White Paper:

Policy Recommendations for Sustainable and Digital Agri-Food Systems

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Executive Summary

Agricultural systems across Europe and Africa are undergoing a profound transition. Climate pressures, resource constraints, and shifting market dynamics are exposing long-standing vulnerabilities in how food is produced and managed. At the same time, new opportunities are emerging through digital innovation and circular economy practices.

The NESTLER project shows that this transition is no longer theoretical—it is already happening. By combining Internet of Things (IoT) monitoring, artificial intelligence (AI), remote sensing, and insect-based protein production, the project has demonstrated tangible improvements in productivity, resource efficiency, and environmental sustainability across diverse pilot regions. In addition, pilot results confirm strong economic viability, with return on investment exceeding 100% in aquaculture systems and reaching significantly higher levels in optimised poultry production. More than 1,400 farmers and practitioners have been trained across pilot regions, demonstrating both the scalability of the approach and its practical relevance for local stakeholders.

A key insight from this work is that farmers and stakeholders are ready to adopt new solutions—provided they are accessible, affordable, and relevant to local realities. However, while the technologies are mature, their large-scale deployment remains limited.

This white paper argues that the main challenge is no longer technological innovation, but the creation of enabling conditions for adoption and scale. Addressing regulatory fragmentation, financial barriers, infrastructure gaps, and capacity constraints will be essential.

The recommendations presented here provide a policy roadmap to support this transition and unlock the full potential of sustainable, digital, and circular agri-food systems within the EU–Africa partnership.

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1 Evidence Base: What NESTLER Has Demonstrated

The NESTLER project brings together research, real-world implementation, and stakeholder engagement across different regions and agricultural systems. What makes its findings particularly valuable is that they are not based on theory alone, but on tested solutions under real conditions.

At the technological level, the project confirms that digital agriculture is ready to deliver practical value. The combination of IoT sensors, satellite data, and AI models allows farmers to monitor conditions in real time, anticipate risks, and make more informed decisions. In environments increasingly affected by climate variability, this kind of responsiveness is becoming essential rather than optional.

At the same time, NESTLER demonstrates that circular approaches can work at scale. Organic waste can be transformed into inputs for insect production, while by-products such as frass fertiliser improve soil quality and reduce dependency on synthetic inputs. This creates a system where productivity and sustainability reinforce each other instead of competing.

The project also highlights strong market signals. In particular, the use of Black Soldier Fly larvae as an alternative protein source has gained significant interest, especially in African contexts where feed costs are rising and supply chains are unstable. Farmers are not only open to these solutions—they are actively seeking them. However, supply remains limited, pointing to a clear opportunity for expansion.

A distinctive feature of the NESTLER approach is its system-level integration. Rather than deploying isolated technologies, the project combines digital infrastructure, artificial intelligence, and circular bioeconomy solutions into a unified operational framework. This enables a shift from reactive management to predictive and adaptive decision-making, strengthening resilience across agri-food systems.

Taken together, these results demonstrate that the core components of a sustainable and digital agri-food system are already in place. The remaining challenge is to connect, scale, and embed them within broader agricultural systems.

2 Structural Barriers to Scaling

Despite promising results, the transition from pilot implementation to large-scale adoption remains complex. One of the most pressing issues is regulatory fragmentation. Different regions operate under different rules, particularly when it comes to insect-based products and digital agriculture. While the European Union has made progress in establishing frameworks, many African countries are still developing their regulatory environments. This creates uncertainty, slows down investment, and makes cross-border collaboration more difficult.

Financial constraints also play a critical role. Many of the solutions demonstrated in NESTLER require initial investment, which is often beyond the reach of smallholder farmers and smaller enterprises. Existing financial systems are not always designed to support these types of innovations, especially when risk-sharing mechanisms are limited.

Infrastructure remains another key challenge. Digital agriculture depends on connectivity, energy, and reliable data systems. In many rural areas, these are still insufficient, limiting the effectiveness of even the most advanced technologies.

Human capacity is equally important. The shift towards data-driven agriculture requires new skills, from basic digital literacy to more advanced technical capabilities. However, access to training and advisory services is uneven, which can slow down adoption and reduce long-term impact.

Finally, data itself presents challenges. Information is often fragmented across systems, with limited interoperability and unclear governance. Concerns about data ownership and privacy further complicate collaboration and reduce trust in digital platforms.

These issues point to a common conclusion: scaling innovation requires more than technology—it requires an enabling system.

3 From Evidence to Action: Scaling Pathways

While the evidence generated through NESTLER confirms the technical and economic viability of circular and digital solutions, scaling requires more than isolated interventions. It requires coordinated system design.

Findings from project activities indicate that the main constraint is not demand, but system organisation. In the case of insect-based protein, farmer surveys demonstrate near-universal willingness to adopt, while market analysis reveals a persistent supply deficit. This indicates that the transition is constrained not by acceptance, but by the structure of production, logistics, and governance.

Scaling therefore depends on three interdependent elements.

First, the availability of reliable input streams. Organic waste must be treated not as a disposal problem, but as a strategic resource. This requires structured collection systems, source segregation, and long-term agreements between municipalities and producers.

Second, the development of industrial capacity. Distributed production models—such as hub-and-spoke systems—allow processing close to waste sources while maintaining efficiency at scale. These models are particularly suited to African urban and peri-urban contexts.

Third, the creation of stable markets. Early-stage industries require demand certainty. Public procurement, feed industry engagement, and quality standards can play a decisive role in anchoring market confidence.

These elements underline a critical point: scaling sustainable agri-food solutions is not only a technological process, but an organisational and policy-driven transformation.

