

Interdependent Futures

Aligning Conservation, Agriculture, and
Technology for Resilient Systems

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Interdependent Futures: Aligning Conservation, Agriculture, and Technology for Resilient Systems

Author: Dr. David Bergvinson, DevGlobal

Reviewers: David Gadsden, Matt Manning

Editor: Laura Guzmán

Research Support: Sophie Barrowman

DevGlobal LLC

Edmonds, Washington, USA

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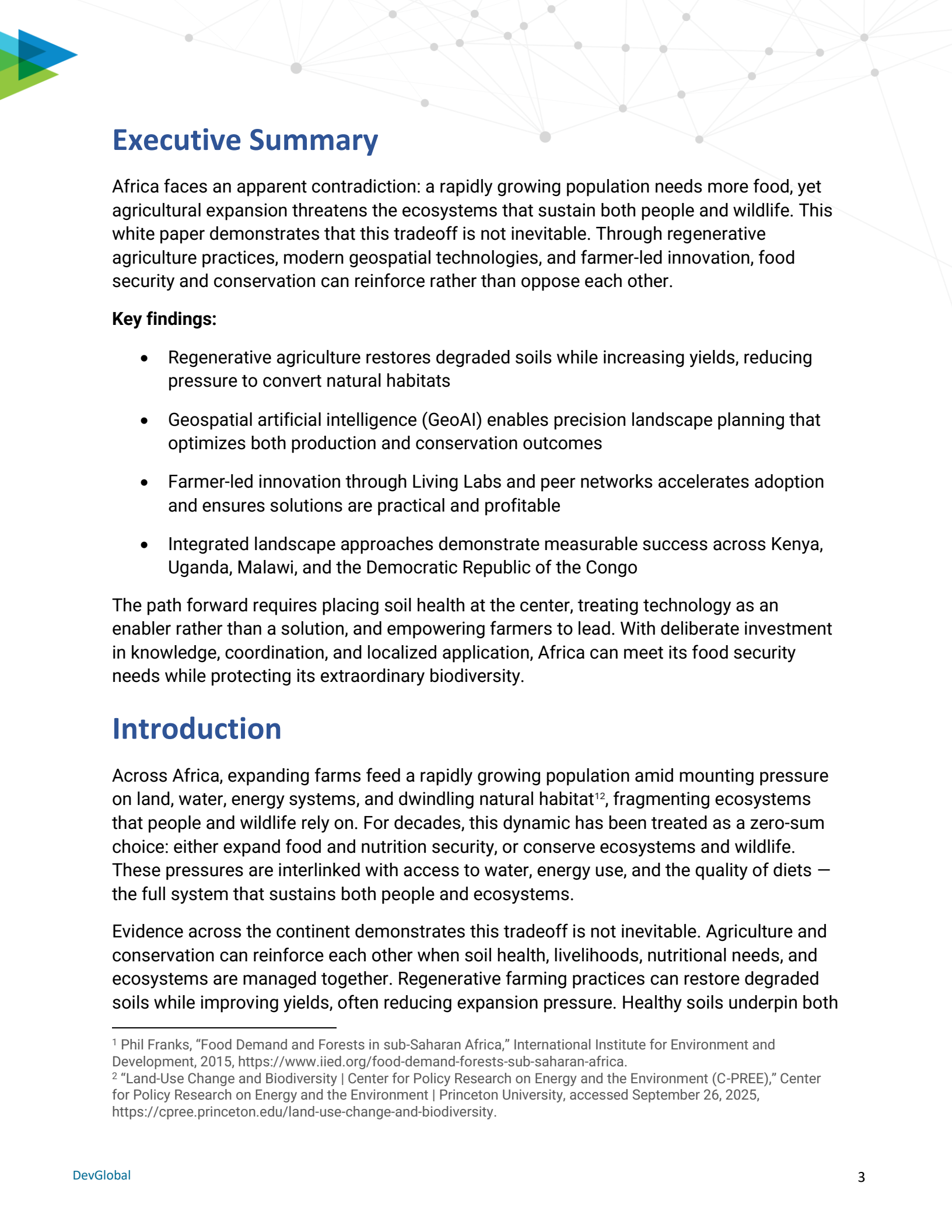
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Executive Summary

Africa faces an apparent contradiction: a rapidly growing population needs more food, yet agricultural expansion threatens the ecosystems that sustain both people and wildlife. This white paper demonstrates that this tradeoff is not inevitable. Through regenerative agriculture practices, modern geospatial technologies, and farmer-led innovation, food security and conservation can reinforce rather than oppose each other.

Key findings:

- Regenerative agriculture restores degraded soils while increasing yields, reducing pressure to convert natural habitats
- Geospatial artificial intelligence (GeoAI) enables precision landscape planning that optimizes both production and conservation outcomes
- Farmer-led innovation through Living Labs and peer networks accelerates adoption and ensures solutions are practical and profitable
- Integrated landscape approaches demonstrate measurable success across Kenya, Uganda, Malawi, and the Democratic Republic of the Congo

The path forward requires placing soil health at the center, treating technology as an enabler rather than a solution, and empowering farmers to lead. With deliberate investment in knowledge, coordination, and localized application, Africa can meet its food security needs while protecting its extraordinary biodiversity.

Introduction

Across Africa, expanding farms feed a rapidly growing population amid mounting pressure on land, water, energy systems, and dwindling natural habitat¹², fragmenting ecosystems that people and wildlife rely on. For decades, this dynamic has been treated as a zero-sum choice: either expand food and nutrition security, or conserve ecosystems and wildlife. These pressures are interlinked with access to water, energy use, and the quality of diets – the full system that sustains both people and ecosystems.

Evidence across the continent demonstrates this tradeoff is not inevitable. Agriculture and conservation can reinforce each other when soil health, livelihoods, nutritional needs, and ecosystems are managed together. Regenerative farming practices can restore degraded soils while improving yields, often reducing expansion pressure. Healthy soils underpin both

¹ Phil Franks, "Food Demand and Forests in sub-Saharan Africa," International Institute for Environment and Development, 2015, <https://www.iied.org/food-demand-forests-sub-saharan-africa>.

² "Land-Use Change and Biodiversity | Center for Policy Research on Energy and the Environment (C-PREE)," Center for Policy Research on Energy and the Environment | Princeton University, accessed September 26, 2025, <https://cpree.princeton.edu/land-use-change-and-biodiversity>.



ecological integrity and food nutrient density, linking farm-level management to public health outcomes. Farmer-led innovation can spread solutions through peer-to-peer networks. Advances in geospatial mapping and artificial intelligence, when augmented by human insights, enable precision targeting of interventions, dependency modeling, and outcome monitoring.

This paper explores the evidence and ongoing work that bridges efforts to strengthen nutrition security and protect biodiversity. It shows that moving from an oppositional view to integration requires three elements: placing soil health—and its links to water and nutrition—at the center, treating technology as an enabler, and ensuring farmers are empowered to lead.

1. The Stakes: Diverse ecosystems, food security and sustainable development

Africa holds a large share of the world's biodiversity: one-quarter of all mammal species, one-fifth of bird species, and at least one-sixth of all plants are found here. The continent's ecosystems also sustain people directly, with forests alone providing about one-fifth of household income in many countries, while wild foods and fisheries contribute to the health of millions.³ These ecosystems are globally significant to climate as well. Africa is home to one-sixth of the world's remaining forests, including the Congo Basin, which absorbs 1.5 billion tons of carbon dioxide per year⁴ – more than the entire continent emits⁵.

At the same time, as population grows, so does the need for affordable and nutritious food. Globally, food demand is expected to increase by 50% by 2050.⁶ In Africa, current projections suggest that meeting Africa's increased food needs could mean converting 200 million more hectares of natural habitat into farmland by 2050.⁷ Food and nutrition security depend on water availability, energy access, and the nutritional quality of diets, all of which are tightly linked to ecosystem health. As soils degrade and water becomes scarcer, both agricultural productivity and nutritional outcomes decline.

³ "African Biodiversity Loss a Risk to Human Security." *Africa Center for Strategic Studies*, April 22, 2024. <https://africacenter.org/spotlight/african-biodiversity-loss-risk-human-security/>

⁴ "Critical Ecosystems: Congo Basin Peatlands," UN Environment Programme, February 27, 2023, <https://www.unep.org/news-and-stories/story/critical-ecosystems-congo-basin-peatlands>.

⁵ AJLabs, "How Much Does Africa Contribute to Global Carbon Emissions?," Al Jazeera, 2023, <https://www.aljazeera.com/news/2023/9/4/how-much-does-africa-contribute-to-global-carbon-emissions>.

⁶ "Regenerative Food Systems," The Nature Conservancy, accessed September 26, 2025, <https://www.nature.org/en-us/what-we-do/our-priorities/provide-food-and-water-sustainably/food-and-water-stories/regenerative-food-systems/>.

