's M&E Matrix

The Matrix is designed to be flexible and adaptable, allowing for modifications based on the specific context and needs of each intervention. It provides a structured approach to ensure that progress is trackable and impacts are measurable. By implementing this matrix, stakeholders can systematically monitor the effectiveness of climate-smart agricultural practices and make informed decisions to enhance sustainability and resilience in agriculture.

This general framework serves as a guide for future planning and implementation, providing a comprehensive overview of potential interventions and their associated monitoring and evaluation requirements.

Efficient Drip Irrigation Systems

Component	Details
Objective	To enhance water use efficiency and ensure sustainability in agricultural practices in Kosovo.
Outputs	Installation of drip irrigation and rainwater harvesting systems, solar-powered water pumps.
Output Indicators	Number of systems installed; number of training sessions conducted.
Outcomes	Increased water use efficiency, increased use of renewable energy.
Outcome Indicators	% of water used per hectare, % increase in crop yield per hectare.
Baseline Data	Baseline water use per hectare, Baseline crop yield per hectare. Dependency on external water sources
Frequency	Quarterly monitoring, Annual impact assessment.
Data Collection Methods	Site inspections, water usage logs, training attendance records.

Soil and Crop Health Enhancement

Component	Details
Objective	Improve soil health and crop yield.
Outputs	Installation of biochar production units, distribution of organic fertilizers, application of mulch.
Output Indicators	Number of units installed, number of fertilizers distributed, amount of mulch applied, number of training sessions conducted.
Outcomes	Enhanced soil fertility, reduced use of synthetic fertilizers, improved soil moisture retention, improved crop resilience.
Outcome Indicators	% reduction in synthetic fertilizer use, % increase in soil nutrient levels , % increase in soil moisture levels. .
Baseline Data	Baseline soil health indicators (organic matter, pH), Baseline synthetic fertilizer usage, Baseline soil matter level.
Frequency	Semi-annual soil tests, Annual impact assessment.
Data Collection Methods	Soil tests, Farmer interviews, Field visits.

Renewable Energy and Energy Efficiency

Component	Details
Objective	Reduce reliance on grid electricity and fossil fuels, improve processing efficiency.
Outputs	Installation of solar-powered cold storage units, energy-efficient processing equipment.
Output Indicators	Number of units installed; number of training sessions conducted.
Outcomes	Increased use of renewable energy, reduced energy consumption, improved processing efficiency.
Outcome Indicators	% of kWts used for cold storage from solar, % reduction in energy use based on kWts.
Baseline Data	Current energy sources for cold storage, energy consumption data for processing operations.
Frequency	
Data Collection Methods	Site inspections, energy usage logs, training attendance records.

Climate Resilience and Risk Management

Component	Details
Objective	Protect crops from climate-related risks.
Outputs	Installation of anti-hail nets, frost protection systems, procurement of low-impact logging equipment.
Output Indicators	Number of nets, systems, and equipment units installed, number of training sessions conducted.
Outcomes	Reduced crop loss due to hail and frost, enhanced forest health and structure.
Outcome Indicators	% reduction in crop per hectare loss due to hail, % reduction in crop per hectare loss due to frost,
Baseline Data	Current crop loss data due to hail and frost.
Frequency	Seasonal monitoring of crop health and yield, Annual assessment of hail damage incidents.
Data Collection Methods	Field observations, Farmer surveys, Yield data analysis.

Technological Integration and Monitoring

Component	Details
Objective	Optimize resource use, improve product quality, and enhance monitoring.
Outputs	Installation of IoT sensors, control systems, and drones.
Output Indicators	Number of sensors, systems, and drones installed, number of training sessions conducted.
Outcomes	Improved monitoring and control of environmental conditions, enhanced sustainable harvesting practices.
Outcome Indicators	% improvement in NWFP monitoring accuracy
Baseline Data	Current product quality data, NWFP monitoring accuracy data, harvesting practices data.
Frequency	Monitoring during frost risk periods, End of season evaluation.

