

Adaptive Crop Management and Agroforestry: Best Practices to Strengthen Household Resilience to Climate Shocks (Focus on Burkina Faso)

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A best practice is a method or technique that has been generally accepted as superior to any alternatives because it produces results that are superior to those achieved by other means or because it has become a standard way of doing things. This document is one of a series of reports from the Food Security Portal on best practices for emerging topics in agriculture and food security policy.

Introduction

This brief synthesizes robust evidence on climate-smart agriculture (CSA) practices on adaptive crop management and agroforestry that strengthen household resilience to climate shocks in Burkina Faso and Africa south of the Sahara (SSA). The findings highlight a set of proven practices, including agroforestry, farmer-managed natural regeneration (FMNR), improved seeds, integrated soil fertility management (ISFM), and composting. These practices deliver consistent benefits in terms of yield gains, improved soil fertility, enhanced water retention, diversified incomes, and stronger food security under climate stress. Their effectiveness is highest when implemented in integrated systems and supported by access to inputs, extension services, inclusive financing, and enabling policies. Drawing on evidence from Burkina Faso and comparable contexts in SSA, the brief identifies scalable, policy-relevant solutions to strengthen climate resilience, improve livelihoods, and support sustainable agrifood systems.

Background and Context

Africa south of the Sahara (SSA) remains highly vulnerable to climate change, with agriculture particularly exposed due to its strong dependence on rainfall and natural resources. Over half of the regional workforce is employed in agriculture, and about 95 percent of cropland is rainfed, making the sector highly sensitive to rainfall variability (Trisos et al., 2022). Rising temperatures, erratic rainfall, and more frequent droughts are already affecting crop productivity, with climate change reducing agricultural productivity growth in Africa by an estimated 34 percent since 1961 (Trisos et al., 2022; Ariom et al., 2021).

Burkina Faso exemplifies these challenges. Agriculture employs around 60 percent of the population and remains highly vulnerable to climate shocks, including droughts, floods, and land degradation (World Bank, 2025). Approximately 46 percent of arable land is degraded, further constraining productivity and increasing the vulnerability of smallholder farmers (NDC Partnership, 2025). These conditions contribute to unstable yields, income losses, and persistent food insecurity, particularly among rural households. In this context, emerging climate-smart agricultural practices (CSA) play a critical role in strengthening resilience. Among them, practices such as agroforestry, farmer-managed natural regeneration (FMNR), improved and drought-tolerant crop varieties, crop diversification, integrated soil fertility management (ISFM), and

organic soil amendments have demonstrated strong potential to stabilize yields, improve soil fertility, and diversify livelihoods under climate stress (Douxchamps et al., 2016; Kone and Uzmay, 2024; Partey et al., 2018).

Aligning these practices with policy and investment priorities is essential to support climate-resilient agricultural systems. This brief contributes to this objective by synthesizing evidence on adaptive crop and agroforestry practices that can enhance household resilience in Burkina Faso and similar contexts across SSA and by providing actionable insights to inform policy and program design.

Approach

A comprehensive literature search was conducted across academic databases and development organization repositories, focusing on CSA practices in SSA with an emphasis on Burkina Faso. Studies were included if they addressed CSA practices related to adaptive crops and agroforestry and resilience outcomes. Both peer-reviewed and gray literature were reviewed to ensure a balanced perspective. Evidence was extracted into information, including the types of practices, contexts, documented outcomes, enabling conditions, and scalability. The synthesis focused on identifying practices with strong, consistent results and clear policy relevance.

Best Practices in CSA for Climate Shock Resilience

Adaptation Practices in Forestry and Agroforestry

Agroforestry

Agroforestry is the deliberate integration of trees with crops and/or livestock to improve productivity, ecosystem services, and household resilience. It is one of the oldest and most widespread land-use systems in SSA, with strong roots in Burkina Faso, Niger, Mali, and Senegal. In Burkina Faso, the dominant form is agroforestry parklands, where farmers manage species such as *Vitellaria paradoxa* (shea), *Parkia biglobosa* (nééré), *Faidherbia albida*, *Lanea microcarpa*, and *Azadirachta indica* within crop fields. Other systems include farmer-managed natural regeneration (FMNR), home gardens, hedgerows, alley cropping, fodder banks, windbreaks, cocoa and cashew agroforestry, and multi-storey systems. These tree-crop associations improve soil fertility through litter decomposition and nitrogen fixation, regulate microclimate, increase water infiltration, and boost biodiversity. In addition to ecological benefits, tree products (nuts, fruits, gum, timber, fodder, fuelwood) provide food and income, contributing to household resilience and livelihood diversification.

In Burkina Faso and other Sahelian countries, agroforestry systems deliver substantial yield, income, and ecological benefits. Yield increases of 20–120 percent have been recorded for cereals such as sorghum and millet under *Vitellaria* and *Faidherbia* parklands compared to open fields (Fané et al., 2024; Sanou et al., 2025; Sawadogo, 2011; Tschora et al., 2020). In Burkina Faso, households using parklands reported yield gains of 25–35 percent alongside additional income from nuts and timber. Topsoil carbon content under trees is 1.04–1.47 times higher than outside canopy zones (Bayala et al., 2020), with increased soil organic matter, nitrogen, and microbial activity improving soil fertility in degraded lands (Dimobe et al., 2025). Agroforestry systems store between 12 and 228 Mg C/ha depending on the system type (Mulugeta, 2014;

Awazi et Tchamba, 2019; Dimobe et al., 2025), with home gardens and perennial systems achieving the highest stocks.

Socioeconomic impacts are equally important. Tree products contribute between 19 and 39 percent of total household income across several countries (Berihu et al., 2024; Manaye et al., 2020). In Burkina Faso's parklands, tree densities of 8–14 trees/ha and over 30 species are common (Yaméogo et al., 2013). Cocoa agroforestry systems in Côte d'Ivoire have more than 90 percent farmer adoption, with trees providing food, timber, energy, and microclimate regulation. Agroforestry improves rainfall infiltration, buffers temperature extremes, and reduces erosion by 50–80 percent (Tschora et al., 2020). Studies across Niger, Mali, Senegal, Ethiopia, Chad, and Kenya show farmers using agroforestry have higher adaptive capacity and lower exposure to climate shocks (Awazi et al., 2025; Kouassi et al., 2020; Kissi et al., 2023). Women play a key role in managing home gardens and parkland resources, contributing directly to household food security and income diversification (Dimobe et al., 2025; Tschora et al., 2020).