⁷ FAO. 2023. *In Brief to The State of Food and Agriculture 2023. Revealing the true cost of food to transform agrifood systems*. Rome. <https://doi.org/10.4060/cc7937en>

⁸ Zia Mehrabi et al., "Research Priorities for Global Food Security under Extreme Events," *One Earth* (Cambridge, Mass.) 5, no. 7 (2022): 756–66, <https://doi.org/10.1016/j.oneear.2022.06.008>.



Meeting these growing food and nutrition needs could threaten Africa's rich biodiversity. Africa holds 60% of the world's remaining arable land, and over 60% of Africa's working population is engaged in agriculture.⁹ Expanding agricultural production across the continent could accelerate biodiversity and ecosystem loss, with 2020 estimates pointing to agriculture already being responsible for 80% of global deforestation.¹⁰

Beyond habitat loss, agriculture is a major driver of greenhouse gas emissions. In Africa, an estimated 43% of CO₂ emissions are caused by land clearing for agricultural use, and 316 billion tons of CO₂ equivalent are stored in topsoil at risk from degradation.¹¹ Water scarcity compounds these pressures. Agriculture accounts for about 70% of freshwater withdrawals globally,¹² and in many African regions, degraded watersheds and erratic rainfall threaten both irrigation and drinking water access.¹³ Protecting forests, soils, and wetlands is therefore also an investment in water security.

This trajectory is untenable. Meeting future nutrition needs cannot come at the expense of the ecosystems that make agriculture possible. Just as living soils differ from depleted dirt, resilient systems depend on living landscapes that sustain water, biodiversity, and the nutrient cycles that underpin human health. A new approach is urgently needed, one that aligns food security with ecological integrity.

Agriculture & Conservation, why now?

Per IUCN's [2024 report on agriculture and conservation](#), agriculture is a key player in reducing global extinction risk — driving 42% of the global extinction-risk reduction opportunity.

Changing how we do agriculture can have positive climate impacts as well. Smarter land allocation can deliver +22% GHG mitigation and +30% biodiversity with no loss of returns. Repurposing \$160 billion per year of harmful agriculture support could avoid 27 million hectares conversion and cut 1.5% of agriculture's greenhouse gas emissions.

This apparent contradiction — the rapidly growing need for food and the threats to conservation — has seemed intractable, creating institutional silos that will not serve us looking ahead to the future. Indeed, as the International Institute for Sustainable Development notes, "management approaches that consider agriculture, forestry, biodiversity and poverty alleviation as separate issues or in 'silos' do not suffice. The scale of the global

⁹ African Development Bank Group, "Feed Africa," n.d., accessed September 26, 2025, https://www.afdb.org/fileadmin/uploads/afdb/Documents/Generic-Documents/Brochure_Feed_Africa_-En.pdf.

¹⁰ "WWF Impact Investing: Regenerative Agriculture | Pages | WWF," World Wildlife Fund, accessed September 26, 2025, <https://www.worldwildlife.org/pages/wwf-impact-investing-regenerative-agriculture>.

¹¹ PwC and Rockefeller Foundation, *Agricultural Carbon Markets: Opportunities and Challenges for sub-Saharan Africa* (2011).

¹² FAO. 2020. "The State of Food and Agriculture 2020." www.fao.org. 2020. <https://www.fao.org/interactive/state-of-food-agriculture/2020/en/>.

¹³ David Michel, "Building Resilient Water Systems in sub-Saharan Africa," Center for Strategic and International Studies, July 25, 2025, <https://www.csis.org/analysis/building-resilient-water-systems-sub-saharan-africa>.



challenges is too great; there is a need for genuinely integrated approaches.”¹⁴

The siloing trend has been shifting, with an expanding field of practitioners, academics, farmers and communities exploring integrated approaches, leveraging digital technologies and centering farmer expertise.

1.1 Growing Alongside Others

The integration of conservation and agriculture has been foundational to many organizations, community groups, and academics. The mounting urgency of today's environmental and food security challenges makes revisiting this integration both timely and essential.

McNeely and Scherr's (2001) seminal work introduced "eco-agriculture," arguing that agricultural productivity and biodiversity conservation cannot be treated as separate domains. Protected areas alone are insufficient to halt biodiversity loss when surrounded by farmland pressures. They laid out practical strategies—increasing productivity on existing farmland, embedding habitat and corridors into farm mosaics, and adopting reduced-input practices—demonstrating how farms can serve ecological functions. This framing set the stage for integrated landscape approaches, positioning farmers as central actors in sustaining both food systems and ecosystems.¹⁵

The Jane Goodall Institute's Tacare program offers a compelling model for integrated conservation. Through participatory land-use planning combined with geospatial mapping tools, Tacare enabled local farmers to design land-use systems supporting both agricultural productivity and habitat restoration in service of improved livelihoods (Jane Goodall Institute, 2022). When people are given the means to manage their landscapes with precision, conservation and agriculture reinforce rather than compete with one another.¹⁶

Organizations like the African Wildlife Foundation¹⁷, Conservation International¹⁸, and the World Wildlife Fund¹⁹, among others, have piloted production-protection landscapes that link sustainable production with nature conservation, embed wildlife corridors within

¹⁴ James Reed et al., "What Are 'Integrated Landscape Approaches' and How Effectively Have They Been Implemented in the Tropics: A Systematic Map Protocol," *Environmental Evidence* 4, no. 1 (2016): 2, <https://doi.org/10.1186/2047-2382-4-2>.

¹⁵ Jeffrey A McNeely and Sara J Scherr, *Common Ground, Common Future: How Ecoagriculture Can Help Feed the World and Save Wild Biodiversity*, 2001.

¹⁶ Jane Goodall Institute, *Local Voices, Local Choices: The Tacare Approach to Community-Led Conservation* | Esri Press (2022), <https://www.esri.com/en-us/esri-press/browse/local-voices-local-choices-the-tacare-approach-to-community-led-conservation>.

¹⁷ African Wildlife Foundation, "Agriculture and Conservation Can Be Complementary," 2024, <https://www.awf.org/news/agriculture-and-conservation-can-be-complementary>.

¹⁸ "Expanding Nature-Positive Economies," accessed September 30, 2025, <https://www.conservation.org/priorities/expanding-nature-positive-economies>.

¹⁹ "In the Salonga National Park, 'Model Farms' Initiated by WWF Help Population Embrace Conservation," accessed September 30, 2025, <https://www.wwf.org/en/?25661/In-the-Salonga-National-Park--model-farms-initiated-by-WWF-help-population-embrace-conservation-agriculture>.



farming systems, encourage farming practices that reduce human-wildlife conflict, and more.

Other groups, like the 1000 Landscapes for 1 Billion People (1000L) and EcoAgriculture Partners are bringing together a group of practitioners on the ground to intentionally disrupt historical silos.²⁰ Through capacity strengthening, novel finance mechanisms, improved technology, and the development of local and national coalitions they are implementing integrated solutions that consider both increasing agricultural needs and ecosystem

Inclusive Conservation: Learning from the Past

Early models of conservation often excluded or displaced Indigenous peoples and local communities from the lands they had stewarded for generations. Today, many organizations are working to redress this history by advancing rights-based, community-led approaches that recognize Indigenous and local peoples as central to the stewardship of biodiversity and climate resilience.

When conservation initiatives draw on traditional ecological knowledge and strengthen local land tenure and livelihoods, outcomes for both people and ecosystems improve

health.²¹ As one 1000L Kenyan farmer, David Kuria, noted, “people will extract from the forest at any cost if we continue talking about forests but we do not include agriculture in the conversation. All of these components must unite together to create true transformation.”²²

Groups like CGIAR network, including ICRAF/World Agroforestry and the Alliance of Bioversity International and CIAT are advancing agroforestry and climate-smart agricultural practices that restore soils and increase productivity — thereby reducing the need to expand farmland. For example, the Accelerating Impacts of CGIAR Climate Research for Africa (AICCRA),

led by the Alliance of Bioversity International and CIAT, recently reached over 4 million farmers across Africa. AICCRA has provided access to climate information and innovations that visibly enhance resilience and productivity for smallholder farmers, demonstrating large-scale success in the integration of conservation, agroforestry, and climate adaptation.²³

