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Sustainable Agricultural Production, Productivity and Agroecology

Africa's agrifood systems stand at a critical juncture. Smallholder farmers, who produce most of the food, face mounting pressures from climate variability, land degradation, and the urgent need for sustainable practices to ensure long-term food security and environmental health. In regions like West Africa and the Sahel, these challenges are exacerbated by recurrent droughts, shifting weather patterns, and the imperative to balance productivity gains with biodiversity conservation and greenhouse gas mitigation. Drawing on evidence from the Program of Accompanying Research for Agricultural Innovation (PARI) program, this policy brief synthesizes insights into pathways for resilient and sustainable agriculture. It explores agroecological approaches to enhance productivity, the potential of carbon farming and soil management innovations, the overlooked trade-offs in livestock policies, adaptive strategies against climate impacts, and the role of agrobiodiversity in bolstering system resilience. By highlighting context-specific opportunities and barriers, the brief aims to guide policymakers, practitioners, and stakeholders toward integrated solutions that foster inclusive and climate-smart agrifood systems.

Sustainable production methods

Agroecological practices could boost productivity in African smallholder farming systems, particularly through the combined use of organic and mineral fertilizers, but impacts will vary by the context in which they are applied (Romero Antonio et al., 2024). Agroecological practices have long been incorporated in African farming systems, even if the term was not explicitly used, such as intercropping, integrated crop-livestock systems and the use of organic fertilizers. A meta-analysis exploring possible effects of agricultural practices on land and labour productivity in Africa finds that agroecological practices are associated with positive and significant differences in land productivity compared to monocropping systems - especially monocrops grown without inputs. However, the extent and direction of yield improvements vary depending on the specific practice, crop type, climatic conditions, soil properties and the type of control used. The application of organic fertiliser, in particular if combined with even small amounts of mineral fertilizer, showed most consistent yield gains. Evidence on labour productivity, however, remains scarce. The limited studies available suggest that while agroecological practices may require more labour, they can also result in higher profits, such as increased yields or additional income from intercropped legumes.

Carbon farming is emerging as a promising solution to address food insecurity while reducing greenhouse gas (GHG) emissions, but obstacles related to financing, skills institutional arrangements and monitoring could hinder widespread adoption (Schilling et al., 2023)**.** By promoting agricultural practices that enhance carbon sequestration, mitigate GHG emissions and boost agricultural productivity, carbon

farming offers a pathway toward sustainability. Despite its potential, financial constraints faced by smallholder farmers remain a major challenge. High transaction costs - such as those related to developing baselines, certification and administration - pose significant barriers to cost-effective carbon farming initiatives. Strengthening the institutional capacity of farmer organizations is therefore critical to overcoming these challenges.

The success of agricultural carbon markets also relies on the accurate measurement and monitoring of carbon stock changes in both soils and biomass (Schilling et al., 2023). Currently, the most reliable approaches for verifying soil carbon sequestration depend on laboratory methods, which are often costly and inaccessible. To advance carbon farming, further research is needed to develop accurate yet cost-effective tools for monitoring carbon sequestration, reducing GHG emissions and verifying the avoidance of emissions. Implementation research is also required to explore institutional arrangements that can facilitate carbon credits and support sustainable production methods in Africa.

Biochar and compost production stand out as valuable interventions within the carbon farming framework (Okyere and Kornher, 2023). Policymakers should consider supporting training programs for farm households to promote the production and use of soil carbon resources like biochar and compost. For example, findings from Ghana indicate that such training initiatives can increase agricultural productivity while simultaneously improving welfare outcomes. Therefore, promoting training programs focused on soil carbon resource production could enhance livelihoods while contributing to climate change mitigation.

Greater attention is needed to ensure the sustainability of livestock production. Insights from Kenya, Zambia and Burkina Faso reveal that sustainability trade-offs are not sufficiently reflected in livestock policies (Kariuki et al., 2022). While all three countries have committed to livestock development through dedicated policies and programs, key trade-offs - such as adverse environmental impacts, uneven distribution of socio-economic benefits between men and women and negative nutritional outcomes - are often overlooked. Specifically, policy documents pay limited attention to issues such as GHG emissions, water pollution and the negative health implications of consuming animalsourced foods. To address these blind spots, an integrated and multi-stakeholder approach is needed in policymaking processes. Such approaches would help identify and mitigate environmental, social and health-related trade-offs, ensuring that livestock policies contribute to sustainable development goals without compromising other critical areas.