Farmer-Managed Natural Regeneration (FMNR)

Farmer-managed natural regeneration (FMNR) is a farmer-led land restoration practice that focuses on protecting and actively managing naturally regenerating tree stumps and root systems instead of planting new trees. Originating in Niger and rapidly spreading to Burkina Faso and Mali in the 1980s, FMNR is now a core practice in the Sahel. In Burkina Faso, it is integrated into traditional parkland systems dominated by *Faidherbia albida*, *Vitellaria paradoxa*, *Parkia biglobosa*, *Balanites aegyptiaca*, and *Piliostigma reticulatum*. FMNR enhances soil fertility, protects against erosion and wind damage, improves microclimate and biodiversity, and contributes to carbon sequestration. It also provides households with fuelwood, fruits, nuts, gum, honey, and fodder, reinforcing livelihood resilience and income diversification.

FMNR has delivered strong ecological and livelihood benefits in Burkina Faso and across the Sahel. In Burkina Faso, regeneration was observed on 75 percent of surveyed plots with median tree densities of 30 trees/ha, and *Vitellaria paradoxa* represented 38 percent of tree species (Lohbeck et al., 2020). In the eastern regions, woody species density increased to 104–113 individuals/ha, with regeneration rates above 50 percent and Shannon diversity indices of 2.01–2.17 (Kafando et al., 2023). In Niger, tree density under FMNR reached 160 trees/ha, and in Mali, 277 trees/ha (Kuyah et al., 2023). Mali also recorded 167–266 percent increases in tree biodiversity and wood volume gains of 35–100 t/ha after FMNR adoption (Moussa et al., 2022).

FMNR improves crop yields, food security, and income. In Burkina Faso and Niger, sorghum and millet yields increased by 50–100 percent compared to non-FMNR fields (Chomba et al., 2020). In Senegal, FMNR adopters achieved an additional 275 kg/ha in groundnut yields (Sanogo et al., 2021). In Ghana, households practicing FMNR had a Household Dietary Diversity Score (HDDS) of 9.6 compared to 4.3 among non-adopters, and 86 percent reached acceptable Food Consumption Scores (FCS) versus 37 percent of non-adopters (Opoku Mensah et al., 2024). In Niger, the lean season shortened from six to two or three months, while household cash income rose significantly from shea, fuelwood, and other tree-based products (Kuyah et al., 2023; Opoku Mensah et al., 2024). Economic assessments in Sahelian zones show returns of \$2–\$3 for every \$1 invested and net benefits exceeding \$1,200/ha over 20 years (Nkonya et al., 2024). FMNR also plays a critical role in climate mitigation, with carbon sequestration rates ranging from 0.29 to 6.31 Mg C/ha/year depending on system and context (Kuyah et al., 2023).

Adaptation Practices in Crop Management

Drought-Tolerant Seed/Crop Varieties, Improved Crop Varieties, and Crop Diversification

The use of drought-tolerant and improved crop varieties is a key strategy for stabilizing yields and reducing the risk of crop failure in the face of increasing climate variability. These varieties mature earlier or perform better under water and heat stress and are often combined with soil and water conservation practices to maximize impact. In Burkina Faso, the main crops concerned include maize, sorghum, millet, sesame, cassava, cowpea, and cotton (Savadogo et al., 2011). The country has an active seed system through INERA, which has released or adopted stress-tolerant varieties over the past decades (Bougma et al., 2018).

Burkina Faso has generated strong results with improved and drought-tolerant varieties. Quinoa Titicaca produced 1.9 t/ha under heat and deficit irrigation at 60 percent PET with low nitrogen input (Alvar-Beltrán et al., 2019). Maize–cowpea intercropping with improved cultivars achieved grain Land Equivalent Ratios (LER) between 1.02 and 1.45 and fodder LER between 1.18 and 1.41, reducing weed biomass by 50 percent (Sanfo et al., 2023). Sorghum–cowpea intercropping maintained total grain yield around 2 t/ha and increased protein output by 34 percent with an LER of 1.29 (Raboin et al., 2025). National data indicate 37.5 percent of maize farmers have adopted improved seeds, with 12.2 percent continuous use (Sanou et al., 2017). Under value chain support, Kabako drought-tolerant maize doubled yields on demonstration plots (4.5 t/ha) compared to typical smallholder farms (1.3–2.0 t/ha), generating gross margins of 767,500 FCFA/ha (Sithole et al., 2022). Improved rice varieties achieved 42.9 percent adoption in central lowlands with perceived yields of 5.6 t/ha (Zonou et al., 2023). Burkina Faso maize landraces also displayed high drought tolerance, with yields of 2.0–2.16 t/ha under stress similar to hybrid checks and favorable traits such as short anthesis silking intervals (Olaoye et al., 2009). Diversification of cash and food crops significantly improved food security outcomes ($p=0.007$), while late onset of rainfall and livestock competition reduced them (Thiombiano et Ouedraogo, 2025).

Across SSA, evidence further confirms the benefits of improved and drought-tolerant varieties. In Mali, diversification (Simpson Index 0.63) was associated with significant production gains (Douyon et al., 2022). Drought-tolerant maize out-yielded checks by 83–137 percent under controlled drought, 26–47 percent under random drought, and 25–56 percent under good rainfall across six countries in Eastern and Southern Africa (Fisher et al., 2015). In Benin, adoption of drought-tolerant maize increased per capita food expenditure by 1.44 percent, Food Consumption Score by 31.8 percent, dietary diversity by 2.34 percent, and reduced food insecurity by 45.5 percent (Atchikpa et al., 2020). In Ghana, Burkina Faso's Bambara groundnut landrace achieved the highest pod yield under heat (118.5 g/m²) and continued pod setting under drought (Berchie et al., 2012). In Côte d'Ivoire, adoption of improved sorghum reached 54.7 percent, with a 36 percent yield gain (Simtowe et al., 2019). In Ethiopia, drought-tolerant maize adoption of 44.2 percent generated a 26 percent yield advantage, a 9-point poverty reduction, and a 13 percent lower food insecurity gap (Geffersa et al., 2022; Jaleta et al., 2018). In Tanzania, improved maize increased per capita consumption by 17.9 percent and reduced poverty by 11.7 points (Wossen et al., 2017). In Zambia, adoption increased yields by 26 percent, crop income by ZMK 2.3–2.4 million/ha, and improved food security by up to 21 points (Khonje et al., 2015). In Ghana, improved rice increased dietary diversity by 26 percent and gross margins by GHS 1,249 (Lu et al., 2021). In Mali, top biofortified sorghum hybrids yielded 3–5 t/ha with early maturity (68–70 days) and stay-green traits (Maiga et al., 2023), increasing the share of crops sold by 160–250 percent and

dietary diversity by 7–8 percent (Smale et al., 2018). In Ethiopia, combining diversification, conservation tillage, and improved seed raised maize income by ETB 5,579/ha (Teklewold et al., 2013).