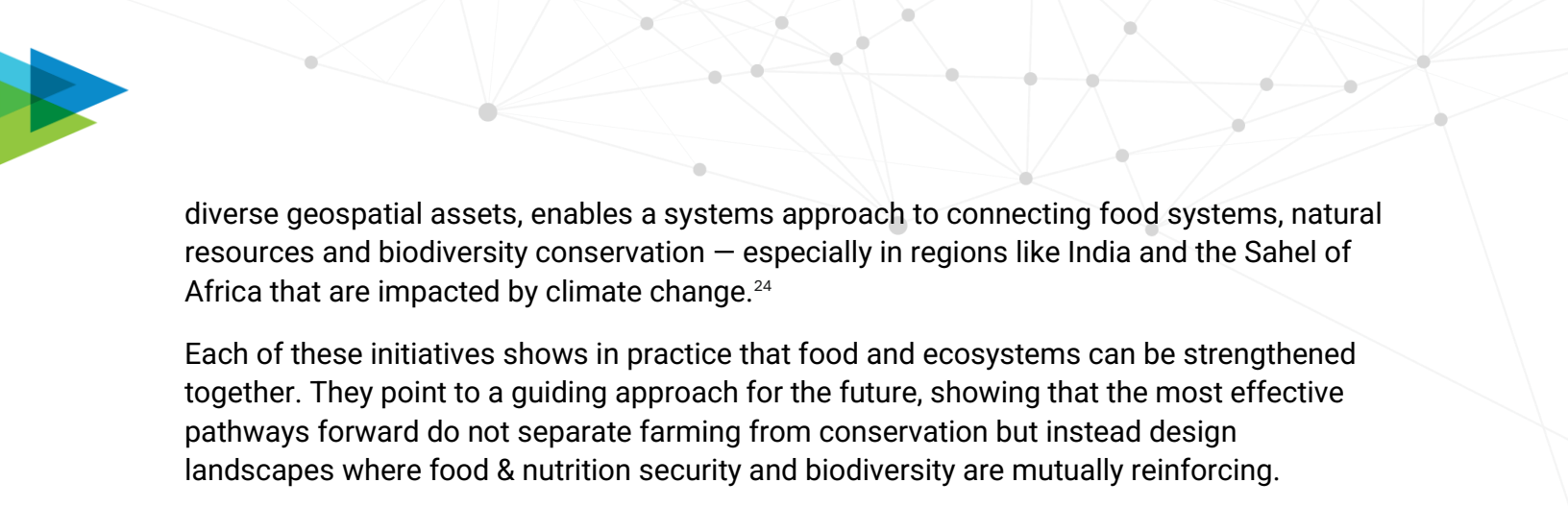
Finally, technical hubs such as ICRISAT’s iHUB and partnerships with geospatial leaders like Esri are bringing precision mapping and farmer-led innovation into practice. Integrating

²⁰ Ecoagriculture Partners, “IntegratedLandscapeManagementforPolicymakers_Brief_Final_Oct24_2013_smallfile,” 2013, https://www.un.org/esa/ffd/wp-content/uploads/sites/2/2015/10/IntegratedLandscapeManagementforPolicymakers_Brief_Final_Oct24_2013_smallfile.pdf.

²¹ “Home - 1000 Landscapes for 1 Billion People at 1000 Landscapes for 1 Billion People,” 1000 Landscapes for 1 Billion People, accessed September 30, 2025, <https://landscapes.global/>.

²² 1000 Landscapes for 1 Billion People, “Lari Landscape, Kenya: Cooperation Sows Benefits for Livelihoods and Ecosystems,” Landscapes. Global, accessed October 3, 2025, <https://stories.landscapes.global/kenvo-lari-kenya>.

²³ “Resilience through Climate Action | Annual Report 2023.” 2023. Alliance Bioversity International - CIAT. 2023. <https://alliancebioversityciat.org/2023-annual-report/climate>.



diverse geospatial assets, enables a systems approach to connecting food systems, natural resources and biodiversity conservation — especially in regions like India and the Sahel of Africa that are impacted by climate change.²⁴

Each of these initiatives shows in practice that food and ecosystems can be strengthened together. They point to a guiding approach for the future, showing that the most effective pathways forward do not separate farming from conservation but instead design landscapes where food & nutrition security and biodiversity are mutually reinforcing.

2. Regeneration, Innovation, and Local Leadership as the Path Forward

To further deepen this integration of agriculture and conservation, we propose a three-fold focus. First, soil health must be treated as the foundation of both productive farming and resilient ecosystems. Second, new technologies — from Earth observation (EO) to artificial intelligence — can act as enablers that bring precision and scale to integrated approaches. And third, long-term success depends on farmer ownership and leadership in pragmatic innovation, ensuring that solutions are practical, profitable, and rooted in local knowledge. The following sections examine each of these elements in turn.

2.1 The role of regenerative agriculture: Foundations in soil and ecosystem health

The foundation of this symbiosis can be found in regenerative and other sustainable agriculture practices, philosophies of farming that work with, rather than against, nature's biological processes.²⁵ A central principle is that soil health is ecosystem health. Unlike conventional systems that often reduce soil organic carbon and disrupt belowground biodiversity, regenerative practices seek to rebuild both soil carbon stocks and the diversity of soil organisms that sustain nutrient cycling and resilience. Across the literature, terms like 'regenerative,' 'sustainable,' or 'conservation agriculture' are often used interchangeably. While they differ in emphasis, they all share a focus on context-appropriate, responsible choices that sustain soil, water, biodiversity, and people.

One reason regenerative agriculture is critical for Africa is its potential to boost productivity of rainfed environments through increased soil carbon capture. Crop yields in sub-Saharan Africa persistently remain among the lowest, and over the past four decades most increases in food production have come from expanding cropland rather than improving

²⁴ Tahira Carter, "ICRISAT Unveils Groundbreaking Study on Geospatial Mapping for Sustainable Agriculture in South Asia," The International Crops Research Institute for the Semi-Arid Tropics, September 5, 2024, <https://pressroom.icrisat.org/icrisat-unveils-groundbreaking-study-on-geospatial-mapping-for-sustainable-agriculture-in-south-asia>.



yields.²⁶ This reliance on land expansion has come at the cost of forests, savannahs, and other habitats rich in biodiversity.²⁷ Raising yields through practices that also restore soils and ecosystems is therefore essential. Improving yields through sustainable intensification can relieve expansion pressure on forests and habitats.^{28 29}

Regenerative agriculture practices can also turn farms into powerful tools for climate action.³⁰ African agricultural soils, many of which have lost 20-50% of their original carbon,³¹ have the potential to sequester carbon each year by adopting these methods.³²

Regenerative Agriculture in Practice

Key regenerative farming practices include:

- **Minimal soil disturbance:** No-till practices protect the intricate underground networks of life, reduce erosion, and preserve soil structure.³³ This needs to be augmented by inputs that reduce soil compaction and increase moisture infiltration and oxygen exchange in the soil profile.
- **Crop rotations and diversification:** Planting diverse crops in a managed manner increases the resilience of the farming system, improving soil structure, nutrient cycling, and water-use efficiency without reducing yields. In water-limited environments, diversified systems have been shown to help retain soil moisture and stabilize productivity across seasons.³⁴
- **Cover cropping:** Where appropriate, depending on crop type and ecosystem, planting diverse cover crops keeps the soil covered year-round to sustain the soil microbiome, creating habitat for birds and beneficial insects while replenishing organic matter. Studies have shown farms using cover crops promote pollinator

²⁶ Hannah Ritchie, "Increasing Agricultural Productivity across sub-Saharan Africa Is One of the Most Important Problems This Century," Our World in Data, April 4, 2022, <https://ourworldindata.org/africa-yields-problem>.

²⁷ FAO, "The State of Food and Agriculture 2020," www.fao.org, 2020, <https://www.fao.org/interactive/state-of-food-agriculture/2020/en/>.

²⁸ Maxwell Gomera and Edward Mabaya, "Farmland Expansion Is a Significant Risk to Our Planet's Health. But There Is a Solution," World Economic Forum, July 11, 2018, <https://www.weforum.org/stories/2018/07/killer-farms/>.

²⁹ Peter Potapov et al., "Global Maps of Cropland Extent and Change Show Accelerated Cropland Expansion in the Twenty-First Century," *Nature Food* 3, no. 1 (January 1, 2022): 19–28, <https://doi.org/10.1038/s43016-021-00429-z>.

³⁰ Richard Gledhill et al., "Agricultural Carbon Markets: Opportunities and Challenges for sub-Saharan Africa," 2011, <https://www.pwc.co.uk/assets/pdf/agricultural-carbon-markets.pdf>.

³¹ Edzo Veldkamp et al., "Deforestation and Reforestation Impacts on Soils in the Tropics," *Nature Reviews Earth & Environment* 1, no. 1 (September 15, 2020): 1–16, <https://doi.org/10.1038/s43017-020-0091-5>.

³² Arun Khatri-Chhetri, Ciniro Costa Junior, and Eva Wollenberg, "Greenhouse Gas Mitigation Co-Benefits across the Global Agricultural Development Programs," *Global Environmental Change* 76, no. 102586 (September 2022), <https://doi.org/10.1016/j.gloenvcha.2022.102586>.

³³ Bertrand, Savannah, Anna Sophia Roberts, and Emma Walker. "No-till Farming Improves Soil Health and Mitigates Climate Change | Article | EESI." www.eesi.org, March 28, 2022. <https://www.eesi.org/articles/view/no-till-farming-improves-soil-health-and-mitigates-climate-change>.