Climate change and resilience

Climate change significantly affects food security in West Africa in diverse and complex ways (Mbaye et al., 2021). It impacts food availability by reducing crop yields and livestock productivity, while shifting agricultural potentials profoundly influence crop and livestock choices, thereby altering local food value chains. For many net food-buying households in the region, declines in crop yields and livestock productivity often lead to reduced access to food due to rising food prices. Moreover, the increasing frequency of extreme weather events - such as heatwaves, droughts and floods - continues to destabilize West African food systems. These weather extremes exacerbate existing food safety and nutritional security challenges, posing particularly severe risks to the most vulnerable social groups. Additionally, changing climatic

conditions are projected to facilitate the spread of infectious diseases, further undermining nutritional security and human health in the region.

In response to the interlinked threats of climate change and land degradation, numerous innovative solutions are being tested and deployed across West Africa (Mbaye et al., 2021; Mirzabaev et al., 2021). Mitigation strategies include irrigation, rainwater harvesting, crop diversification, the adoption of drought-tolerant crops, conservation agriculture, agroforestry and rational grazing practices. Complementary policies - such as carbon trading, land-use zoning, payment for ecosystem services and empowering women - align with these efforts to promote sustainability and resilience. A conflict-sensitive approach, however, is critical to ensure that these initiatives do not exacerbate existing tensions in the region. Local solutions integrate tested climate change adaptation and sustainable land management practices should be prioritized. For these strategies to be effective, policies must set achievable objectives, secure adequate funding and implement robust monitoring systems. Sustained focus on these challenges post COVID is essential to prevent a diversion of resources and priorities away from critical development needs in the Sahel.

The impact of drought is of particular concern in the Sahel, given its devastating effects on livelihoods. A survey of key experts across public, private and societal sectors indicates that rural households in the region commonly respond to drought by adopting sustainable agricultural practices, migrating, diversifying income sources and relying on social networks (Boukary et al., 2023). To strengthen drought resilience in the Sahel, several key actions are needed, including disseminating climate-friendly agricultural practices supported by robust monitoring and evaluation systems, providing timely information on early drought warnings and preparedness measures and mobilizing financial resources to implement policies aimed at building drought resilience. Moreover, drought policies should be participatory, results-oriented and informed by long-term forecasting to ensure sustainability and resilience. By integrating these elements into policymaking, the Sahel region can better prepare for and mitigate the impacts of future droughts.

Biodiversity

Agrobiodiversity is essential for the sustainability and resilience of agrifood systems. contrary to common perception, evidence from Burkina Faso and ghana suggests that the number of crop varieties has actually increased in recent years in the surveyed villages (Ademilola et al., 2024). This positive trend can largely be attributed to socio-economic factors such as market demand, yield potential, market value, irrigation schemes, migration and government initiatives. Certain crops, such as bambara groundnut, sorghum and millet, are cultivated not only for their economic value but also for their cultural significance. Findings from the case study villages indicate that “not all is lost” with respect to agrobiodiversity: while crop and varietal diversity is increasing in some parts of Africa, it is declining in others. To further enhance the conservation of crop and varietal diversity, policymakers and stakeholders should leverage the identified economic drivers and cultural factors. Incorporating farmers’ preferences and values into policy frameworks is particularly critical to ensure that conservation efforts align with economic incentives and the practical realities of agricultural production.

Strategies aimed at promoting biodiversity-smart farming systems must reconcile biodiversity conservation with the need to

improve land and labour productivity (Daum et al., 2023). Farmers are often motivated to adopt laboursaving technologies, even when these have adverse effects on biodiversity (e.g., mechanization or pesticide use). Conversely, labour constraints may prevent farmers from adopting biodiversity-enhancing practices that increase labour intensity, such as intercropping or planting basins. Addressing these trade-offs is essential to balance agricultural productivity growth with biodiversity conservation. One promising approach is scale-appropriate mechanization, where machinery is adapted to the size of farms rather than forcing farmers to adapt to large-scale equipment. Examples include the use of draught animals, small tractors and two-wheeled tractors, which are already common in parts of Asia and some regions of Africa. Additionally, innovations such as mechanized conservation agriculture, agricultural robotics and precision spraying could further enhance productivity while minimizing negative impacts on biodiversity

KEY TAKEAWAYS

Agro ecological practices: Agroecological practices can improve land productivity in African smallholder farming, especially when combining organic and mineral fertilizers, though their effectiveness depends on specific practices, crops and local conditions.

Carbon farming: Carbon farming can address food insecurity and reduce emissions, but requires training in implementing related practices, cost-effective carbon monitoring and stronger farmer organization support.

Sustainable livestock: Livestock policies often overlook environmental, social and health trade-offs, such as GHG emissions and unequal socio-economic benefits. Integrated, multi-stakeholder approaches are needed to ensure livestock development aligns with sustainability goals.

Climate change impacts: Climate change reduces crop yields, livestock productivity and food security in West Africa, while extreme weather worsens nutrition and health risks for vulnerable groups.

Building resilience: Strategies like drought-tolerant crops, agroforestry and early warnings, supported by participatory policies and funding, are essential for drought resilience and longterm sustainability in the Sahel.

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