



**PROMOTING CLIMATE-SMART AGRICULTURAL (CSA)
TECHNOLOGIES FOR THE SOCIO-ECONOMIC TRANSFORMATION
OF SMALLHOLDER FARMERS THROUGH COMMERCIAL
CIRCULAR DAIRY FARMING AND AGRIBUSINESS IN UGANDA**



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Promoting Climate-Smart Agricultural (CSA) Technologies for the Socio-economic Transformation of Smallholder Farmers through commercial Circular Dairy Farming and Agribusiness in Uganda

Project: Strengthening Agricultural Knowledge & Innovation Ecosystem for Inclusive Rural Transformation & Livelihoods in Eastern Africa (AIRTEA)

Sub-Project: Retaining Next-generation Farmers in Agribusiness through Enhanced Knowledge Sharing Platforms along with the Dairy Value Chains in Uganda (TP005)

*Ssemwanga Mohammed^{1,4}, Nakiguli Fatumah^{4,5}, Kigozi Abasi^{2,3}, Zziwa Emmanuel², Nkumba Ashraf^{1,4}

¹Agriculture, Environment and Ecosystem (AGRENES), P.O. Box 71257, Kampala, Uganda

²Makerere University, P. O. Box 7062, Kampala - Uganda

³National Agricultural Research Organization (NARO), P.O Box 295, Entebbe, Uganda

⁴Agriculture, Environment, and Livelihoods (AGRILIV), P. O. Box 71259, Kampala, Uganda

⁵Muni University, P.O. Box 725, Arua - Uganda

*Corresponding author: Ssemwanga Mohammed, E-mail: ssemwangaali@gmail.com

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Policy Vision: To inform the transformation of Uganda's agriculture into inclusive, sustainable and commercial value chains and agribusiness systems by enhancing the participation of youth and women through innovative practices and climate-resilient technologies.

Executive summary

This policy paper outlines a comprehensive framework to transform Uganda's Agriculture Sector, primarily the livestock (dairy) and horticulture sub-sectors into sustainable and inclusive agribusiness ecosystems. Centred on empowering youth, women, and smallholder farmers, the policy leverages innovative climate-smart agriculture (CSA) technologies to enhance productivity, climate resilience, and profitability.

The policy aims to address key institutional challenges identified during the implementation of the project "*Retaining Next-Generation Farmers in Agribusiness*" including limited access to quality inputs, digital illiteracy, inadequate market access and linkages, climate-related risks, and socio-economic barriers to youth and women's participation in agribusiness.

Strategic objectives:

1. **Enhancing Digital Inclusion:** Expanding access to and training on the Multi-Stakeholder Platform (MSP) to improve decision-making, market access, and value chain coordination.
2. **Promoting Climate-Smart Agriculture (CSA):** Scaling the adoption of drought-tolerant crops, solar-powered irrigation, and organic farming techniques to mitigate climate risks.
3. **Strengthening Dairy Innovation Centres (DICs):** Establishing DICs as hubs for training, co-creation of value-added products, and fostering partnerships across the dairy value chain.
4. **Empowering Women and Youth:** Ensuring equitable access to resources, training, and financial services while addressing cultural norms limiting participation.
5. **Improving Market Linkages:** Enhancing coordination among producers, traders, and off-takers through formal agreements and targeted support for B2B and B2C engagements.
6. **Institutionalizing Green Dairying Practices:** Promoting zero-waste circular agricultural models through accessible technologies and policy integration.

Recommendations: To achieve these objectives, the policy recommends CSA actions such as funding digital infrastructure, and farmer platforms, building drought-resilient dairy farming facilities, enhancing cooperative financing of agribusiness, and developing robust monitoring frameworks. Partnerships with government agencies, academic institutions, private enterprises, and civil society organizations will also ensure effective implementation and scalability.

Expected outcomes include: increased employment among farmers, youth and women, higher incomes for smallholder farmers, and strengthened sustainability in the dairy sectors. By addressing systemic challenges and leveraging innovative solutions, this policy paves the way for Uganda's agribusiness sector to thrive in a competitive and climate-resilient manner.

