



Global Sustainable Agriculture: Challenges, Strategies, And Future Pathways

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ABSTRACT

Internationally, sustainable agriculture is a critical approach to addressing both the challenge of food demand growth and environmental deterioration. As the global population is estimated to increase to 9-10 billion in 2050, agricultural systems need to increase LIAM production without significant resource depletion, land loss, or carbon emissions. This review takes a global view of sustainable agriculture and also draws attention to integrated approaches to adjusting productivity alongside ecological and social criteria. We consider key drivers, such as climate change, restrictions on land use, and growth in global food demand, among others, and their implications for both industrialized countries and developing nations. Particularly, the review focuses on environmental, economic, and social challenges that limit extensive scaling up of sustainable practices, as they depend largely on high-input, industrial farming systems; resource depletion; and limited access to technology and finance. We have heard of a number of more sustainable agricultural practices, such as agroecology, conservation agriculture, precision farming, and climate-smart agriculture, that aim to increase productivity without harming the environment. Policy, governance, and international co-operation to facilitate sustainable agricultural transitions are also considered. Finally, we identify key research gaps and propose future directions to achieve the sustainability of global agriculture. Here, we posit that the success of such technical innovations is a great hope but can only be realized if both local ad hoc solutions integrate into robust institutional performance and innovative connectedness in scale, and policies ensure long-term resilience in global food systems as well as equity.

Keywords: Sustainable agriculture, international agriculture, agro ecology, climate-smart agriculture, agricultural trade, food systems, global sustainability.

INTRODUCTION

One of the basic necessities of human life is food, and its effective production depends on a country's food safety under its social-economic conditions and quality environment (Farooq et al., 2025). However, the industry faces numerous obstacles in supplying and meeting the increasing global demand for food, resulting from population growth, urbanization, and changes in dietary habits (Daszkiewicz et al., 2022). Moreover, it causes over 70 per cent of all environmental damage (i.e., losses) such as land use, water stress, biodiversity depletion, and GHG emissions (Jafari et al., 2030; Sarhadi et al., 2023). The very fact that the world's population will reach 9-10 billion by 2050 means there is no better time than now to seek an urgent, radical form of agriculture (Wijerathna-Yapa & Pathirana 2022).

There's been a great deal of excitement about ecological agriculture as the option for a densely populated planet in the coming generations. This includes the development of environmentally friendly, economically viable, socially acceptable farming systems that, when passed on to future generations, will allow those same future generations to have their food needs met without negatively impacting or depleting it. (Jha and Sharma 2025). Sustainability in agriculture: A never-ending number of possibilities for soil health, reduced water use (beyond just the necessary) and minimal residue buildup of pesticides and fertilizers, peaking level of biodiversity with a trade-off upliftment in livelihoods - because your social welfare escalates with sustainable farming (Sharma et al., 2024).

Sustainability is a complex and multidimensional notion, shaped by global discourses as well as local dynamics. High-input systems, and the case of high-input, industrial systems is not only a special one for developed countries,

which have to move away from damaging but also well-established ways towards sustainable agricultural production (Rashid and Gani, 2025), mainly due to interest groups such as economies of scale or market conditions that are again playing their already known role. On the one hand, they need to boost food production as fast as possible to fight poverty and hunger; on the other, such rapid ramp-ups must be balanced against preserving fragile ecosystems and building systems that are resilient in the face of climate change." While the scale and complexity of both contexts may not align, integrated solutions are required in light of environmental, economic and social sustainability considerations (Hariram et al., 2023).

This paper examines the global dimensions of sustainable agriculture, with reference to key driving forces, challenges and opportunities. Issues such as the use of techniques, opportunities for new techniques, and actors in new methods in agro ecology, precision agriculture and climate smart agriculture - but also: how does policy stimulate sustainable agriculture? With the effects of climate change and trade networks connecting agricultural systems, it is increasingly crucial to develop policies that promote sustainability at the global level (Wang et al., 2023).

Defining Sustainable Agriculture and Its Dimensions

One challenge in the literature is reaching consensus on what constitutes sustainable agriculture. For example, Velten et al. (2015), sustainable agriculture is an "integrated system of plant and animal production practices" that will, over the long term: (a) satisfy human food and fiber needs; (b) enhance environmental quality; (c) make efficient use of non-renewable and on-farm resources; (d) sustain economic viability of farms; and (e) improve quality of life for farmers and society (Fig 1).

Several important dimensions may be derived from this definition:

- Productivity and food security: The necessity of creating enough product for an expanding population.
- Environmental health: Preserving soil, water, biodiversity, and ecosystem services.
- Efficient use of resources: decreasing the dependence on non-renewable inputs, waste reduction, efficient use of energy, nutrients and water.
- Economic sustainability – Enterprises must be financially viable to ensure uptake over time.
- Social equity & livelihoods: Enhancing the well-being of farmers and rural communities, fair labor, and inclusion.



Fig. 1: Constitutes Sustainable Agriculture

As agriculture takes place within society and is affected by global processes, some authors suggest that further dimensions should be considered, such as governance, value chains, institutional structures, and the spatial/temporal operating scale (local/regional/global) (Barbero et al., 2024). Because of this complexity, presuppositions regarding sustainable agriculture need to be contextual rather than one-size-fits-all.