Integrated Soil Fertility Management (ISFM)

Integrated soil fertility management (ISFM) is a climate-smart agricultural approach that combines organic inputs (compost, manure, crop residues, green manures), inorganic fertilizers (NPK, urea), improved germplasm, and complementary soil and water conservation measures to improve soil fertility, nutrient use efficiency, crop productivity, and resilience to climate variability (Vanlauwe et al., 2010). ISFM is widely used across Burkina Faso and other SSA countries, often in combination with zai pits, stone bunds, or half-moons to enhance effectiveness under climate stress.

In Burkina Faso, ISFM has consistently delivered significant productivity and resilience gains. On-farm trials in the Northern Sudanian zone increased sorghum grain yields from 793.6 to 1,428.7 kg/ha in 2018 and from 535.2 to 1,158.4 kg/ha in 2019 using zai plus NPK plus urea, with straw yields rising from 2,173.5 to 3,729.9 kg/ha (Ouedraogo et al., 2020). Microdosing fertilizer increased sorghum yields by 385 kg/ha in Sissili, 571 kg/ha in Oubritenga, and 388 kg/ha in Zandoma (Ouedraogo et al., 2022). Integrating manure and NPK with millet–cowpea systems raised biomass from 600 ± 43 to $1,460 \pm 102$ kg/ha, millet grain from 44 ± 6 to 246 ± 23 kg/ha, and cowpea from 160 ± 19 to 218 ± 21 kg/ha (Sanou et al., 2016). Across semi-arid Burkina Faso and Niger, ISFM increased millet yields by 35–80 percent and sorghum yields by about 55 percent, boosting marketable surplus and reducing drought-year failure risk (Garba et al., 2018). Fertilizer optimization within ISFM raised maize yields by 181 percent, pearl millet by 53 percent, sorghum by 40 percent, and rice by 27 percent (Ouattara et al., 2017). High manure–fertilizer combinations sustained productivity over 48 years under climate variability (Adams et al., 2020).

Evidence from other SSA countries supports these results. In Ghana, ISFM adoption increased maize yields by 27 percent (Adolwa et al., 2019); in Kenya, by 16 percent (Kakamega trials); and across SSA, maize yields increased by 71–158 percent with improved drought resilience. In Ghana, ISFM adoption increased maize yields by 86.5 percent and net income by 51.3 percent (Boansi et al., 2024). In Nigeria, ISFM raised crop production value by 36 percent per ha (Kato et al., 2011). In Ethiopia, ISFM adoption increased maize, wheat, and teff income by 30 percent in moist zones and 21 percent in dry zones, reduced food insecurity by 16 percentage points, and improved school enrollment by 15 points (Hörner et Wollni, 2021). Yebo et al. (2024) recorded maize yield gains of 50–180 percent and teff increases of 33–120 percent with manure–fertilizer combinations. In Kenya, zai combined with ISFM doubled sorghum yields, while adopters harvested 4.8 bags/acre vs. 2.4 for non-adopters, reaching 5.7 bags under full ISFM (Mogaka et al., 2025). In Tanzania, using multiple ISFM components increased yields by 45 percent, reduced food insecurity months from 1.4 to 0.4, and improved dietary diversity (Kihara et al., 2022). In Zimbabwe and other semi-arid zones, maize yields ranged between 4.2 and 5.5 t/ha and sorghum yields between 0.69 and 3.5 t/ha under ISFM (Kugedera et al., 2023). In Benin, ISFM increased net farm income for maize from 14,342 FCFA/ha to 64,355 FCFA/ha and for soybean from 73,780 FCFA/ha to 127,355 FCFA/ha (Bambani et al., 2025). In Cameroon, ISFM adoption raised dietary diversity scores by 0.281 and improved consumption of cereals, dairy, pulses, and nuts, with women benefiting more from organic ISFM options (Wenda et al., 2025).

Composting and Organic Amendments

Composting and organic amendments are widely used soil fertility management practices that rely on locally available organic materials such as crop residues, manure, household waste, and agro-industrial by-products to improve soil structure, nutrient availability, water retention, and yield stability under variable climate conditions (Savadogo et al., 2011). In Burkina Faso, composting is a long-established practice often combined with zai pits, mulching, or other CSA measures to boost soil fertility and climate resilience. Organic amendments include compost, manure, biochar, biofertilizer, and crop residues, which are applied alone or integrated with mineral fertilizers to enhance efficiency.

In Burkina Faso, composting has produced substantial productivity gains across multiple crops. Early compost trials in Mediga and Yimtenga increased sorghum yields by 45 percent at 5–10 Mg/ha and tripled yields compared to control plots, while buffering against delayed rainfall onset (Ouedraogo et al., 2001). Residue recycling in Farako-Bâ raised maize yields by 17–34 percent, cotton by 18–38 percent, and sorghum by 6–14 percent compared to residue export (Ouattara et al., 2022). Enriching compost with *Trichoderma harzianum* increased tomato yields by 300–400 percent and added 3 t/ha using Bokashi compost in Soala (Coulibaly et al., 2021). In Tenkodogo, applying 4–5 t/ha of cow dung raised Bambara groundnut plant height by 19–20 percent, plant width by 19 percent, and haul yield by 37 percent; combining cow dung with NPK increased pod weight by 24 percent, seed weight by 20 percent, and nodule number by 43 percent (Zongo et al., 2023; 2024). Using neem cake at 6 t/ha raised sorghum yields to 2,293 kg/ha compared to 1,039 kg/ha for mineral fertilizer alone, while improving soil pH and nutrient availability (Traoré et al., 2021). Biochar at 20 t/ha increased amaranth yields by 39 percent, lettuce by 17 percent, and carrots by 11 percent in Ouagadougou urban systems (Manka'abusi et al., 2019). Farmer surveys confirmed biochar's potential for improving soil fertility and yield resilience under drought conditions (Koné and Galiegue, 2023). Long-term trials at Saria (1960–2008) found sorghum yields 3.6 times higher with low manure and 8.7 times higher with high manure compared to control plots (Adams et al., 2020).