Data Collection Methods	Sensor data logs, product quality tests, drone flight logs, image analysis reports, training attendance records.
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Post-Harvest Processing and Value Addition

Component	Details
Objective	Reduce post-harvest losses, improve product quality and shelf-life, enhance value addition.
Outputs	Installation of solar-powered drying units, processing units.
Output Indicators	Number of units installed; number of training sessions conducted.
Outcomes	Reduced post-harvest losses, increased value addition and marketability of products.
Outcome Indicators	% reduction in kgs of post-harvest losses, % increase in product shelf-life.
Baseline Data	Current post-harvest loss data, product shelf-life data, value addition data, marketability data.
Frequency	Monthly monitoring
Data Collection Methods	Site inspections, product quality tests, market analysis reports, training attendance records.

To assess the progress made in implementing climate-smart agriculture practices in Kosovo, it is essential to track the adoption of low-emission practices and improvements in energy efficiency. The indicators listed below provide valuable insights into the sector's (four targeted sectors) ability to reduce greenhouse gas emissions and enhance resource use efficiency. By monitoring these changes, we can evaluate the effectiveness of CSA initiatives and identify areas for further improvement.

- **Adoption of low-emission practices:** % of farmers using practices like organic farming, reduced tillage, or precision agriculture in agriculture production
- **Energy efficiency:** % reduction in energy consumption for processing and storage of agricultural products

7.5 Data Management and Reporting

Data Collection

Effective data collection is the key for the Monitoring and Evaluation (M&E) process. For this purpose, a combination of surveys, field visits, interviews, focus group discussions, and direct observations will be employed to gather comprehensive data. Surveys will involve structured questionnaires administered to farmers and other stakeholders to collect both quantitative and qualitative data. Regular field visits will be conducted to observe and document the implementation and progress of interventions, providing firsthand insights and validating data collected through other methods. Semi-structured interviews with key stakeholders, including farmers, project staff, and community leaders, will gather in-depth information and feedback on the interventions. Focus group discussions will engage multiple stakeholders in dialogue, enabling the collection of diverse perspectives and experiences. Additionally, direct observation of farming practices, crop conditions, and resource use will be used to collect real-time data and identify any immediate issues.

It is important to note that some of the data collection work done during the previous phases and tasks of the project can be utilized to establish baselines and provide a foundation for ongoing M&E activities.

Data Analysis

Data analysis involves transforming collected data into meaningful information that can guide decision-making. The analysis will include descriptive analysis to summarize data using measures of central

tendency (mean, median) and dispersion (range, standard deviation). Comparative analysis will be employed to compare baseline data with data collected during and after the interventions, assessing changes and impacts. Trend analysis will help identify patterns and trends over time to understand the long-term effects of the interventions. Qualitative analysis will involve examining data from interviews, focus group discussions, and open-ended survey responses to identify key themes, insights, and stakeholder perspectives. Geospatial analysis using GIS tools will visualize the geographical distribution of interventions and their impacts.

Reporting

Effective reporting ensures that stakeholders are informed about the progress and impact of the interventions. Regular reports will provide a comprehensive overview of progress, including detailed data analysis, achievements, challenges, and adjustments made, and are recommended to be distributed to a broader audience, including funders and partners. Annual impact assessments may evaluate the overall impact of the interventions over the year, including a detailed analysis of outcomes and impacts, success stories, and lessons learned. End-of-project reports will summarize the entire project lifecycle, and pilot projects, highlighting key achievements, impacts, and recommendations for future projects. Additionally, stakeholder meetings and workshops should be organized to present findings, discuss progress, and gather feedback from stakeholders.

7.5.1 Learning and Adaptive Management

The primary purpose of collecting and analyzing M&E data is to inform decision-making and improve the implementation of the program. Real-time data utilization allows for making informed decisions during the implementation phase, ensuring that interventions are responsive to emerging needs and challenges. Adaptive management involves continuously adjusting strategies and activities based on M&E findings to enhance effectiveness and promptly address any issues. Strategic planning will leverage M&E data for long-term planning and prioritizing interventions that demonstrate the highest impact and scalability.