³⁴ Xiaolin Yang et al., "Diversifying Crop Rotation Increases Food Production, Reduces Net Greenhouse Gas Emissions and Improves Soil Health," *Nature Communications* 15, no. 1 (January 3, 2024): 198, <https://doi.org/10.1038/s41467-023-44464-9>.



activity, support beneficial insect populations important to natural pest control³⁵, and retain higher soil microbiome populations and diversity key to healthy soil ecosystems.³⁶

- **Agroforestry:** Strategically integrating trees into farms creates wildlife corridors, provides alternative income from fruit or timber, and enhances soil health.³⁷ In the case of some high-value crops, like coffee or fruit trees, this integration has been shown to have multiple benefits – increased nutritional and economic security, improved soil health, and increased biodiversity.³⁸

Major communities and organizations are implementing these practices and reaping the mutual benefits to food security and conservation. For example, World Wildlife Fund (WWF) has developed a regenerative agriculture portfolio through its Impact Investing Initiative, which channels capital into farming systems that restore soil, improve water retention, and enhance worker welfare. Their Nature-Based Solutions Accelerator is working with partners to help farmers transition toward regenerative practices that improve soil fertility, biodiversity, and resilience while reducing reliance on synthetic inputs.³⁹

Similarly, the Sasakawa Africa Association works together with farmers to increase their income and food and nutrition security through the promotion of market-oriented, sustainable, resilient, and regenerative and nutrition-sensitive agricultural innovations.

Efforts such as these illustrate how regenerative agriculture is moving from concept to practice at scale, with lessons that are highly relevant for Africa's landscapes.

The Importance of Context

To broaden the uptake of these practices and ensure their effective use, it's critical to understand them within local contexts.⁴⁰ For example, some research shows that likelihood of crop diversification benefitting both conservation and yield depends strongly on context: crop type, climate, market opportunities, and management choices shaped outcomes. Diversification strategies that combine multiple elements – such as intercropping with cover crops, integrating crops and livestock, or minimizing expensive, synthetic

³⁵ Foltz Jordan, Sarah, Karin Jokela, Naomy Candelaria, Mary Rogers, and Julie Grossman. "Pollinator-Friendly Cover Cropping for Vegetable Producers in the Upper Midwest - SARE North Central." SARE North Central, July 29, 2025. <https://northcentral.sare.org/resources/pollinator-friendly-cover-cropping-for-vegetable-producers-in-the-upper-midwest/>.

³⁶ Castellano-Hinojosa, Antonio, and Sarah L. Strauss. "Impact of Cover Crops on the Soil Microbiome of Tree Crops." *Microorganisms* 8, no. 3 (February 26, 2020): 328. <https://doi.org/10.3390/microorganisms8030328>.

³⁷ Fergus Sinclair et al., "The Contribution of Agroecological Approaches to Realizing Climate-Resilient Agriculture," 2019, <https://gca.org/wp-content/uploads/2020/12/TheContributionsOfAgroecologicalApproaches.pdf>.

³⁸ Luís, Jose, Escobar Guevara, and Boris Fernández Arancibia. "Innovations to Promote Adoption of Coffee Agroforestry in Bolivia: The Role of ASOCAFE," 2025. <https://www.iied.org/sites/default/files/pdfs/2025-05/22641g.pdf>.

³⁹ "Resilience through Climate Action | Annual Report 2023," Alliance Bioversity International - CIAT, 2023, <https://alliancebioversityciat.org/2023-annual-report/climate>.

⁴⁰ Christian Thierfelder et al., "Conservation Agriculture in Southern Africa: Advances in Knowledge," *Renewable Agriculture and Food Systems* 30, no. 4 (February 19, 2014): 328–48, <https://doi.org/10.1017/s1742170513000550>.



agrochemicals — were more likely to generate positive outcomes for both biodiversity and yields.⁴¹

Similarly, research in Southern Africa shows that while conservation agriculture's three core principles can have positive ecosystem effects, it is not a "one-size-fits-all" solution: challenges to adoption include residue availability, weed and pest control, farmer perceptions, and economic barriers.⁴²

Taken together, these findings point to a need to pilot, measure and localize these broader practices.

The Economics of Regenerative Agriculture

For any model to scale, it must be profitable — this is the key to success. The business case for integrating conservation and agriculture is compelling at both a farm and landscape level.

At the farm level, farmers who adopt regenerative practices can realize increased profitability through reduced input costs, increased yields and increased resilience.⁴³ New income streams can also be realized (e.g., from water conservation⁴⁴ and carbon sequestration.⁴⁵ For example, a 24-study synthesis spanning 2,655 farms across 11 countries found that using multiple diversification strategies (e.g., rotations, non-crop habitat, soil conservation, water conservation, and livestock integration) was associated with consistent "win-wins": higher food security and human well-being, with yields maintained or increased, especially when several practices were combined.⁴⁶

At the landscape level, the returns may be greater. Recent research by the IUCN shows that biodiversity-friendly policies could add around \$150 billion to global GDP each year, while continued degradation could cost the agriculture sector roughly \$100 billion annually. Core ecosystem services such as pollination and crop genetic diversity already represent hundreds of billions of dollars in value, with pollination alone underpinning roughly three-

⁴¹ Sarah K. Jones et al., "Achieving Win-Win Outcomes for Biodiversity and Yield through Diversified Farming," *Basic and Applied Ecology* 67 (March 2023): 14–31, <https://doi.org/10.1016/j.baae.2022.12.005>.

⁴² Christian Thierfelder et al., "Conservation Agriculture in Southern Africa: Advances in Knowledge," *Renewable Agriculture and Food Systems* 30, no. 4 (February 19, 2014): 328–48, <https://doi.org/10.1017/s1742170513000550>.

⁴³ "Achieving Economic Balance with Regenerative Agriculture," Alliance Bioversity International - CIAT, November 1, 2024, <https://alliancebioversityciat.org/stories/achieving-economic-balance-regenerative-agriculture>.

⁴⁴ "Agricultural Stewardship Tax Credit | Department of Agriculture," Colorado.gov, 2022, <https://ag.colorado.gov/ag-stewardship-tax>.

⁴⁵ Richard Gledhill et al., "Agricultural Carbon Markets: Opportunities and Challenges for sub-Saharan Africa," 2011, <https://www.pwc.co.uk/assets/pdf/agricultural-carbon-markets.pdf>.

⁴⁶ Laura Vang Rasmussen et al., "Joint Environmental and Social Benefits from Diversified Agriculture," *Science (New York, N.Y.)* 384, no. 6691 (April 5, 2024): 87–93, <https://doi.org/10.1126/science.adj1914>.



quarters of global crops.⁴⁷ Furthermore, wildlife-compatible agriculture can bolster ecotourism, a major source of regional employment and revenue.⁴⁸

2.2 The role of technology: Precision tools for integrated landscapes

Achieving this vision of an integrated, regenerative landscape requires a level of precision in planning and management that has historically not been possible. Technology can provide the means to apply these practices at scale.

For example, digital and geospatial tools can enable more efficient use of agricultural inputs, reducing fertilizer and pesticide over-application and limiting associated emissions and runoff. Remote sensing, drones, tracking collars, and camera traps when integrated with GIS can support the monitoring of land-use change and wildlife movements, informing the design of corridors that reduce human-wildlife conflict. At the same time, decision-support systems powered by Earth observation and artificial intelligence can match crops and varieties to local soils and climates, increasing yields and lowering production risks.

The Landscape of Geospatial Tools & Technologies

The variety of technologies and digital tools that can be applied to agriculture and conservation efforts is broad. Here, we survey geospatial and AI technologies in particular and map the impact their adoption can have upon regenerative agriculture practice uptake, conservation, and food security.

Modern **Earth observation and remote sensing technologies** make fine-scale monitoring feasible. For example, the Sentinel-2 satellite captures freely available 10-meter multispectral images that provide data on land and vegetation. It can provide detailed and multi-temporal data that helps farmers and conservationists monitor, manage, and protect agricultural lands more sustainably.⁴⁹

Landsat imagery adds a long, continuous record of Earth observation — with a 40+ year archive — allowing for the mapping of crop types, assessment of vegetation health, measurement of land-use change, and evaluation of water use and drought impacts.⁵⁰ Together, these systems offer a complementary toolkit for evidence-based decision-making at field, landscape, and regional scales.

Geospatial artificial intelligence (GeoAI) — the fusion of EO/GIS with machine learning (ML) — can enable farmers and researchers to conduct analyses that would be otherwise

⁴⁷ T.M. Brooks and J. Siikamäki, eds. Agriculture and Conservation. IUCN, International Union for Conservation of Nature, 2025. <https://doi.org/10.2305/AMHX3737>.

⁴⁸ “Economic Development | Amboseli Ecosystem Trust,” Amboseli Ecosystem, 2024, <https://amboseliecosystem.org/economic-development/>.