Target Audience

Farmers, policymakers, government ministries, departments and agencies, private sector, academia, donors, civil society organizations (CSOs), non-governmental organizations (NGOs).

Key messages

Uganda's dairy sector can drive sustainable growth by integrating digital tools, climate-smart technologies, and zero-waste practices. As Africa faces the challenge of feeding 2 billion people by 2050, prioritizing innovative and inclusive agribusiness models is essential. Empowering women and youth with skills, resources, and market access fosters equity and drives innovation across value chains.

Investments in climate-resilient technologies, such as drought-tolerant forage varieties, solar-powered irrigation, and agroforestry practices, are critical to mitigating climate risks and enhancing productivity. Expanding biogas production and recycling agricultural waste supports energy security while reducing greenhouse gas emissions and deforestation.

Strengthened value chain coordination and improved digital infrastructure will ensure better market access and equitable opportunities for smallholder farmers. Aligning these efforts with national policies ensures long-term impact. Engaging stakeholders in policy development and implementation promotes ownership, driving the adoption of sustainable agricultural practices.



Introduction

Agriculture is the backbone of Uganda's economy, contributing about 24% to GDP and employing over 70% of the population, primarily in rural areas. However, Africa faces an escalating food insecurity crisis, compounded by rapid population growth, with projections indicating that the continent will struggle to feed 2 billion people by 2050 (FAO, 2022). In response, intensive livestock production has increased, yet its productivity is constrained by the scarcity of quality feeds, which account for 60% of production expenses (FAO, 2023).

Livestock farming, despite its critical role, generates significant waste streams that, if unmanaged, harshly pollute ecosystems. Currently, 80% of agricultural waste in Africa, amounting to 1.2 million tons daily, remains uncollected, contributing 3.2 million tons of CO₂-equivalent greenhouse gases annually. This figure is projected to double to 6.3 million tons by 2025 if sustainable interventions are not adopted (IPCC, 2021).

In Uganda, these challenges are also exacerbated by widespread energy poverty, with rural households living below \$1 per day and relying on unsustainable energy sources such as charcoal and firewood. This dependency accelerates deforestation of ecosystems, amplifies greenhouse gas emissions, and results in biodiversity loss (World Bank, 2021).

Recognizing these intertwined challenges, the project "Retaining Next-Generation Farmers in Agribusiness through Enhanced Knowledge Sharing Platforms along the Dairy Value Chains in Uganda" was implemented in Gomba, Mityana, and Wakiso districts. It aimed to transform Uganda's agricultural landscape through innovative, climate-smart, and sustainable practices. Core components of the project included:

- **Innovation Platforms:** new physical and digital 'Multi-Stakeholder Platforms (MSPs)' were piloted to enhance decision-making, market access, and coordination of the value chains, mainly among youth, women, and smallholder farmers.
- **Green/circular Dairying Models:** Circular Dairy Innovation Centres (DICs) were established as the community hubs for training, co-cre-

ation of value-added products, and promotion of zero-waste practices, including biogas and organic fertilizer production.

- **Climate-resilient elite forages and feed systems:** Demonstration plots for elite forage species were established to mitigate feed scarcity and support sustainable livestock production.

Despite the successes achieved, including training over 200 farmers and operationalizing 2 pilot DICs, challenges persist. Limited smartphone access, poor internet connectivity, and dry spells hinder the scalability of digital and climate-smart interventions. Also, weak coordination among value chain actors and delayed funding undermines efforts to establish resilient systems.

This policy brief provides a roadmap to address these systemic challenges, emphasizing the integration of circular CSA models, equitable resource distribution, and innovative energy solutions. By prioritizing the interventions, Uganda can transform its dairy sector into inclusive, sustainable, and viable ecosystems, addressing the national and continental food security challenges.