Evidence from other SSA countries confirms similar patterns. In Togo, maize yields rose from 1.7 to 4.3 t/ha with biochar at 20 t/ha (Aziandeke et al., 2025). In Tanzania, biochar increased maize yields by 145 percent at 20 t/ha (Nassary et al., 2025). In Mali, compost microdosing at 2.5 t/ha produced 2,061 kg/ha of sorghum, matching 5 t/ha broadcast rates but with 55 percent higher nitrogen use efficiency and higher margins (Guindo et al., 2022). In Niger, compost at 5 t/ha increased millet grain yields by 44 percent and plant height by 22 cm (Assane et al., 2024). In Cameroon, combining *Tithonia* biomass with poultry manure increased cassava yields by 76.6–172.2 percent (Bilong et al., 2022). In Benin, compost + biochar raised cotton yield by 86% (2.53 t/ha) with net returns of USD 513.7/ha and a benefit–cost ratio of 2.6 (Tovihoudji et al., 2022). In Kenya, 100 Mg/ha biochar in maize–soybean rotations increased maize by 1.17 Mg/ha, soybean by 0.43 Mg/ha, reduced yield variability from 57.3 to 21.5 percent, and improved soil pH and water holding capacity over 10 years (Kätterer et al., 2019). In Nigeria, biochar improved soil organic carbon by up to 72 percent and total nitrogen by 48 percent, increasing yields across multiple crops (Zubairu et al., 2023).

Policy Recommendations

Based on the evidence presented, strengthening household resilience to climate shocks in Burkina Faso and across SSA requires scaling proven adaptive crop and agroforestry practices.

- **Scale Up Proven Agroforestry and FMNR Systems:** Agroforestry and FMNR have demonstrated strong and consistent impacts on crop productivity, soil fertility, income diversification, and climate resilience. Public investment should prioritize the expansion of parkland systems, assisted natural regeneration, and tree-based farming through large-scale restoration programs. Supporting tree tenure security, seedling supply systems, and farmer incentives will be critical to accelerate adoption and ensure long-term sustainability.
- **Strengthen Seed Systems and Promote Climate-Resilient Crop Varieties:** Expanding access to improved and drought-tolerant crop varieties is essential to reduce yield variability and production risks. Governments and partners should invest in strengthening national seed systems, supporting research institutions, and improving distribution channels to ensure the availability and affordability of adapted varieties. They should also ensure timely access to improved-quality seeds at the beginning of the planting season and promote affordability through targeted subsidies or price-reduction mechanisms. This should be complemented by farmer training on improved seed multiplication techniques and the establishment of community-based seed banks to enhance local availability, accessibility, and resilience of seed supply systems. Promoting crop diversification and intercropping systems can further enhance resilience and food security.
- **Promote ISFM at Scale:** Evidence shows that combining organic and inorganic inputs significantly improves yields, soil health, and resilience. Policies should support the widespread adoption of ISFM through input subsidies, extension services, and farmer training. Encouraging site-specific nutrient management, fertilizer microdosing, and integration with agroforestry systems can maximize productivity gains under climate stress.
- **Support Composting and Organic Soil Amendments:** Composting and organic inputs, including compost, manure, and biochar, have demonstrated strong impacts on soil fertility, water retention, and yield stability. Scaling these practices requires investment in farmer training, access to organic materials, and support for decentralized compost production systems, along with the provision of necessary materials and equipment for composting and biochar production. Integrating organic amendments with mineral fertilizers can improve nutrient efficiency and long-term soil health.
- **Invest in Monitoring, Evaluation, and Scaling Mechanisms:** Scaling requires robust monitoring of adoption, productivity, and resilience outcomes. Governments and partners should strengthen monitoring and evaluation (M&E) systems and support knowledge-sharing platforms to facilitate learning, replication, and continuous improvement of adaptive practices across regions.
- **Promote Integrated and Context-Specific Practice Packages:** Evidence shows that combining practices, such as agroforestry, improved seeds, ISFM, and composting, delivers stronger and more stable outcomes than single interventions. Scaling strategies should prioritize integrated packages tailored to local agroecological and socio-economic conditions to maximize impact and sustainability.

Conclusion

The impacts of climate change on agriculture in Burkina Faso and similar contexts in SSA are intensifying, threatening productivity and food security. Evidence shows that scaling adaptive crop and agroforestry practices, including improved and drought-tolerant varieties, diversification, agroforestry, FMNR, and integrated soil fertility management, can significantly enhance resilience, stabilize yields, and diversify incomes. Sustained progress will depend on aligning these proven practices with supportive policies, effective seed and input systems, and targeted investments. Promoting integrated practice packages and strengthening local capacities will be essential to achieve resilient and sustainable agrifood systems across Africa south of the Sahara.