To promote continuous learning and adaptation, the program should implement regular feedback sessions with project staff and stakeholders to review M&E data, discuss findings, and identify areas for improvement. Learning workshops should be conducted to share lessons learned, best practices, and innovative solutions among stakeholders. The establishment of Knowledge-sharing platforms is useful for sharing reports, case studies, and other relevant documents, facilitating knowledge exchange and collaboration. Periodic stakeholder surveys will gather feedback on the M&E process and the interventions, ensuring their perspectives are incorporated into project adjustments.

7.5.2 Stakeholder Engagement

Engaging key stakeholders in the M&E process is crucial for ensuring the relevance, transparency, and effectiveness of the interventions. Stakeholders will be involved in participatory planning to ensure that the interventions align with their needs and priorities. Joint data collection activities will engage stakeholders to promote ownership and ensure accuracy. Stakeholder committees comprising representatives from various stakeholder groups should be established to oversee the M&E process and provide guidance.

Transparency and accountability are fundamental to the success of the program. Open communication should be maintained with stakeholders, providing regular updates on progress and findings. M&E reports and findings should be made publicly available to ensure transparency and build trust among stakeholders. Feedback mechanisms be implemented to allow stakeholders to provide input on the interventions and the M&E process, ensuring their voices are heard and considered. Inclusive participation will ensure that

marginalized groups, including women and minority communities, are actively involved in the M&E process, and that their perspectives are integrated.

Conclusion

The feasibility study on the adoption of sustainable and climate-smart agricultural practices in Kosovo has demonstrated the significant potential for transforming the sector. By analyzing the current agricultural landscape, identifying key challenges and opportunities, and developing tailored interventions, the study has provided a comprehensive roadmap for a more resilient, productive, and environmentally sustainable agricultural system.

The findings emphasize the need for a multifaceted approach that combines policy reforms, technological advancements, capacity building, and financial incentives. By focusing on priority value chains such as NWFPs, MAPs, fruits, and vegetables, and by implementing proposed interventions, Kosovo can harness the benefits of climate-smart agriculture while addressing pressing agricultural challenges.

The proposed interventions, including the development of pilot projects and capacity building initiatives, offer a promising pathway to achieving the project's objectives.

A results-based monitoring and evaluation framework is essential to track progress, measure impact, and inform future decision-making. Continuous learning and adaptation will be crucial for the successful implementation of the proposed strategies.

A particular focus on empowering women and youth is essential for the successful implementation of these practices. By addressing gender disparities and creating opportunities for young people to engage in agriculture, the project can contribute to more equitable and inclusive development.

It is recommended that the government, in collaboration with the private sector, farmers' organizations, and development partners, prioritize the implementation of the identified interventions. By investing in sustainable agriculture, Kosovo can enhance food security, improve livelihoods, and protect the environment for future generations.

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Annex 1: Proposed interventions that impact sustainable agriculture

Proposed Intervention	Budget source
Transitional income support (The support should target the market-oriented sectors: vegetables, fruits (including berries), vineyards, and MAPs)	National Budget
Preparation of the prefeasibility, feasibility, and technical designs for the rehabilitation, modernization, and extension of the irrigation and drainage systems	Donors, National budget
Young farmers installation grant	National budget, Donors
Support for producers' groups on fruits and vegetables	National budget, Donors
Agri environment and climate schemes: Organic farming	EU IPA III, National budget
Grants for rural public infrastructure	EU IPA III, National budget, Donors
Grants for afforestation	EU IPA III, National budget
Elaboration of an Action Plan for the implementation of the Western Balkans Green Agenda	IPA
Extra-staffing and further training for the MAFRD departments, the Paying Agency, and AVUK	National budget, Donors (World Bank)
Preparing context baseline sectoral and environmental indicators	TAIEX / IPA, IPARD III TA / Donors
Introducing Good Agricultural and Environmental Conditions	TAIEX / IPA, IPARD III TA / Donors
Elaboration of a voluntary Code of Good Agricultural Practices for the prevention and reduction of the nitrates pollution caused by agriculture	TAIEX / Donors