⁴⁹ Joel Segarra et al., “Remote Sensing for Precision Agriculture: Sentinel-2 Improved Features and Applications,” *Agronomy* 10, no. 5 (May 1, 2020): 641, <https://doi.org/10.3390/agronomy10050641>.

⁵⁰ NASA Landsat. “Agriculture & Food Security | Landsat Science,” November 30, 2021. <https://landsat.gsfc.nasa.gov/benefits/agriculture-food-security/>.



impossible without ML technologies. GeoAI enables researchers to classify crops, forecast yields, detect degradation, and prioritize restoration sites. Recent research suggests applications can materially accelerate climate mitigation across sectors — including agriculture and biodiversity conservation — highlighting both evaluative use cases (such as near real-time environmental monitoring from satellite data) and decision-support cases (like modeling for potential effects of agriculture-driven deforestation).⁵¹

One recent study in Thailand applied GeoAI techniques to assess the habitat suitability of vetiver grass (*Chrysopogon zizanioides*), an erosion-control grass species. Researchers integrated multiple datasets — land cover, bioclimatic variables, topography, and soil characteristics — into models to map where vetiver planting would be most effective. The analysis produced suitability maps with high accuracy, identifying areas where planting could trap sediment, reduce erosion, and enhance soil moisture. By combining satellite data, machine learning, and local environmental factors, the study demonstrated how GeoAI can provide decision-makers with evidence for targeting regenerative interventions.⁵²

People, Process, Data: Tech only delivers if all three line up

- People: Local farmers, conservationists, and institutions need the skills and ownership to act on insights.
- Process: Clear workflows are needed to turn maps and models into timely field decisions.
- Data: Access to reliable, up-to-date, and transparent datasets is the foundation.

Invest in these three pillars, and tools like GeoAI can shift from pilots to lasting impact.

As analyses move across plots, cities and watersheds, datasets arrive to analysts in different resolutions, timescales and geometries. Historically, we have mapped the world onto square grids, but nature rarely works in right angles. A **hexagonal indexing system**, like Uber Technology's H3, normalizes the inputs of varying resolutions and geometries while preserving ecological realism. The use of these hexagons, rather than square grids, reduces edge bias and maintains consistent neighbor

relationships, better approximating curved features such as rivers and wildlife corridors.⁵³ This newer indexing system offers unique advantages to the conservation-agriculture conversation.

⁵¹ Thavavel Vaiyapuri and Golden Julie, "AI and Geospatial Technologies for Climate Change Mitigation: Opportunities, Challenges, and Pathways to Sustainability," *Procedia Computer Science* 259 (May 12, 2025): 1346–55, <https://doi.org/10.1016/j.procs.2025.04.089>.

⁵² Yaowaret Jantakat et al., "Using GeoAI for Assessing Habitat Suitability of Vetiver Grass Planting to Support Soil and Water Conservation in Thailand," *Environment Asia* 18, no. Special Issue (March 1, 2025): 103–12, <https://doi.org/10.14456/ea.2025.26>.

⁵³ Helen McKenzie, "Hexagons for Location Intelligence: Why, When & How?," Carto.com, 2022, <https://carto.com/blog/hexagons-for-location-intelligence>.



It is important to note that technology alone is not enough. The impact of geospatial and AI tools depends on the quality of underlying data, the capacity of people and institutions to use them, and the processes that connect analysis to action.

Across Africa, challenges remain. Satellite coverage can be uneven, technical capacity is limited, and institutional “pipelines” for translating insights into practice are often weak. Research also highlights barriers specific to GeoAI,⁵⁴ including unequal data access, high computational demands, questions of model transparency, and privacy concerns. Ultimately, the value of these tools comes from their usability by local partners. Platforms like **Terraso**⁵⁵ and resource hubs like **Digital Earth Africa** point to what this looks like in practice, providing shared mapping tools, knowledge repositories, and project management functions that enable farmer groups, conservation NGOs, and public authorities to plan together based on the same evidence.

Finally, turning analysis into action also means turning data into language people use. AI-powered translation and speech tools could be used to better localize guidance into Kiswahili, Amharic, Hausa, Kinyarwanda and other regional languages, so smallholders receive contextual advice in accessible terms. Lightweight, offline-capable models could further enable extension agents to translate maps and recommendations during meetings, closing the last-mile gap between GeoAI insights and practice.

2.3 The role of farmer leadership: Driving adoption and lasting change

Those best placed to localize regenerative practices and adopt context-appropriate technologies are the people who know the land best: local farmers, communities, and conservation practitioners. Peer-to-peer learning and exchange programs, like Living Labs and Farmer Field Schools have been shown to be more effective than traditional approaches, like extension programs. These spaces are participatory, and learner-centered, rather than one-size-fits-all, top-down approaches. When engaged in collaboration, farmer uptake of new practices has been shown to be higher.⁵⁶ Digital tools such as SMS and WhatsApp groups also show promise in strengthening farmer networks and encouraging adoption of conservation-friendly practices.⁵⁷

For example, the 1000 Landscapes for 1 Billion People initiative convenes coalitions of farmers, NGOs, and governments to co-design integrated land-use strategies. Similarly, the previously mentioned Tacare program also illustrates this dynamic. Tacare’s foundation is

⁵⁴ Thavavel Vaiyapuri and Golden Julie, “AI and Geospatial Technologies for Climate Change Mitigation: Opportunities, Challenges, and Pathways to Sustainability,” *Procedia Computer Science* 259 (May 12, 2025): 1346–55, <https://doi.org/10.1016/j.procs.2025.04.089>.

⁵⁵ “Integrated Landscape Management Overview,” Terraso, September 28, 2021, <https://terraso.org/ilm-overview/>.

⁵⁶ Teatske Bakker, Patrick Dugué, and Stéphane de Tourdonnet, “Assessing the Effects of Farmer Field Schools on Farmers’ Trajectories of Change in Practices,” *Agronomy for Sustainable Development* 41, no. 2 (March 3, 2021), <https://doi.org/10.1007/s13593-021-00667-2>.

⁵⁷ Violet Lasdun et al., “Peer Learning and Technology Adoption in a Digital Farmer-To-Farmer Network,” *Journal of Development Economics*, March 1, 2025, 103496–96, <https://doi.org/10.1016/j.jdevco.2025.103496>.



built upon participatory land-use planning and farmer-led experimentation to restore habitats while improving food production. It links conservation objectives with improved livelihoods — both driven by the expertise and needs of local communities. Both efforts recognize that lasting conservation and food security gains depend on local ownership and farmer leadership.

The Living Labs model builds upon these principles. With an epistemological history crossing continents, Living Labs are uniquely dedicated to involving real end-users (here: farmers, communities, conservation practitioners) in the development, testing and implementation of solutions. They're particularly well-suited to "wicked problems," complex challenges that are difficult to define and resolve, and that implicate many stakeholders with competing interests — much like the opportunity at hand when exploring agriculture, food security and conservation needs.⁵⁸

Agriculture-focused Living Labs, such as [AgLivingLabs](#) in Kenya,⁵⁹ provide spaces where farmers test, validate, and refine conservation-promoting practices directly on their own land. This ensures that every intervention — whether a soil amendment, new crop variety, or digital tool — demonstrates a tangible economic and ecological benefit. These farms then become living classrooms where neighbors learn from neighbors, building networks of practice that scale organically. These farms also serve as critical ground-truthing sites for technologies like GeoAI-enabled systems, providing high-quality data that can be used to refine and localize AI models. In return, the farms could receive AI-powered recommendations that increase their productivity and natural resource improvements, creating a feedback loop that accelerates both innovation and adoption.⁶⁰

Ultimately, farmer leadership ensures that regenerative practices and technologies do not remain isolated pilots but become part of everyday farming systems. When farmers are central, solutions spread faster, last longer, and reshape the broader food and conservation landscape.

3. In Practice: Addressing food security and conservation in practice

This way forward is not a theoretical exercise. Across the continent, pioneering efforts are already proving that agriculture and conservation can be powerful allies.

- **Kenya:** In Kenya's Laikipia region, Ol Pejeta Conservancy has pioneered the integration of cattle, wildlife, and farming communities. Using AI-driven tracking, practicing managed grazing, and building strong community partnerships, they've

⁵⁸ European Network of Living Labs ENoLL et al., "Living Lab Origins, Developments, and Future Perspectives 2025," 2025, <https://doi.org/10.5281/zenodo.14764597>.