References

- Adams, A. M., Gillespie, A. W., Dhillon, G. S., Kar, G., Minielly, C., Koala, S., Ouattara, B., Kimaro, A. A., Bationo, A., Schoenau, J. J., & Peak, D. (2020). Long-term effects of integrated soil fertility management practices on soil chemical properties in the Sahel. *Geoderma*, 366, 114207. <https://doi.org/10.1016/j.geoderma.2020.114207>
- Adolwa, I. S., Schwarze, S., & Buerkert, A. (2019). Impacts of integrated soil fertility management on yield and household income: The case of Tamale (Ghana) and Kakamega (Kenya). *Ecological Economics*, 161, 186-192. <https://doi.org/10.1016/j.ecolecon.2019.03.023>
- Alvar-Beltrán, J., Dao, A., Marta, A. D., Heureux, A., Sanou, J., & Orlandini, S. (2020). Farmers' Perceptions of Climate Change and Agricultural Adaptation in Burkina Faso. *Atmosphere* 2020, 11, 0827; www.mdpi.com/journal/atmosphere doi:10.3390/atmos11080827
- Ariom, T. O., Dimon, E., Nambeye, E., Diouf, N. S., Adelusi, O. O., & Boudalia, S. (2021). Climate-Smart Agriculture in African Countries: A Review of Strategies and Impacts on Smallholder Farmers. *Sustainability*, 14(18), 11370. <https://doi.org/10.3390/su141811370>
- Assane, M. M., Magagi, A. S., Bodo, B. S., Mahamane, A., Marin, B., Morvan, X., ... & Fronteau, G. (2024). Compost, a natural fertilizer to improve pearl millet [*Pennisetum glaucum* (L.) R. br.] growth and its productivity in the Sahel (south-eastern Niger): an experiment to convince small producers to manage their soil sustainably. *International Journal of Biological and Chemical Sciences*, 18(3), 864-881.
- Atchikpa, T. M., Kane, C. S., Tambo, J. A., Abdoulaye, T., & Yabi, J. A. (2021). Impact of climate-smart innovations on food security of farming household in Benin: a case study of drought tolerant maize (DTM) varieties.
- Awazi, N. P., & Tchamba, N. M. (2019). Enhancing agricultural sustainability and productivity under changing climate conditions through improved agroforestry practices in smallholder farming systems in sub-Saharan Africa. *African Journal of Agricultural Research*, 14(7), 379-388.
- Aziandeke, D. K., Dos Santos Vianna, M., Bouka, E. C., Mawussi, G., Coulibaly, A., & Gaiser, T. (2025). The influence of rice husk biochar, compost, and their mixture on maize yields and soil organic carbon content in southern Togo. *Geoderma Regional*, 42, e00996. <https://doi.org/10.1016/j.geodrs.2025.e00996>

- Bambani, R. C., Fifanou, V. G., & Jacob, Y. A. (2024). Déterminants des stratégies de gestion intégrée de fertilité des sols comme technique d'adaptation aux changements climatiques par les producteurs agricoles au Nord du Bénin: Determinants of integrated soil fertility management strategies as a technique for adaptation to climate change by agricultural producers in Northern Benin. *Revue Africaine d'Environnement et d'Agriculture*, 7(1), 37-49.
- Bayala, J., Sanou, J., Bazié, H. R., Coe, R., Kalinganire, A., & Sinclair, F. L. (2020). Regenerated trees in farmers' fields increase soil carbon across the Sahel. *Agroforestry Systems*, 94(2), 401-415. <https://doi.org/10.1007/s10457-019-00403-6>
- Berihu Tesfamariam Zeratsion, Ashenafi Manaye, Yirga Gufi, Musse Tesfaye, Adefires Werku & Agena Anjulo (2024) Agroforestry practices for climate change adaptation and livelihood resilience in drylands of Ethiopia, *Forest Science and Technology*, 20:1, 47-57, DOI: 10.1080/21580103.2023.2292171
- Bilong, E. G., Abossolo-Angue, M., Ajebesone, F. N., Anaba, B. D., Madong, B. À., Nomo, L. B., & Bilong, P. (2022). Improving soil physical properties and cassava productivity through organic manures management in the southern Cameroon. *Heliyon*, 8(6), e09570. <https://doi.org/10.1016/j.heliyon.2022.e09570>
- Boansi, D., Owusu, V., & Donkor, E. (2024). Impact of integrated soil fertility management on maize yield, yield gap and income in northern Ghana. *Sustainable Futures*, 7, 100185. <https://doi.org/10.1016/j.sfr.2024.100185>
- Bougma, L. A., Sawadogo, N., Ouedraogo, M. H., Ouedraogo, M., Balma, D., & Sawadogo, M. (2018). Overview of the Burkina Faso seed system: case of the formal seed system.
- Chomba S, Sinclair F, Savadogo P, Bourne M and Lohbeck M (2020) Opportunities and Constraints for Using Farmer Managed Natural Regeneration for Land Restoration in Sub-Saharan Africa. *Front. For. Glob. Change* 3:571679. doi: 10.3389/ffgc.2020.571679
- Coulibaly, P. J., Sawadogo, J., Bambara, Y. A., Ouedraogo, W., Legma, J. B., & Compaoré, E. (2021). Effect of Bio-Fertilizers on Tomato (*Solanum Lycopersicum*) Production and on Soil Physico-Chemical Properties In Sudan Area of Burkina Faso. *Current Agriculture Research Journal*, 9(1).
- Dimobe, K., Zoungrana, B. J. B., Yoni, M., & Thiombiano, A. (2025). Agroforestry's contribution to sustainable soil fertility, livelihoods, and carbon sequestration in Sub-Saharan Africa: a systematic review. *International Journal of Agriculture and Biosciences*, 14(3), 436-446.
- Douxchamps, S., Van Wijk, M. T., Silvestri, S., Moussa, A. S., Quiros, C., Ndour, N. Y. B., Buah, S., Somé, L., Herrero, M., Kristjanson, P., & Thornton, P. K. (2016). Linking agricultural adaptation strategies, food security and vulnerability: Evidence from West Africa. *Regional Environmental Change*, 16(5), 1305–1317. <https://doi.org/10.1007/s10113-015-0838-6>
- Douyon A, Worou ON, Diama A, Badolo F, Denou RK, Touré S, Sidibé A, Nebie B and Tabo R (2022) Impact of Crop Diversification on Household Food and Nutrition Security in Southern and Central Mali. *Front. Sustain. Food Syst.* 5:751349. doi: 10.3389/fsufs.2021.751349
- Fané, S., Agbotui, D. K., Graefe, S., Sanou, L., Sanogo, S., & Buerkert, A. (2024). Adoption of agroforestry systems by smallholders' farmers in the Sudano-Sahelian zones of Mali and