Proposed Intervention	Budget source
Preparing GIS soil maps	National budget, Donors
Setting up a national agency for managing the irrigation and drainage systems under the MAFRD coordination	National budget, with TA support sourced from TAIX and Donors
Strengthening the MAFRD department for Advisory Services	National budget
Strengthening the MAFRD control on the issued licenses for wild MAPs and NWFP	National budget
Advisory services for farmers on farming practices, accountancy, and marketing with the consideration of the innovation	IPA III, National budget, Donors
Awareness campaigns on organic farming, sGAECs, on the Code of Good Agricultural Practices for the prevention and reduction of the nitrates pollution caused by agriculture and on illegal waste dumping	IPARD III TA Measure, National budget, Donors
Knowledge transfer on Global GAP (for farmers) and HACCP (for AVUK)	National budget, Donors
Research on bio-economy and bio-based circular economy (agriculture and forest based biomass, biofuels)	Donors, Research institutions (international, regional, national)

Annex 2: Key Strategies in Kosovo's Strategic Agro-Environmental Documents

Document	Key Strategies		Reference
National Organic Action Plan (NOAP) 2023 – 2026	- Promote organic farming techniques - Use of natural fertilizers and pest control - Enhance soil carbon sequestration - Composting organic waste	- Subsidies for inputs, certification, and conversion - Infrastructure development for organic farming - Public communication and promotion campaigns - Developing organic statistics and market information systems	Ministry of Agriculture, Forestry and Rural Development (2023)
Strategic Plan of the Kosovo Advisory System for Agriculture and Rural Development 2023-2027	- Increase high-value crops (berries, grapes, vegetables) - Use of greenhouse technology - Develop drought-resistant crop varieties - Improved irrigation techniques	- Training programs for advisors and farmers - Establishment of demonstration plots - Support and specialized training for women and young farmers - Creation of digital reporting systems and advisory platforms - Establishment of regional advisory offices and transfer of municipal advisors - Strengthening public-private partnerships and international cooperation	Kosovo Advisory System for Agriculture and Rural Development (2023)
Strategy for Agriculture and Rural Development 2022-2028	- Crop diversification (medicinal and aromatic plants) - Sustainable intensification of staple crops - Promote agroforestry systems	- Support for niche and specialty crops - Development of sustainable farming practices - Integration of tree crops with agricultural crops - Facilitating local markets for recycled agricultural products - Promoting renewable energy sources in farming	Ministry of Agriculture, Forestry and Rural Development (2022)
Climate Change Strategy 2019-2028	- Introduce climate-resilient crops - Develop early-maturing, drought-resistant varieties	- Climate risk assessments and management - Mitigation measures for reducing emissions	Ministry of Environment and Spatial Planning (2019)

Document	Key Strategies		Reference
	• Adopt agroecological practices • Enhance carbon sequestration	• Adaptation strategies for extreme weather events • Promoting conservation agriculture	
Annual State of the Environment Report 2021	• Evaluate environmental impact of crop production • Provide sustainability indicators • Recommend improvements for sustainable practices	• Data collection and analysis on greenhouse gas emissions • Monitoring the impact of agricultural practices • Developing recommendations for sustainability improvements	Kosovo Environmental Protection Agency (2021)
Report of Municipal Waste Management in Kosovo 2021	• Manage agricultural waste • Promote composting and recycling • Reduce need for chemical fertilizers	• Development of waste management systems • Promoting the use of organic waste as fertilizer • Policy recommendations for sustainable waste management	Ministry of Environment and Spatial Planning (2021)
Hazardous Flood Risk Maps	• Identify flood-prone agricultural areas • Implement flood risk mitigation measures • Improve drainage systems	• Creation of flood risk assessments and maps • Development of mitigation strategies and infrastructure • Providing guidelines for land management practices	Authority for Water Basins – Ministry of Environment, Spatial Planning and Infrastructure (2019)