Objectives

1. **Enhance Digital Inclusion and Skills training:** train farmers, youth and women to use the digital skills, and access and use the Multi-Stakeholder Platform (MSP) for decision-making and market linkages.
2. **Promote Climate-Smart Agriculture:** Strengthen adoption of resilient elite forages and sustainable farming practices. Scale up micro-irrigation and related adaptive farming technologies to mitigate risks from climate change.
3. **Develop the Dairy Innovation Centres (DICs):** Establish and operationalize DICs as the hubs for training, demonstration, and co-creation of dairy value-added products such as biogas, organic fertilizers, and processed feeds. Leverage DICs for fostering partnerships between the farmers, off-takers, and agro-processors.
4. **Empower women and youth:** Facilitate equi-

table access to key resources, training, and decision-making platforms (MSPs) for women and youth. Incentivize farmer participation in agribusiness through training and related capacity-building initiatives, as well as access to credit.

5. Strengthen value chains and market linkage: Enhance coordination among the farmers, agro-processors, off-takers and traders to formalize agreements and market linkages. Promote the 'business-to-business (B2B)' and the 'business-to-customer (B2C)' models to facilitate fair pricing and consistent demand.
6. Institutionalize Dairying Innovation Centre (DICs): mainstream the model DICs, based on zero-waste and circular agriculture principles in policies governing the dairy sector. Ensure that green technologies, such as biogas and organic horticulture, are accessible and affordable.

Methodology

The project employed a participatory, multi-pronged approach to address challenges in Uganda's dairy value chains. This approach emphasized inclusivity, capacity building, and the adoption of climate-smart technologies to transform subsistence dairy farming into climate-resilient and viable agribusiness models. The following steps and tools were implemented:

Participatory Stakeholder Engagement:

The project identified and engaged key stakeholders, including smallholder farmers (youth, women, and men), government agencies, academic institutions (or universities), private sector partners, and civil society organizations.

Through the focus group discussions, surveys, and interviews, stakeholders were consulted to:

- Understand the barriers to productivity and value chain participation.
- Co-design tailored dairy interventions to address specific challenges such as feed scarcity, digital access, and market linkages.

Development and Implementation of Solutions

Physical and digital Multi-Stakeholder Platforms (MSPs) were developed to serve as the knowledge-sharing and decision-making tools for value chain actors and stakeholders. The platform facilitated:

- Data collection on farmer profiles and challenges across the dairy value chain.
- Dissemination of the climate-smart agricultural practices and market information.
- Enrolment of farmers into e-learning modules on production, input sourcing, and marketing.

Training sessions were conducted in rural areas to ensure accessibility and uptake of the platform by participants, particularly youth and women. Offline solutions were considered for regions with limited internet connectivity.

Establishment of the Dairy Innovation Centres (DICs)

Three DICs were established to serve as community hubs for training, innovation, and co-creation. These centres incorporated:

- Demonstration plots for climate-resilient forage and elite feed production.
- Facilities for biogas production, water-for-production, and feed storage facilities to promote zero-waste circular agriculture.
- Training programs on sustainable dairy farming, including the fabrication and use of low-cost on-farm machinery (e.g., hay balers, feed pellet makers).

Farmers were trained through field-based hands-on demonstrations, supported by training manuals and visual aids. The DIC centres also facilitated market linkages through partnerships with the farmers, off-takers and agro-processors.

Climate-Resilient Agriculture Interventions

To address feed scarcity and mitigate the effects of climate change, the project implemented:

- Establishment of the demonstration plots for elite forage varieties (e.g., Napier grass, Brachiaria, and Rhodes grass).

- Installation of solar-powered irrigation systems to ensure continuous forage production.
- Promotion of agroforestry practices using multi-purpose tree species like Calliandra to enhance feed resources and soil health.

Capacity Building and Skill Development

The project also prioritized training and knowledge transfer, targeting youth, women, and smallholder farmers. The training focused on:

- Digital literacy for effective use of the MSP.
- Climate-smart farming techniques, such as silage production and organic fertilizer application.
- Agribusiness development skills to enhance the youth and women’s participation in value-added dairy enterprises.