- Burkina Faso, West Africa. *Agroforestry Systems*, 98(7), 2385-2396. <https://doi.org/10.1007/s10457-024-01020-8>
- Fisher, M., Abate, T., Lunduka, R. W., Asnake, W., Alemayehu, Y., & Madulu, R. B. (2015). Drought tolerant maize for farmer adaptation to drought in sub-Saharan Africa: Determinants of adoption in eastern and southern Africa. *Climatic Change*, 133(2), 283-299. <https://doi.org/10.1007/s10584-015-1459-2>
- Garba, M., Serme, I., Maman, N., Korodjouma, O., Gonda, A., Wortmann, C., & Mason, S. (2018). Crop response to manure and fertilizer in Burkina Faso and Niger. *Nutrient Cycling in Agroecosystems*, 111(2), 175-188. <https://doi.org/10.1007/s10705-018-9921-y>
- Geffersa, A. G., Agbola, F. W., & Mahmood, A. (2022). Improved maize adoption and impacts on farm household welfare: Evidence from rural Ethiopia. *Australian Journal of Agricultural and Resource Economics*, 66(4), 860–886. <https://doi.org/10.1111/1467-8489.12489>
- Golli, S., Nekesa, T., Jaquet, S., Bayala, S. B., Katsir, S., Vollmann Tinoco, V. (2024). *Gestion Durable des Terres (GDT). Compilation des technologies et approches de GDT au Burkina Faso. World Overview of Conservation Approaches and Technologies (WOCAT) / Centre for Development and Environment (CDE), University of Bern, Switzerland, Alliance of Bioversity International & CIAT and Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH.*
- Guindo, M., Traoré, B., Birhanu, B. Z., Coulibaly, A., & Tabo, R. (2022). Microdosing of Compost for Sustainable Production of Improved Sorghum in Southern Mali. *Agronomy*, 12(6), 1480. <https://doi.org/10.3390/agronomy12061480>
- Hörner, D., & Wollni, M. (2021). Integrated soil fertility management and household welfare in Ethiopia. *Food Policy*, 100, 102022. <https://doi.org/10.1016/j.foodpol.2020.102022>
- Jaleta, M., Kassie, M., Marenya, P., Yirga, C., & Erenstein, O. (2018). Impact of improved maize adoption on household food security of maize producing smallholder farmers in Ethiopia. *Food Security*, 10 (1), 81–93. <https://doi.org/10.1007/s12571-017-0759-y>
- Kafando, W. A. C., Zomboudre, G., Kabore, R., Bourgou, T., & Hien, M. (2023). Biodiversité et distribution des peuplements ligneux issus de la Régénération Naturelle Assistée (RNA) dans les agroécosystèmes de la zone Soudanosahélienne du Burkina Faso. *International Journal of Biological and Chemical Sciences*, 17(3), 907-919.
- Kato, E., Nkonya, E. M., & Place, F. (2011). Heterogeneous treatment effects of integrated soil fertility management on crop productivity: evidence from Nigeria.
- Kätterer, T., Roobroeck, D., Andrén, O., Kimutai, G., Karlton, E., Kirchmann, H., Nyberg, G., Vanlauwe, B., & Röing de Nowina, K. (2019). Biochar addition persistently increased soil fertility and yields in maize-soybean rotations over 10 years in sub-humid regions of Kenya. *Field Crops Research*, 235, 18-26. <https://doi.org/10.1016/j.fcr.2019.02.015>
- Khonje, M., Manda, J., Alene, A. D., & Kassie, M. (2015). Analysis of adoption and impacts of improved maize varieties in eastern Zambia. *World Development*, 66, 695–706. <https://doi.org/10.1016/j.worlddev.2014.09.008>

- Kihara, J., Manda, J., Kimaro, A., Swai, E., Mutungi, C., Kinyua, M., Okori, P., Fischer, G., Kizito, F., & Bekunda, M. (2022). Contributions of integrated soil fertility management (ISFM) to various sustainable intensification impact domains in Tanzania. *Agricultural Systems*, 203, 103496. <https://doi.org/10.1016/j.agry.2022.103496>
- Kissi, A. E., Villamor, G. B., & Abbey, G. A. (2023). Ecosystem-Based Adaptation Practices of Smallholder Farmers in the Oti Basin, Togo: Probing Their Effectiveness and Co-Benefits. *Ecologies*, 4(3), 535-551. <https://doi.org/10.3390/ecologies4030035>
- Koné, S., & Galiegue, X. (2023). Potential development of biochar in Africa as an adaptation strategy to climate change impact on agriculture. *Environmental Management*, 72(6), 1189-1203. <https://doi.org/10.1007/s00267-023-01821-0>
- Kone, S., & Uzmay, A. (2024). Impact assessment of sustainable agricultural practices on smallholder households food security: evidence from Burkina Faso. *Climate and Development*, 17(3), 255–269. <https://doi.org/10.1080/17565529.2024.2357183>
- Kouassi, J. L., Diby, L., Konan, D., Kouassi, A., Bene, Y., & Kouamé, C. (2023). Drivers of cocoa agroforestry adoption by smallholder farmers around the Taï National Park in southwestern Côte d'Ivoire. *Scientific Reports*, 13(1), 14309.
- Kugedera, A. T., Badza, T., & Odindo, A. O. (2023). Integrated soil fertility management practices for improved crop production in smallholder farming systems of semi-arid areas: A synthetic review. *Cogent Food & Agriculture*, 9(1). <https://doi.org/10.1080/23311932.2023.2256137>
- Kuyah, S., Buleti, S., Dimobe, K., Nkurunziza, L., Moussa, S., Muthuri, C., & Öborn, I. (2023). Farmer-managed natural regeneration in Africa: evidence for climate change mitigation and adaptation in drylands. In *Agroforestry for sustainable intensification of agriculture in Asia and Africa* (pp. 53-88). Singapore: Springer Nature Singapore.
- Lu, W., Addai, K. N., & Ng'ombe, J. N. (2021). Impact of improved rice varieties on household food security in Northern Ghana: A doubly robust analysis. *Journal of International Development*, 33(2), 342– 359. <https://doi.org/10.1002/jid.3525>
- Maiga, A. M., Diallo, A. G., & Kane, Y. (2023). Adaptation of bio-fortified Sorghum hybrids (*Sorghum bicolor*) to drought resilience in Mali. *Int J Agric Environ Bioresearch*, 8(05), 1-12.
- Manka'abusi, D., Steiner, C., Akoto-Danso, E. K., Lompo, D. J., Haering, V., Werner, S., ... & Buerkert, A. (2019). Biochar application and wastewater irrigation in urban vegetable production of Ouagadougou, Burkina Faso. *Nutrient cycling in agroecosystems*, 115(2), 263-279. <https://doi.org/10.1007/s10705-019-09969-0>
- Mogaka, H., & Kiprotich, S. (2025). Effects of Integrated Soil Fertility Management Technologies on the Productivity of Sorghum in the Drier Parts of Upper Eastern Kenya. *Journal of Global Innovations in Agricultural Sciences*, 121-127.
- Moussa, Z., Mahamadou, D., Binta, D., Sayon, K., Soumaila, M. B., Kalifa, T., ... & Anewin, T. M. (2022). Impact of a Climate Smart Technology: Case of the Farmer Managed Natural Regeneration on Trees Biodiversity in Sudano-Sahelian Parklands of Kayes and Koulikoro, in Mali. *trees*, 10(2).