Annex 3: Additional Innovative CSA ideas

Pilot Project	Objective	Implementation	Timeline	Rough Cost Estimation	Climate Mitigation and Adaptation Potential	Innovativeness and Scalability	Alignment with Kosovo's Agricultural Context
Smart Pollination Management System for Berries and MAPs	Evaluate effectiveness of smart pollination management system	1. Install sensors 2. Develop AI 3. Train participants 4. Monitor and collect data 5. Analyze results 6. Disseminate knowledge	12 months	€10,000 – €13, 000	• Mitigation: Optimizes pollinator movement • Adaptation: Improves crop resilience	Innovative application of IoT and AI. Scalable across various crops and regions	Supports Kosovo's growing berry and MAP sectors
Multi-Crop AI-Driven Vertical Farming with Blockchain Traceability	To evaluate and demonstrate the effectiveness of an AI-driven vertical farming system with blockchain traceability in	1. Infrastructure Setup 2. System Development and Integration 3. Training 4. Crop Cultivation and Monitoring 5. Comparative Analysis	12 months	€10,000 – €13,000	• Mitigation: Significant reduction in water and energy use, minimal transportation emissions - Adaptation: Controlled environment reduces	• Combines vertical farming, AI, IoT, and blockchain in a single integrated system. • Scalable to various sizes and adaptable to	• Addresses land scarcity and water management issues. • Enables year-round production of high-value crops for local consumption and export.

Pilot Project	Objective	Implementation	Timeline	Rough Cost Estimation	Climate Mitigation and Adaptation Potential	Innovativeness and Scalability	Alignment with Kosovo's Agricultural Context
	enhancing crop yield, resource efficiency, and market transparency for multiple crop types in Kosovo.	6. Blockchain Implementation Knowledge Dissemination			vulnerability to climate variability	different crop types	Aligns with Kosovo's goals for technological advancement and EU integration.
Biochar Production and Application System	Evaluate effectiveness of biochar system in improving soil health and crop yield	- Set up biochar unit - Develop protocols - Train participants - Implement and monitor - Analyze results - Disseminate knowledge	12 months	€7,000 €10,000	- Mitigation: Sequesters carbon - Adaptation: Improves soil water retention	Innovative in bringing advanced biochar technology to small-scale farms. Scalable to community-level	Addresses soil degradation issues and supports sustainable farming practices
Drone-Based Multispectral Imaging for NWFP	To evaluate and demonstrate the effectiveness of an AI-powered multispectral	- Technology Acquisition and Setup - System Development and Integration - Training	12 months	€10,000	Mitigation: Reduced use of resources in agriculture; optimized NWFP management reducing unnecessary interventions	Applies advanced remote sensing and AI across multiple agricultural and forestry sectors.	- Addresses resource management needs in small-scale farming and forestry. - Applicable to high-value

Pilot Project	Objective	Implementation	Timeline	Rough Cost Estimation	Climate Mitigation and Adaptation Potential	Innovativeness and Scalability	Alignment with Kosovo's Agricultural Context
	imaging system in enhancing crop health monitoring, resource efficiency, yield prediction, and sustainable management of Non-Wood Forest Products (NWFPs) across multiple sectors in Kosovo.	4. Monitoring and Data Collection 5. Comparative Analysis 6. Precision Agriculture and Sustainable NWFP Management Implementation 7. Knowledge Dissemination			• Adaptation: Improved crop and forest ecosystem resilience through early stress detection and targeted interventions	• Scalable across various crop types, farm sizes, and forest areas.	crops (MAPs, berries), staple FVP production, and NWFP management • Supports Kosovo's goals for agricultural modernization and sustainable forest management.

Please note that some of the pilot projects proposed, such as the "Smart Pollination Management System" can be effectively utilized across multiple sectors like berries, Medicinal and Aromatic Plants (MAPs), and fruit and vegetable processing. For example, the Smart Pollination Management System, originally designed for berries, can also be adapted to MAPs to optimize pollinator activity, which is crucial for both crop types. The adaptability of these technologies makes them valuable across various agricultural contexts, enhancing their overall utility.