⁵⁹ Note: the authors of this paper are investors in AgLivingLabs

⁶⁰ AgLivingLabs, accessed October 7, 2025, <https://www.aglivinglabs.org/>.



reduced human-wildlife conflict, restored degraded pastures, and improved local livelihoods while conserving endangered species.⁶¹

- **Uganda:** In Uganda's Kidepo landscape, African Wildlife Foundation, Conservation International, and DADO launched a regenerative cotton initiative that pairs farmer training and climate-smart practices with landscape restoration. The program is designed to improve livelihoods while restoring degraded lands in and around protected areas — aligning soil health, biodiversity, and market access so production grows without pushing into wildlife habitat.⁶²
- **Malawi:** Agroecology programs link diversified farming with nutrition and community health in Malawi. Initiatives centering crop diversity, soil stewardship, and local food systems improved dietary quality and resilience while reducing input dependence. The work illustrates how agroecology can serve public health goals alongside conservation.⁶³
- **Democratic Republic of the Congo:** In the Bili-Uele landscape of the DRC, AWF supports participatory land-use planning that designated 4,527 km² of wildlife corridors and zoned areas for livelihoods, including agriculture, fishing, forest use, so that communities and wildlife could both persist. The project also recruited and trained 40 eco-guards in rights-based approaches. Early results show improved safety and stable elephant and chimpanzee populations where AWF works.⁶⁴

4. Conclusion & Recommendations

Evidence across practice and geographies shows that advancing conservation, water stewardship, and nutrition security alongside agricultural productivity is both feasible and beneficial. The combination of regenerative agriculture, geospatial/AI tools, and farmer leadership offers a practical path to higher yields, restored ecosystems, and resilience to climate shocks.

Proof points are growing, yet further scaling these practices requires deliberate investment in knowledge, coordination, and localized application. Real progress will depend on

⁶¹ Ol Pejeta Conservancy, "Harmony in the Wild: How AI Is Bridging the Gap between Humans, Cattle, and Wildlife - Ol Pejeta Conservancy," Ol Pejeta Conservancy, March 18, 2025, <https://www.olpejetaconservancy.org/2025/03/18/harmony-in-the-wild-how-ai-is-bridging-the-gap-between-humans-cattle-and-wildlife/>.

⁶² African Wildlife Foundation (AWF), "AWF, Conservation International & DADO Launch Regenerative Cotton Project in Uganda's Kidepo Landscape," African Wildlife Foundation, February 12, 2025, <https://www.awf.org/pressroom/awf-conservation-international-dado-launch-regenerative-cotton-project-ugandas-kidepo>.

⁶³ Moses Mosonsieyiri Kansanga et al., "Agroecology and Household Production Diversity and Dietary Diversity: Evidence from a Five-Year Agroecological Intervention in Rural Malawi," *Social Science & Medicine* 288, no. 113550 (November 2020): 113550, <https://doi.org/10.1016/j.socscimed.2020.113550>.

⁶⁴ African Wildlife Foundation (AWF), "New Wildlife Corridors Mapped and Eco-Guards Sensitized to Community Rights in the DRC's Bili-Uele Landscape," African Wildlife Foundation, 2024, <https://www.awf.org/news/new-wildlife-corridors-mapped-and-eco-guards-sensitized-community-rights>.



recognizing how soil, water, energy, and nutrition systems interact — ensuring that solutions strengthen the biological and social foundations that sustain all life.

There are many potentially impactful avenues of future practice, research and innovation.

- **Build technical capacity:** Farmers, conservation practitioners, and local institutions need stronger literacy in geospatial and digital tools to translate data into practical decisions. Investment in training programs, accessible technology platforms, and local technical support is essential.
- **Invest in cross-sector convenings:** More structured spaces are needed for dialogue and planning between agriculture and conservation actors to overcome silos and coordinate land-use strategies. Multi-stakeholder platforms at local, national, and regional levels can facilitate integrated planning.
- **Develop standardized approaches to GeoAI for scaling:** Establish shared methods, open data standards, and validation frameworks ensuring geospatial and AI tools can be adapted across regions while maintaining accuracy, transparency, and ethical use. This includes developing protocols for data sharing, model validation, and impact monitoring.
- **Increase context-specific applied research:** Additional studies are needed to identify which regenerative practices deliver both yield and conservation benefits in specific ecological and socio-economic contexts. Research should prioritize farmer-led trials, long-term monitoring, and documentation of lessons learned.
- **Incentivize localization and community leadership:** Effective adoption depends on solutions being rooted in farmer and community expertise, ensuring they are practical, profitable, and context appropriate.
- **Strengthen finance mechanisms:** Innovative financing that rewards farmers for ecosystem services, including carbon sequestration, water conservation, and biodiversity protection, can make regenerative practices more economically attractive. This includes exploring carbon markets, payment for ecosystem services, and results-based financing.

The challenge at hand is multifold, touching upon the wellbeing of people, landscapes, and both wild and domesticated animals. The way forward is to use this interconnectedness as an opportunity — aligning regenerative agriculture, water and energy stewardship, technology, and farmer leadership in service of nutrition security, ecological health, and resilient communities.

As David Kuria, 1000L farmer, reminds us, "all of these components must unite together to create true transformation."⁶⁵ When farmers, conservationists, technologists,

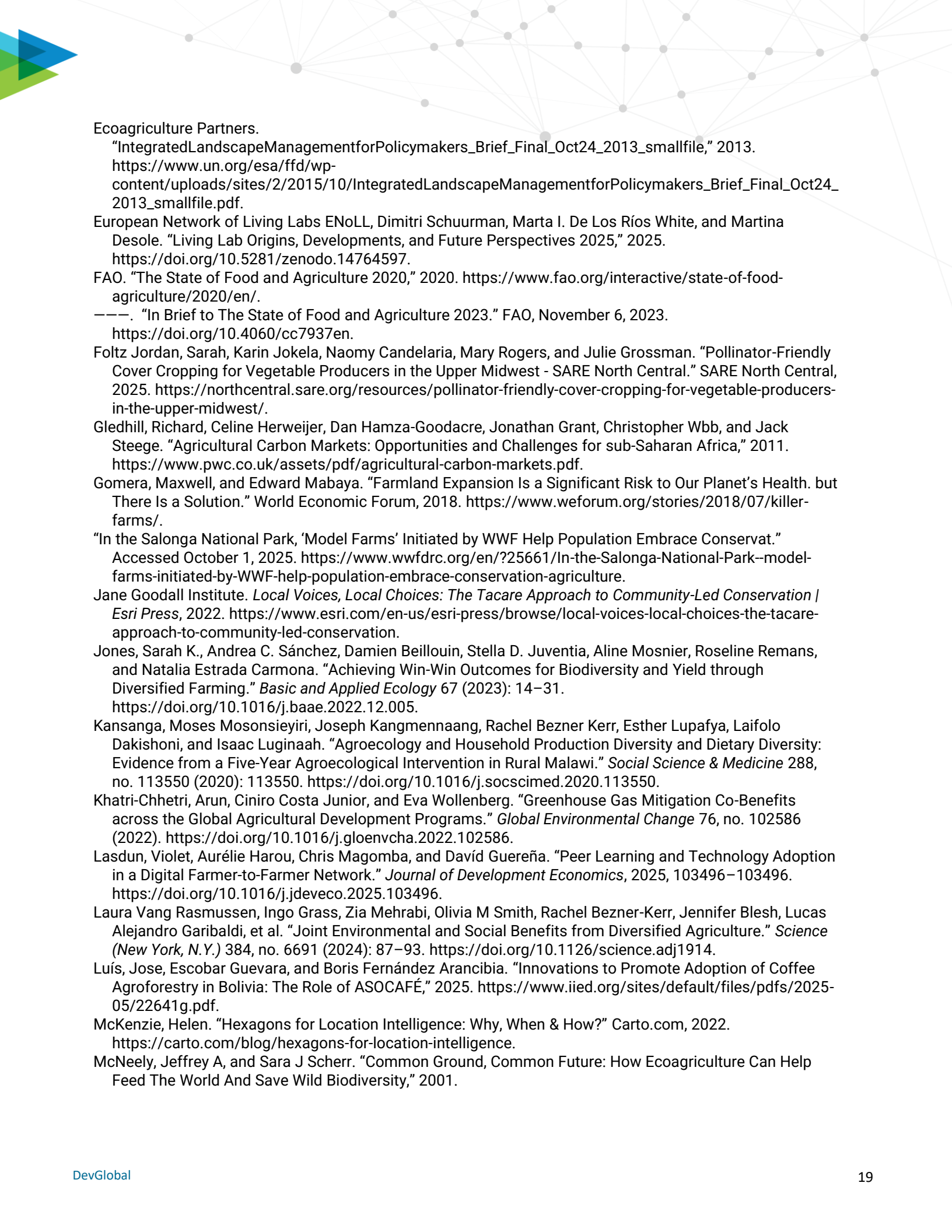
⁶⁵ 1000 Landscapes for 1 Billion People, "Lari Landscape, Kenya: Cooperation Sows Benefits for Livelihoods and Ecosystems," Landscapes. Global, accessed October 3, 2025, <https://stories.landscapes.global/kenya-lari-kenya>.



policymakers, and communities work together with shared tools, shared goals, and mutual respect, we create landscapes where life, in all its forms, can thrive.