Market linkages and value chain coordination

The project facilitated business-to-business (B2B) and business-to-consumer (B2C) partnerships by:

- Organizing the contract farming schemes (CFS), and signing the Memoranda of Understanding (MoUs) between farmers and off-takers.
- Conducting market assessments to identify the effective demand for value-added products like milk, biogas, and organic fertilizers.

Monitoring and Evaluation (M&E) Framework

A robust M&E framework was designed to track project outcomes and impacts. Key metrics included:

- Adoption rates of climate-smart practices.
- Productivity gains in circular dairy and forage production.
- Employment rates and income improvements among youth and women. Regular assessments, including farmer feedback, to inform adaptive strategies to address any emerging challenges.

Results and Discussion

The AIRTEA project (TP005) has achieved significant milestones in advancing Uganda’s dairy and related value chains, with results demonstrating a successful zero-waste, circular dairy innovation Centres (DICs) with the transformative potential of digital tools, climate-smart practices, and inclusive approaches.

Multi-Stakeholder Platform (MSP)

The development of both physical and digital Multi-Stakeholder Platforms (MSPs) proved instrumental in addressing information gaps. An eMSP and digital APP (<https://agro.avienseconsults.com>) were made to facilitate information sharing, e-training, and trade in dairy products and services. (Figure 1).

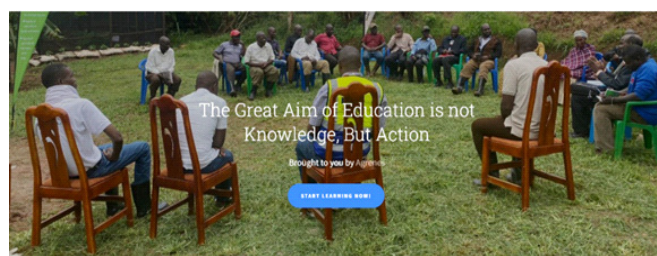


Figure 1: The digital MSP platform for e-training and commerce

The new MSPs enable smallholder farmers to access market information, decision-making tools, and e-learning modules in real-time, which was adopted by 213 farmers (90 youth, 58 women, and 65 men). Farmer training facilitated the integration of digital solutions in the green dairy farming and horticulture (Figure 2).



Figure 2: Farmer training at a model Dairy facility in Mityana, Uganda

However, limited access to smartphones and poor internet connectivity in rural areas con-

strained the platform's broader adoption of resilient technologies. Expanding digital infrastructure and subsidizing smartphones could increase inclusivity and enhance its impact (World Bank, 2021).

Establishment of Dairy Innovation Centres (DICs)

The establishment of Dairy Innovation Centres (DICs), in Mityana, Gomba and Wakiso districts bolstered farmer training and innovation at all nodes of the dairy value chain. These centres became central hubs for value-added production, including biogas, silage, and organic fertilizers (Figure 3).



Figure 3: A Physical MSP as Dairy Innovation Centre (DIC) facility at a model farm in Gomba, Uganda

Climate-Smart Forage and Feed Solutions

Farmer-led demonstration plots for horticulture and forage productions were at the DICs facilities. Over 1,000 kilograms of elite forage is produced monthly, providing enough conserved feed resources for the livestock even during prolonged 3-month dry spells. Moreover, the DICs facilitated knowledge-sharing through 270 visits, fostering community engagement and the adoption of zero-waste practices (Figure 4).



Figure 4: Forage production and feed conservation

The model has strong potential for scalability to other smallholder farming communities, amplifying its role in productivity and sustainability (IPCC, 2021).

Addressing feed scarcity, the project established over 50 acres of elite forage varieties such as Napier grass and Brachiaria in Uganda. Micro-irrigation systems ensured year-round forage and feed conservation, mitigating the adverse effects

of the prolonged dry spells. The introduction of innovative financial models, including credit and barter trade for silage and hay, strengthened access to essential inputs. These DIC interventions effectively reduced reliance on imported feeds while enhancing the sustainability of the dairy production systems (FAO, 2023).