- Mulugeta, G. (2014). Evergreen agriculture: agroforestry for food security and climate change resilience. *Journal of Natural Sciences Research*, 4(11), 80-90.
- Nassary, E. K. (2025). Biochar from maize cob waste: A path to carbon sequestration, enhancing soil health, maize productivity, and climate resilience in Tanzania. *Next Research*, 2(2), 100229. <https://doi.org/10.1016/j.nexres.2025.100229>
- NDC Partnership. (2025, March 10). Building climate resilience in Burkina Faso through sustainable land restoration and climate-smart agriculture. <https://ndcpartnership.org/news/building-climate-resilience-burkina-faso-through-sustainable-land-restoration-and-climate>
- Nkonya, E., Kato, E., & Kabore, C. (2024). Impact of farmer-managed natural regeneration on resilience and welfare in Mali. *Green and Low-Carbon Economy*, 2(1), 14-27.
- Olaoye, G., Menkir, A., Ajala, S. O., & Jacob, S. (2009). Evaluation of local maize (*Zea mays* L.) varieties from Burkina Faso as source of tolerance to drought. *J. Appl. Biosci*, 17(2), 887-898.
- Opoku Mensah, S., Ibrahim, S. K., Jacobs, B., Cunningham, R., Owusu-Ansah, D., & Adjei, E. (2024). Benefits of farmer managed natural regeneration to food security in semi-arid Ghana. *Agriculture and Human Values*, 41(3), 1177-1193.
- Ouattara, A., Koulibaly, B., Dakuo, D., Bazongo, P., Coulibaly, K., Mowrer, J., & Nacro, H. B. (2022). Effects of crops residues management systems on crops yields and chemical characteristics of tropical ferruginous soil in Western Burkina Faso. *African Journal of Agricultural Research*, 18(3), 231-237.
- Ouattara, K., Serme, I., Bandaogo, A. A., Ouedraogo, S., Sohero, A., Gnankambary, Z., ... & Pare, T. (2017). Optimizing fertilizer use within an integrated soil fertility management framework in Burkina Faso. In *Fertilizer use optimization in sub-Saharan Africa* (pp. 40-51). GB: CABI.
- Ouédraogo, E., Mando, A., & Zombré, N. P. (2001). Use of compost to improve soil properties and crop productivity under low input agricultural system in West Africa. *Agriculture, ecosystems & environment*, 84(3), 259-266.
- Ouedraogo, J., Serme, I., Pouya, M. B., Sanon, S. B., Ouattara, K., & Lompo, F. (2020). Amélioration de la productivité du sorgho par l'introduction d'options technologiques de gestion intégrée de la fertilité des sols en zone Nord soudanienne du Burkina Faso. *Int. J. Biol. Chem. Sci*, 14(9), 3262-3274.
- Ouedraogo, Y., Taonda, J. B. S., Sermé, I., Tychon, B., & Biielders, C. L. (2022). Drivers of sorghum response to fertilizer microdosing on smallholder farms across Burkina Faso. *Field Crops Research*, 288, 108709.
- Partey, S. T., Zougmore, R. B., Ouédraogo, M., & Campbell, B. M. (2018). Developing climate-smart agriculture to face climate variability in West Africa: Challenges and lessons learnt. *Journal of cleaner Production*, 187, 285-295.
- Raboin, L., Ouedraogo, N., Kabore, M., Zabre, Y., Ganeme, A., Bonnal, L., Assouma, M. H., Gozé, E., & Dusserre, J. (2025). Sorghum genetic variability for adaptation to intercropping with cowpea in Sudano-Sahelian conditions. *Field Crops Research*, 330, 109984. <https://doi.org/10.1016/j.fcr.2025.109984>