Bibliography

- 1000 Landscapes for 1 Billion People. "Home - 1000 Landscapes for 1 Billion People at 1000 Landscapes for 1 Billion People." Accessed October 3, 2025. <https://landscapes.global/>.
- 1000 Landscapes for 1 Billion People. "Lari Landscape, Kenya: Cooperation Sows Benefits for Livelihoods and Ecosystems." [landscapes.global](https://stories.landscapes.global/kenvo-lari-kenya). <https://stories.landscapes.global/kenvo-lari-kenya>.
- African Development Bank Group. "Feed Africa." Accessed September 26, 2025. https://www.afdb.org/fileadmin/uploads/afdb/Documents/Generic-Documents/Brochure_Feed_Africa_-En.pdf.
- African Wildlife Foundation. "Agriculture and Conservation Can Be Complementary," 2024. <https://www.awf.org/news/agriculture-and-conservation-can-be-complementary>.
- . "AWF, Conservation International & DADO Launch Regenerative Cotton Project in Uganda's Kidepo Landscape." African Wildlife Foundation, 2025. <https://www.awf.org/pressroom/awf-conservation-international-dado-launch-regenerative-cotton-project-ugandas-kidepo>.
- . "New Wildlife Corridors Mapped and Eco-Guards Sensitized to Community Rights in the DRC's Bili-Uele Landscape." African Wildlife Foundation, 2024. <https://www.awf.org/news/new-wildlife-corridors-mapped-and-eco-guards-sensitized-community-rights>.
- AgLivingLabs. <https://www.aglivinglabs.org/>.
- AJLabs. "How Much Does Africa Contribute to Global Carbon Emissions?" Al Jazeera, 2023. <https://www.aljazeera.com/news/2023/9/4/how-much-does-africa-contribute-to-global-carbon-emissions>.
- Alliance Bioversity International - CIAT. "Achieving Economic Balance with Regenerative Agriculture," 2024. <https://alliancebioversityciat.org/stories/achieving-economic-balance-regenerative-agriculture>.
- . "Resilience through Climate Action | Annual Report 2023," 2023. <https://alliancebioversityciat.org/2023-annual-report/climate>.
- Amboseli Ecosystem. "Economic Development | Amboseli Ecosystem Trust," 2024. <https://amboseliecosystem.org/economic-development/>.
- Bakker, Teatske, Patrick Dugué, and Stéphane de Tourdonnet. "Assessing the Effects of Farmer Field Schools on Farmers' Trajectories of Change in Practices." *Agronomy for Sustainable Development* 41, no. 2 (2021). <https://doi.org/10.1007/s13593-021-00667-2>.
- Bertrand, Savannah, Anna Sophia Roberts, and Emma Walker. "No-Till Farming Improves Soil Health and Mitigates Climate Change | Article | EESI." www.eesi.org, 2022. <https://www.eesi.org/articles/view/no-till-farming-improves-soil-health-and-mitigates-climate-change>.
- Brooks, T.M., and J. Siikamäki, eds. *Agriculture and Conservation*. IUCN, International Union for Conservation of Nature, 2025. <https://doi.org/10.2305/AMHX3737>.
- Carter, Tahira. "ICRISAT Unveils Groundbreaking Study on Geospatial Mapping for Sustainable Agriculture in South Asia." The International Crops Research Institute for the Semi-Arid Tropics, 2024. <https://pressroom.icrisat.org/icrisat-unveils-groundbreaking-study-on-geospatial-mapping-for-sustainable-agriculture-in-south-asia>.
- Castellano-Hinojosa, Antonio, and Sarah L. Strauss. "Impact of Cover Crops on the Soil Microbiome of Tree Crops." *Microorganisms* 8, no. 3 (2020): 328. <https://doi.org/10.3390/microorganisms8030328>.
- Center for Policy Research on Energy and the Environment | Princeton University. "Land-Use Change and Biodiversity | Center for Policy Research on Energy and the Environment (C-PREE)." Accessed September 26, 2025. <https://cpree.princeton.edu/land-use-change-and-biodiversity>.
- Colorado.gov. "Agricultural Stewardship Tax Credit | Department of Agriculture," 2022. <https://ag.colorado.gov/ag-stewardship-tax>.
- Conservation International. "Expanding Nature-Positive Economies." Accessed October 1, 2025. <https://www.conservation.org/priorities/expanding-nature-positive-economies>.



Ecoagriculture Partners.

"IntegratedLandscapeManagementforPolicymakers_Brief_Final_Oct24_2013_smallfile," 2013. https://www.un.org/esa/ffd/wp-content/uploads/sites/2/2015/10/IntegratedLandscapeManagementforPolicymakers_Brief_Final_Oct24_2013_smallfile.pdf.

European Network of Living Labs ENoLL, Dimitri Schuurman, Marta I. De Los Ríos White, and Martina Desole. "Living Lab Origins, Developments, and Future Perspectives 2025," 2025. <https://doi.org/10.5281/zenodo.14764597>.

FAO. "The State of Food and Agriculture 2020," 2020. <https://www.fao.org/interactive/state-of-food-agriculture/2020/en/>.

———. "In Brief to The State of Food and Agriculture 2023." FAO, November 6, 2023. <https://doi.org/10.4060/cc7937en>.

Foltz Jordan, Sarah, Karin Jokela, Naomy Candelaria, Mary Rogers, and Julie Grossman. "Pollinator-Friendly Cover Cropping for Vegetable Producers in the Upper Midwest - SARE North Central." SARE North Central, 2025. <https://northcentral.sare.org/resources/pollinator-friendly-cover-cropping-for-vegetable-producers-in-the-upper-midwest/>.

Gledhill, Richard, Celine Herweijer, Dan Hamza-Goodacre, Jonathan Grant, Christopher Wbb, and Jack Steege. "Agricultural Carbon Markets: Opportunities and Challenges for sub-Saharan Africa," 2011. <https://www.pwc.co.uk/assets/pdf/agricultural-carbon-markets.pdf>.

Gomera, Maxwell, and Edward Mabaya. "Farmland Expansion Is a Significant Risk to Our Planet's Health. but There Is a Solution." World Economic Forum, 2018. <https://www.weforum.org/stories/2018/07/killer-farms/>.

"In the Salonga National Park, 'Model Farms' Initiated by WWF Help Population Embrace Conservat." Accessed October 1, 2025. <https://www.wwfdrc.org/en/?25661/In-the-Salonga-National-Park-model-farms-initiated-by-WWF-help-population-embrace-conservation-agriculture>.

Jane Goodall Institute. *Local Voices, Local Choices: The Tacare Approach to Community-Led Conservation* / Esri Press, 2022. <https://www.esri.com/en-us/esri-press/browse/local-voices-local-choices-the-tacare-approach-to-community-led-conservation>.

Jones, Sarah K., Andrea C. Sánchez, Damien Beillouin, Stella D. Juventia, Aline Mosnier, Roseline Remans, and Natalia Estrada Carmona. "Achieving Win-Win Outcomes for Biodiversity and Yield through Diversified Farming." *Basic and Applied Ecology* 67 (2023): 14–31. <https://doi.org/10.1016/j.baae.2022.12.005>.

Kansanga, Moses Mosonsieyiri, Joseph Kangmennaang, Rachel Bezner Kerr, Esther Lupafya, Laifolo Dakishoni, and Isaac Luginaah. "Agroecology and Household Production Diversity and Dietary Diversity: Evidence from a Five-Year Agroecological Intervention in Rural Malawi." *Social Science & Medicine* 288, no. 113550 (2020): 113550. <https://doi.org/10.1016/j.socscimed.2020.113550>.

Khatri-Chhetri, Arun, Ciriaco Costa Junior, and Eva Wollenberg. "Greenhouse Gas Mitigation Co-Benefits across the Global Agricultural Development Programs." *Global Environmental Change* 76, no. 102586 (2022). <https://doi.org/10.1016/j.gloenvcha.2022.102586>.

Lasdun, Violet, Aurélie Harou, Chris Magomba, and David Guereña. "Peer Learning and Technology Adoption in a Digital Farmer-to-Farmer Network." *Journal of Development Economics*, 2025, 103496–103496. <https://doi.org/10.1016/j.jdeveco.2025.103496>.