Socio-Economic Empowerment of Youth and Women

The project's emphasis on empowering women and youth yielded socio-economic benefits. These groups accounted for more than 65% of direct beneficiaries, receiving training in dairy agribusiness skills and participation in dairy value-added enterprises such as horticulture and biogas production. Despite these achievements, entrenched social and cultural norms occasionally limited their full participation. Future efforts should include gender-sensitive policies and equitable resource allocation to enhance inclusivity (FAO, 2022).

Environmental and Energy Benefits

From an environmental perspective, the introduction of biogas facilities at the model DICs exemplified the integration of renewable energy into agriculture. Livestock waste was converted into biogas, reducing dependency on unsustainable fuels such as charcoal and firewood. These efforts align with global goals to reduce waste and greenhouse gas emissions, which remain a significant environmental concern.

Currently, 80% of the agricultural waste in Africa is uncollected, contributing 3.2 million tons of CO₂-equivalent emissions annually, a figure projected to double by 2025 without interventions (IPCC, 2021). Scaling biogas adoption in Uganda could mitigate deforestation and biodiversity loss while enhancing rural energy security (World Bank, 2021).

Despite the progress, challenges persisted, including connectivity issues, prolonged dry spells, and weak coordination among value chain actors. Addressing these barriers will also require investments in digital infrastructure, CSA technologies and practices, and stronger partnerships among producers, traders, and off-takers. These efforts will ensure the sustainability and scalability of the AIRTEA interventions, aligning

Uganda's agricultural value chains with national and continental food security goals.

Promoting CSA involves shifts for the CSA extension and advisory services. Compared to its traditional role of promoting the dissemination of agricultural information and knowledge, AEAS needs to aid in the framework to provide long-term tailored support to farmers to adopt CSA practices. Without a robust enabling framework that promotes cooperation among different stakeholders in the public, private, and civil society sectors, AEAS will not be able to optimize its potential contributions to CSA.

Policy Options and Strategic Action Areas

The policy framework for transforming Uganda's livestock dairy value chains revolves around creating sustainable, inclusive, and climate-resilient farming systems. The following policy options and strategic action areas are recommended to address challenges and enhance the project's impact.

1. Policy Options

1.1 Expand Digital Inclusion in Agriculture

- Option 1: Subsidize digital devices and internet services to improve access to platforms like the Multi-Stakeholder Platform (MSP) for farmers in rural areas.
- Option 2: Develop offline-compatible tools and USSD-based access for remote areas with poor connectivity.

1.2 Promote Climate-Smart Agriculture

- Option 1: Scale up adoption of climate-resilient forage varieties and crop irrigation systems.
- Option 2: Provide financial incentives for local farmers adopting green technologies, such as tax breaks and subsidies for zero-waste and green dairying, micro-irrigation and biogas units.

1.3 Strengthen Value Chain Coordination

- Option 1: Establish producer-trader forums as part of the MSP; to improve communication

and coordination among stakeholders.

- Option 2: Develop cooperative-based marketing models to enhance bargaining power and ensure fair pricing for smallholder farmers.

1.4 Support Women and Youth Empowerment

- Option 1: Implement gender-sensitive programs to address gender, and socio-cultural barriers limiting youth and women participation in agribusiness.
- Option 2: Establish mentorship and financing schemes for youth and women entrepreneurs in agriculture.

1.5 Integrate circular dairy into national policies

- Option 1: Mainstream zero-waste farming into National Development Plans and Agricultural Sector Strategic Plan.
- Option 2: Incentivize the private sector to invest in clean energy and waste recycling technologies.

2. Strategic Action Areas

2.1 Digital Transformation

- Develop and operationalize digital literacy and training programs for women and youth.
- Expand the mobile and internet infrastructure to underserved areas.

2.2 Climate-Resilient Technologies

- Establish more demonstration plots for drought-tolerant forage and promote agroforestry and horticulture practices to boost feed availability.
- Strengthen solar-powered irrigation schemes to support year-round production.