This, in turn, places policy at the centre of the transition. The following section outlines the key priorities required to create an enabling environment for large-scale deployment.

4 Policy Priorities for Enabling Systemic Transformation

The policy challenge is not to introduce new technologies, but to create the conditions under which existing solutions can scale in a predictable, investable, and sustainable manner. Evidence from NESTLER indicates that this requires coordinated action across regulation, waste governance, finance, infrastructure, and market development.

A priority action is the establishment of clear regulatory pathways. This includes defining permitted insect species, approved substrate categories, and hygiene requirements across production, processing, and transport. In parallel, the development of standards for insect-based feed and frass fertiliser is essential to build market trust and enable trade.

Equally critical is the integration of waste governance into agricultural policy. Organic waste streams should be systematically redirected towards productive use through source-segregation policies and contractual arrangements with certified operators. This transforms waste management from a cost centre into a value-generating system.

Market development mechanisms should also be introduced. Public procurement schemes, particularly in aquaculture and poultry value chains, can provide early demand signals and reduce investment risk. At the same time, traceability systems and certification frameworks can support quality assurance and cross-border market integration.

At the same time, the role of digital innovation must be recognised as a key enabler of transformation. The integration of AI-driven analytics, real-time monitoring systems, and federated data architectures allows for more accurate, timely, and context-specific decision-making. These capabilities are particularly important for risk management, including the early detection of crop stress, environmental changes, and zoonotic disease threats. Supporting the deployment of such digital infrastructures should therefore be considered a strategic priority within agricultural policy frameworks.

Finally, access to finance must be aligned with the needs of emerging sectors. Blended finance instruments, equipment credit schemes, and targeted incentives for small and medium-sized enterprises can accelerate the transition from pilot-scale operations to commercially viable systems.

5 Implementation and Scaling Roadmap

Effective policy implementation requires a phased approach. In the short term, priority should be given to regulatory clarity, pilot waste collection systems, and initial financial support mechanisms. These actions reduce uncertainty and enable early adopters to enter the market.

In the medium term, efforts should focus on scaling infrastructure, expanding training programmes, and developing standardisation and certification systems. This phase is critical for ensuring quality, reliability, and market integration.

In the longer term, the focus should shift towards regional harmonisation, market consolidation, and the integration of these systems into broader agricultural and climate strategies.

Such sequencing ensures that policy interventions are both realistic and scalable, avoiding fragmentation and maximising long-term impact.

6 Alignment with Strategic Frameworks

The approach developed through NESTLER aligns closely with major policy priorities at European, African, and global levels. In the European Union, it directly supports the objectives of the European Green Deal, the Farm to Fork Strategy, and the EU Digital Strategy, particularly in relation to sustainability, resource efficiency, and digital innovation.

In the African context, the project contributes to broader development goals related to food security, climate resilience, and economic growth, as outlined in frameworks such as the African Union's Agenda 2063. By focusing on locally adaptable and scalable solutions, NESTLER supports the development of resilient agricultural systems and inclusive value chains.

At the global level, the project contributes to the achievement of several Sustainable Development Goals, including Zero Hunger, Responsible Consumption and Production, Climate Action, and Life on Land. The integration of digital technologies and circular practices provides a practical pathway for translating these goals into concrete actions.

7 Strategic Outlook

The transition towards sustainable and resilient agri-food systems is no longer optional. It is driven by increasing environmental pressures, market dynamics, and the need for long-term food security.

The experience of NESTLER demonstrates that integrating digital intelligence with biological and circular solutions creates a multiplier effect, where the combined impact exceeds that of individual innovations. This highlights the importance of adopting a systemic approach rather than isolated interventions.

At the same time, the success of this transition depends on moving beyond pilot initiatives towards coordinated and large-scale implementation. This requires policies that are integrated, forward-looking, and adapted to regional contexts, as well as strong collaboration between public institutions, private actors, researchers, and local communities.

The EU–Africa partnership is particularly well positioned to lead this transformation. By aligning strategies, sharing knowledge, and fostering innovation, both regions can accelerate the deployment of solutions that are both effective and locally relevant.

8 Conclusion

The NESTLER project provides clear evidence that sustainable, digital, and circular agri-food systems are within reach. The technologies are mature, the benefits are measurable, and stakeholder readiness is evident across multiple contexts.

The remaining challenge lies in enabling scale. This requires coherent policy frameworks, aligned incentives, and coordinated implementation that connect innovation with real-world deployment.

Moving forward, the focus must shift from demonstration to adoption. Circular and digital agriculture should no longer be treated as emerging innovations, but as strategic components of future food systems.

With the right policy support, these solutions can deliver lasting impacts in food security, economic development, and environmental sustainability—across both Europe and Africa.

9 About NESTLER Project

NESTLER (oNe hEalth SusTainabiLity partnership between EU–Africa for food security) is a Horizon Europe Research and Innovation Action (Grant Agreement No. 101060762), implemented over 42 months through a multidisciplinary consortium of European and African partners.

The project addresses the fragmentation between agriculture, environmental management, and public health by developing an integrated approach based on digital technologies and circular bioeconomy solutions. Through its platform and pilot activities, NESTLER enables real-time monitoring, predictive analytics, and data-driven decision-making across the agri-food system.

Through pilot demonstrations across multiple African countries, NESTLER has validated its solutions under diverse real-world conditions, demonstrating their technical feasibility, socio-economic value, and scalability. The project provides a strong foundation for advancing resilient, sustainable, and data-driven agri-food systems within the EU–Africa partnership.

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