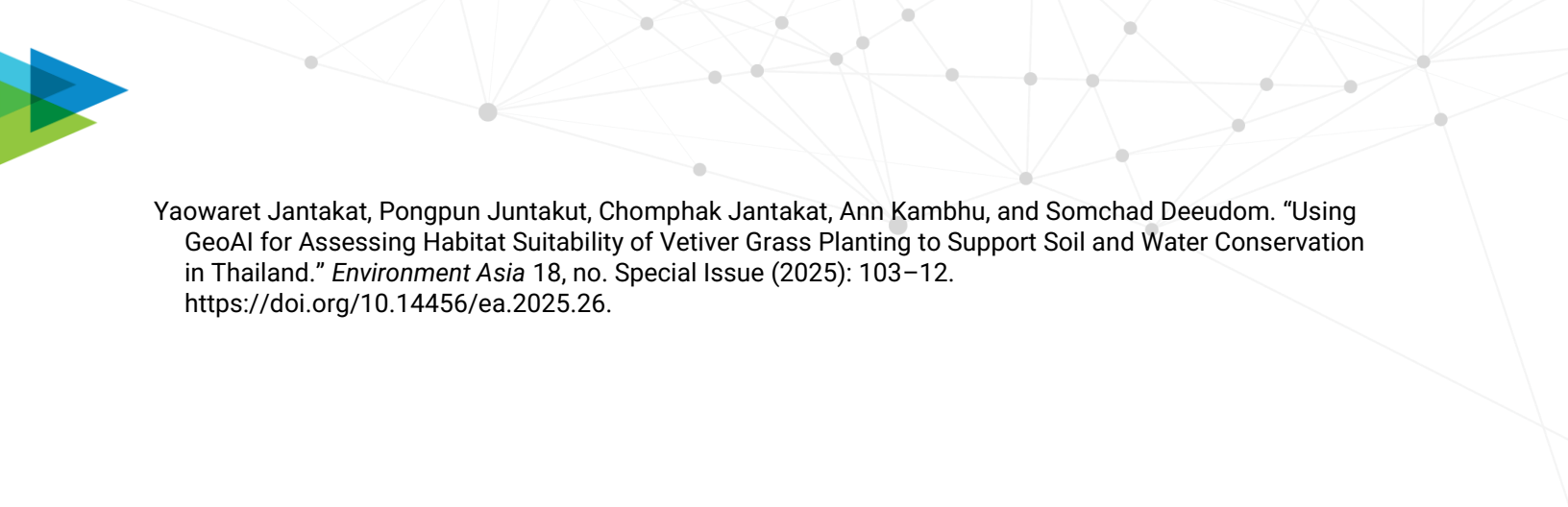
Laura Vang Rasmussen, Ingo Grass, Zia Mehrabi, Olivia M Smith, Rachel Bezner-Kerr, Jennifer Blesh, Lucas Alejandro Garibaldi, et al. "Joint Environmental and Social Benefits from Diversified Agriculture." *Science (New York, N.Y.)* 384, no. 6691 (2024): 87–93. <https://doi.org/10.1126/science.adj1914>.

Luis, Jose, Escobar Guevara, and Boris Fernández Arancibia. "Innovations to Promote Adoption of Coffee Agroforestry in Bolivia: The Role of ASOCAFE," 2025. <https://www.iied.org/sites/default/files/pdfs/2025-05/22641g.pdf>.

McKenzie, Helen. "Hexagons for Location Intelligence: Why, When & How?" Carto.com, 2022. <https://carto.com/blog/hexagons-for-location-intelligence>.

McNeely, Jeffrey A, and Sara J Scherr. "Common Ground, Common Future: How Ecoagriculture Can Help Feed The World And Save Wild Biodiversity," 2001.

- Mehrabi, Zia, Ruth Delzeit, Adriana Ignaciuk, Christian Levers, Ginna Braich, Kushank Bajaj, Araba Amo-Aidoo, et al. "Research Priorities for Global Food Security under Extreme Events." *One Earth* (Cambridge, Mass.) 5, no. 7 (July 15, 2022): 756–66. <https://doi.org/10.1016/j.oneear.2022.06.008>.
- Michel, David. "Building Resilient Water Systems in sub-Saharan Africa." Center for Strategic and International Studies, 2025. <https://www.csis.org/analysis/building-resilient-water-systems-sub-saharan-africa>.
- NASA Landsat. "Agriculture & Food Security | Landsat Science," 2021. <https://landsat.gsfc.nasa.gov/benefits/agriculture-food-security/>.
- Ol Pejeta Conservancy. "Harmony in the Wild: How AI Is Bridging the Gap between Humans, Cattle, and Wildlife - Ol Pejeta Conservancy." Ol Pejeta Conservancy, 2025. <https://www.olpejetaconservancy.org/2025/03/18/harmony-in-the-wild-how-ai-is-bridging-the-gap-between-humans-cattle-and-wildlife/>.
- Phil Franks. "Food Demand and Forests in sub-Saharan Africa." International Institute for Environment and Development, 2015. <https://www.iied.org/food-demand-forests-sub-saharan-africa>.
- Potapov, Peter, Svetlana Turubanova, Matthew C. Hansen, Alexandra Tyukavina, Viviana Zalles, Ahmad Khan, Xiao-Peng Song, Amy Pickens, Quan Shen, and Jocelyn Cortez. "Global Maps of Cropland Extent and Change Show Accelerated Cropland Expansion in the Twenty-First Century." *Nature Food* 3, no. 1 (2022): 19–28. <https://doi.org/10.1038/s43016-021-00429-z>.
- Reed, James, Liz Deakin, and Terry Sunderland. "What Are 'Integrated Landscape Approaches' and How Effectively Have They Been Implemented in the Tropics: A Systematic Map Protocol." *Environmental Evidence* 4, no. 1 (2016): 2. <https://doi.org/10.1186/2047-2382-4-2>.
- Ritchie, Hannah. "Increasing Agricultural Productivity across sub-Saharan Africa Is One of the Most Important Problems This Century." Our World in Data, 2022. <https://ourworldindata.org/africa-yields-problem>.
- Segarra, Joel, Maria Luisa Buchailot, Jose Luis Araus, and Shawn C. Kefauver. "Remote Sensing for Precision Agriculture: Sentinel-2 Improved Features and Applications." *Agronomy* 10, no. 5 (2020): 641. <https://doi.org/10.3390/agronomy10050641>.
- Sinclair, Fergus, Alexander Wezel, Cheikh Mbow, Susan Chomba, Valentina Robiglio, and Rhett Harrison. "The Contribution of Agroecological Approaches to Realizing Climate-Resilient Agriculture," 2019. <https://gca.org/wp-content/uploads/2020/12/TheContributionsOfAgroecologicalApproaches.pdf>.
- Terrasol. "Integrated Landscape Management Overview," 2021. <https://terrasol.org/ilm-overview/>.
- The Nature Conservancy. "Regenerative Food Systems." Accessed September 26, 2025. <https://www.nature.org/en-us/what-we-do/our-priorities/provide-food-and-water-sustainably/food-and-water-stories/regenerative-food-systems/>.
- Thierfelder, Christian, Leonard Rusinamhodzi, Amos R. Ngwira, Walter Mupangwa, Isaiah Nyagumbo, Girma T. Kassie, and Jill E. Cairns. "Conservation Agriculture in Southern Africa: Advances in Knowledge." *Renewable Agriculture and Food Systems* 30, no. 4 (2014): 328–48. <https://doi.org/10.1017/s1742170513000550>.
- UN Environment Programme. "Critical Ecosystems: Congo Basin Peatlands," February 27, 2023. <https://www.unep.org/news-and-stories/story/critical-ecosystems-congo-basin-peatlands>.
- Vaiyapuri, Thavavel, and Golden Julie. "AI and Geospatial Technologies for Climate Change Mitigation: Opportunities, Challenges, and Pathways to Sustainability." *Procedia Computer Science* 259 (2025): 1346–55. <https://doi.org/10.1016/j.procs.2025.04.089>.
- Veldkamp, Edzo, Marcus Schmidt, Jennifer S. Powers, and Marife D. Corre. "Deforestation and Reforestation Impacts on Soils in the Tropics." *Nature Reviews Earth & Environment* 1, no. 1 (2020): 1–16. <https://doi.org/10.1038/s43017-020-0091-5>.
- World Wildlife Fund. "WWF Impact Investing: Regenerative Agriculture | Pages | WWF." Accessed September 26, 2025. <https://www.worldwildlife.org/pages/wwf-impact-investing-regenerative-agriculture>.
- . "Accelerating the Transition to Regenerative Ag," 2024. <https://www.wwf.org.uk/who-we-are/what-we-work-with/nbs-accelerator/aesco>.
- Yang, Xiaolin, Jinran Xiong, Taisheng Du, Xiaotang Ju, Yantai Gan, Sien Li, Longlong Xia, et al. "Diversifying Crop Rotation Increases Food Production, Reduces Net Greenhouse Gas Emissions and Improves Soil Health." *Nature Communications* 15, no. 1 (2024): 198. <https://doi.org/10.1038/s41467-023-44464-9>.



Yaowaret Jantakat, Pongpun Juntakut, Chomphak Jantakat, Ann Kambhu, and Somchad Deeudom. "Using GeoAI for Assessing Habitat Suitability of Vetiver Grass Planting to Support Soil and Water Conservation in Thailand." *Environment Asia* 18, no. Special Issue (2025): 103–12.
<https://doi.org/10.14456/ea.2025.26>.