2.3 Institutionalize Dairy Innovation Centres (DIC)

- Scale up DIC models to other non-target districts, incorporating extra training modules on biogas production, water and feed conservation.
- Formalize the DICs as hubs for market linkages and knowledge dissemination; as strategic

and sustainable communal agribusiness facilities.

2.4 Financial Inclusion and Market Access

- Establish savings and loan associations tailored for women and youth in cooperatives to support investment in green technologies.
- Facilitate partnerships between farmers and off-takers through contract farming and Memoranda of Understanding (MoUs).

2.5 Renewable Energy and Zero-Waste Practices

- Incentivize the adoption of biogas technologies by subsidizing installation costs and providing maintenance support.
- Promote the recycling of agricultural waste into organic fertilizers and energy sources to reduce greenhouse gas emissions.

2.6 Monitoring and Evaluation

- Develop a robust monitoring framework to track progress on key indicators such as employment, productivity, and environmental impact.
- Integrate data collection from platforms like the MSP to inform climate-adaptive strategies and policy adjustments.

Implementation Recommendations

To ensure the successful implementation of these policy options:

- Collaborate with the stakeholders and partners: Engage government ministries, departments or agencies, academic and research institutions, the private sector, and civil society organizations to align efforts.
- Leverage Funding Opportunities: Seek public-private partnerships and international funding to scale interventions.
- Enhance Community Participation: Involve the farmers in decision-making processes to ensure solutions are contextually relevant and widely adopted.

These policy options and strategic actions collectively address the systemic institutional bottlenecks and challenges in Uganda's agricultur-

al sector, ensuring sustainability, inclusivity, and resilience in the face of growing demands and climate risks.

Conclusion

Uganda's dairy sectors are pivotal to the country's economic and social transformation of communities, yet they face persistent challenges that undermine food productivity, inclusivity, and environmental sustainability. This policy brief has highlighted the transformative potential of integrating digital tools, climate-smart technologies, and inclusive practices to address these value chain challenges and position Uganda's agriculture for long-term success.

Key interventions, including the development of the Multi-Stakeholder Platform (MSP), the establishment of Dairy Innovation Centres (DICs), and promotion of climate-resilient feed systems, have demonstrated their efficacy in enhancing livestock productivity, empowering women and youth, and mitigating the environmental risks. However, issues such as limited digital access, climate vulnerability, and weak value chain coordination require targeted policy actions.

Recommended policy options and strategic action areas emphasize digital inclusion, climate resilience, value chain strengthening, and zero-waste practices. By implementing these strategies, Uganda can create a sustainable agricultural ecosystem that not only addresses food insecurity but further supports rural livelihoods, reduces greenhouse gas emissions, and fosters economic growth.

The success of these initiatives hinges on multi-stakeholder collaboration, increased investment in digital and climate-smart infrastructure, and the adoption of inclusive, gender-sensitive policies. With concerted efforts, Uganda can transform its dairy sector into pilot models of sustainable agribusiness, contributing to national food security goals while meeting the needs of its growing population.

References

FAO, 2022. Africa's food insecurity in 2050: Projections and challenges. Rome: Food and Agriculture Organization.

FAO, 2023. Economic impacts of livestock feed scarcity on African farms. Rome: Food and Agriculture Organization.

IPCC, 2021. Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge: Cambridge University Press.

World Bank, 2021. Energy poverty and sustainability in Africa. Washington, DC: World Bank





Forum for Agricultural Research In Africa

Headquarters No. 7 Flower Avenue, New Achimota-Mile 7

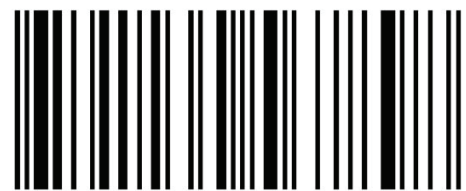
PMB CT 173, Accra, Ghana

Tel +233 (0) 302 772823 / 779421

Fax +233 (0) 302 773676

Email: info@faraafrica.org

www.faraafrica.org



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