- Sanfo A, Zampaligre´ N, Kulo AE, Some´ S, Traore´ K, Rios EF, Dubeux JCB, Boote KJ and Adesogan A (2023) Performance of food–feed maize and cowpea cultivars under monoculture and intercropping systems: Grain yield, fodder biomass, and nutritive value. *Front. Anim. Sci.* 3:998012. doi: 10.3389/fanim.2022.998012
- Sanou, B., Savadogo, K., & Sakurai, T. (2017). Determinants of adoption and continuous use of improved maize seeds in Burkina Faso. *Japanese Journal of Agricultural Economics*, 19, 21-26.
- Sanou, C. L., Neya, O., Agodzo, S. K., Bessah, E., Antwi-Agyei, P., & Balima, L. H. (2025). Woody species diversity and aboveground carbon stocks in agroforestry systems in Burkina Faso. *Discover Sustainability*, 6(1), 234. <https://doi.org/10.1007/s43621-025-00868-9>
- Sanou, J., Bationo, B. A., Barry, S., Nabie, L. D., Bayala, J., & Zougmore, R. (2016). Combining soil fertilization, cropping systems and improved varieties to minimize climate risks on farming productivity in northern region of Burkina Faso. *Agriculture & Food Security*, 5(1), 20. <https://doi.org/10.1186/s40066-016-0067-3>
- Savadogo, M., Somda, J., Seynou, O., Zabré, S., & Nianogo, A. J. (2011). *Catalogue des bonnes pratiques d'adaptation aux risques climatiques au Burkina Faso*. Ouagadougou, Burkina Faso: UICN Burkina Faso.
- Sawadogo, H. (2011). Using soil and water conservation techniques to rehabilitate degraded lands in northwestern Burkina Faso. *International Journal of Agricultural Sustainability*, 9(1), 120–128. <https://doi.org/10.3763/ijas.2010.0552>
- Simtowe, F., Amondo, E., Marenja, P., Rahut, D., Sonder, K., & Erenstein, O. (2019). Impacts of drought-tolerant maize varieties on productivity, risk, and resource use: Evidence from Uganda. *Land Use Policy*, 88, 104091. <https://doi.org/10.1016/j.landusepol.2019.104091>
- Sithole, M., Musafiri, C. M., Kiboi, M., Sales, T., & Ngetich, F. K. (2022). The Role of Agricultural Projects in Building Sustainable and Resilient Maize Value Chain in Burkina Faso. *Sustainability*, 15(24), 16684. <https://doi.org/10.3390/su152416684>
- Teklewold, H., Kassie, M., Shiferaw, B., & Köhlin, G. (2013). Cropping system diversification, conservation tillage and modern seed adoption in Ethiopia: Impacts on household income, agrochemical use and demand for labor. *Ecological Economics*, 93, 85–93. <https://doi.org/10.1016/j.ecolecon.2013.05.002>
- Thiombiano, M., & Ouedraogo, A. R. (2025). Effect of agricultural diversification on food security in Burkina Faso: A conditional mixed process approach. [https://doi.org/10.53936/afjare.2025.20\(3\).15](https://doi.org/10.53936/afjare.2025.20(3).15)
- Tovihoudji GP, Diogo RVC, Abiola AW, Akoha BRMF and Godau T. (2022). Profitability and agronomic potential of cotton (*Gossypium hirsutum* L.) under biochar-compost-based amendments in three agroecological zones of northern Benin. *Front. Sustain. Food Syst.* 6:1036133. doi: 10.3389/fsufs.2022.1036133
- Traoré, A., Yameogo, L. P., Olivier DJINDIERE, K. T., BAZONGO, P., & TRAORE, O. (2021). Effets comparés du tourteau de neem [*Azadirachta indica* (A. Juss)] et du compost sur le rendement du sorgho [*Sorghum bicolor* (L. Moench)] en zone Sud-soudanienne du Burkina Faso. *J. Appl. Biosci.*, 163, 16834-16845.

- Trisos, C.H., I.O. Adelekan, E. Totin, A. Ayanlade, J. Efitre, A. Gameda, K. Kalaba, C. Lennard, C. Masao, Y. Mgaya, G. Ngaruiya, D. Olago, N.P. Simpson, and S. Zakieldean, 2022: Africa. In: *Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* [H.-O. Pörtner, D.C. Roberts, M. Tignor, E.S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, B. Rama (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA, pp. 1285–1455, doi:10.1017/9781009325844.011.
- Tschora, H., & Cherubini, F. (2020). Co-benefits and trade-offs of agroforestry for climate change mitigation and other sustainability goals in West Africa. *Global Ecology and Conservation*, 22, e00919. <https://doi.org/10.1016/j.gecco.2020.e00919>
- Vanlauwe, B., Bationo, A., Chianu, J., Giller, K. E., Merckx, R., Mokwunye, U., Ohiokpehai, O., Pypers, P., Tabo, R., Shepherd, K. D., Smaling, M. A., Woomer, P. L., & Sanginga, N. (2010). *Integrated Soil Fertility Management. Outlook on Agriculture*. <https://doi.org/10.5367/000000010791169998>
- Wenda, B. D. S., Njoya, H. M., Awoke, M. D., Kimaro, P. E., Sieber, S., & Löhr, K. (2025). *Integrated Soil Fertility Management for Sustainable Food Security: Evidence From Cameroon*. *Food and Energy Security*, 14(5), e70145.
- World Bank. (2025). *Burkina Faso Economic Update, April 2025 [Special Chapter: Energy for Economic Growth]*. <https://documents1.worldbank.org/curated/en/099070725193540162/pdf/P507242-d1d2d1e3-c63b-49ba-a5da-c9994d3e747a.pdf>
- Wossen, T., Abdoulaye, T., Alene, A., Feleke, S., Menkir, A., & Manyong, V. (2017). Measuring the impacts of adaptation strategies to drought stress: The case of drought tolerant maize varieties. *Journal of Environmental Management*, 203, 106-113. <https://doi.org/10.1016/j.jenvman.2017.06.058>
- Yaméogo, J. T., Somé, A. N., Mette Lykke, A., Hien, M., & Nacro, H. B. (2013). Restauration des potentialités de sols dégradés à l'aide du zaï et des cordons pierreux à l'Ouest du Burkina Faso. *Tropicultura*, 31(4).
- Zongo, K. F., Dabiré, K., Kaboré, S. A., Tondé, M., Guébré, D., Sanon, A., & Hien, E. (2024). Effects of Organic Compost and *Trichoderma harzianum* Spores on Soil Fertility and Agronomic Performance of Soybean (*Glycine max* (L.) Merr.). *International Journal of Environment and Climate Change*, 14(9), 705-717.
- Zongo, K. F., Nandkangre, H., Sanon, A., Gouba, M., Guebre, D., Kambou, D. J., ... & Ouedraogo, M. (2023). Improvement of Bambara Groundnut Productivity using Organic Manure Fertilization Doses on Plinthite Soil in sub-Saharan Agrosystem of Burkina Faso. *Nigeria Agricultural Journal*, 54(1), 451-458.
- Zonou, B., Nacoulma, Y. R., Guengane, R., & Sanogo, S. (2023). Adoption des semences certifiées de variétés améliorées de riz dans la région du Centre au Burkina Faso: Enjeux et défis. *International Journal of Biological and Chemical Sciences*, 17(7), 2689-2710.
- Zubairu, A. M., Michéli, E., Ocansey, C. M., Boros, N., Rétháti, G., Lehoczky, É., & Gulyás, M. (2023). *Biochar Improves Soil Fertility and Crop Performance: A Case Study of Nigeria*.

Soil Systems, 7(4), 105. <https://doi.org/10.3390/soilsystems7040105> Zouré, C. O., Sy, T., Coulibaly, A., Rouamba, I. F., Kindo, B., Bazyomo, D., Ouédraogo, R. M., Drabo, P. H., & Ouédraogo, O. (2025). On the Performance of Traditional Agroecological Practices in Mitigating the Effects of Climate Variability on Ecosystems: A Case Study in Northern Burkina Faso. *Applied and Environmental Soil Science*. <https://doi.org/10.1155/aess/8855588>

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