Global Drivers and International Context

Global demand and trade

Growing human population (estimated at 9–10 billion by 2050) and per capita consumption, especially of animal products, vegetable oils, and processed foods, leading to rapid rises in demand for foodstuffs, will increase agricultural production/output –diversity in production systems is inevitable. International trade links production areas and is associated with land-use change, supply chains, and sustainability performance (Hemathilake et al., 2022).

Environmental change and climate

Agriculture both contributes to and is directly affected by climate change. AFOLU are typically deemed to account for 20-30% of global anthropogenic GHG emissions. But increasing temperatures, precipitation variability, extreme weather events, and soil acidification put yields at risk, especially in fragile zones (Rezaei et al., 2023).

Land and resource constraints

A large proportion of land used for agriculture has been taken over from natural ecosystems. Depletion of degraded land, soil erosion, and water scarcity represent the main bottlenecks to scaling up production in a sustainable manner (Wang et al., 2022).

The SDGs and global policy context

This reflects what is also highlighted by the Food and Agriculture Organization (FAO) and other multilateral organizations: that agriculture is in line with the SDGs Zero Hunger (SDG2), Climate Action (formerly known as SDG13), Life on Land (SDG15), and Responsible Consumption and Production (SDG12). Agriculture is a global industry, so sustainability doesn't stop at national boundaries (Fig 2).

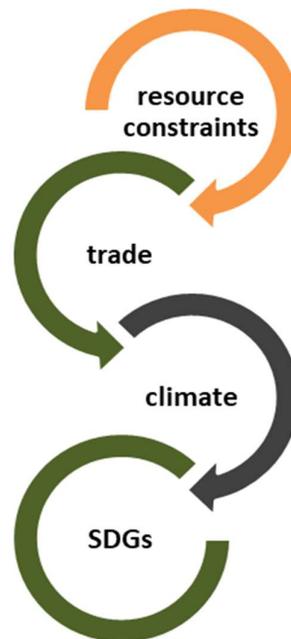


Fig 2: Global Drivers and International Context.

Key Challenges in International Sustainable Agriculture

Yield Gaps and Productivity vs. Sustainability Trade-offs

Farm productivity in many (but not all) parts of the developing world is well below potential, suggesting significant scope for increases here without requiring more water (Fig 3). But closing these productivity gaps may require reverting to high-input practices of the past at an environmental cost. The challenge is to balance increased output with reduced environmental harm (Shi & Umair, 2024). Therefore, increased yield should be accompanied by sustainable production practices to prevent further ecological decline in the long run, an issue that is crucial for sustainable agriculture worldwide (Donmez et al., 2024).

Resource and Input Dependency

The other main challenge of our agro-environmental system worldwide is dependence on chemical inputs (i.e., fertilizers, pesticides, and machinery), as well as on irrigation and fossil fuels (De Vente et al., 2023). These inputs, which have been responsible for increasing agricultural yields, however, come at a great investment of financial and natural resources. Misuse of chemical fertilizer (synthetic), such as nutrient leaching and soil acidification, causes an

increase in greenhouse gas emissions. So does excessive irrigation, depleting water supplies and saturating soil with salt. These practices also threaten the long-term resilience of agroecosystems, and therefore, new, effective, and environmentally safe alternatives have been demanded (Rehman et al., 2022).

Environmental Degradation and Ecosystem Service Loss

Environmental degradation is another very real threat to sustainable farming. The likes of declines in soil organic matter content, erosion, loss of biodiversity, overexploitation of aquifers leading to depletion, and deforestation, as well as changes in land use, continue to result in slow sustainability degradation of some natural resources for agriculture (Adedibu et al., 2023). When the capacity of ecosystems declines, their services — like pollination, water infiltration, and carbon storage — are lost, and it becomes harder to maintain productive agriculture over time. The decrease in such ES directly diminishes the sustainability of agriculture and drives towards more ecologically friendly agricultural practices (Rehman et al., 2023).

Adaptation to and Resilience against Climate Change

The prospect of climate change affecting agriculture is particularly worrying in poorer regions, where farms are on the edge and have no margin to spare. Variability in the climate, characterized by varying rainfall patterns, temperature fluctuations, and extreme conditions such as droughts, is observed to increase agricultural risks, with implications for livelihoods and food security (Kipkemboi et al., 2021). We need to design climate-smart agricultural systems that are resilient to such changes and able to adapt and mitigate the ongoing climate change. Adaptation strategies such as breeding drought-resistant crops, improving water-use efficiency, and adopting a climate-smart agriculture system are required to sustain agricultural production under a changing climate (Nfornkah et al., 2025).

Globalisation, Value Chains and Governance

Sustainable farming, globalization, and international value chains are opportunities as well as threats. On the one hand, trade can generate markets for agricultural goods and facilitate technology transfer among countries; on the other hand, it tends to concentrate economic benefits while externalizing environmental offsetting costs (Anderson et al., 2022). Governance in many developing countries is poor, incentives are frequently misaligned, and the gains from global agricultural trade are unequally shared in many instances. Moreover, farmers may not have access to markets, and their innovations often do not reach investors who can fund them as they wish and when they want, in an environment of instability linked to global price changes (price shocks) concurrently with changes in supply chains (Hamidu et al., 2022).

Social Equity, Employment and Smallholder Inclusions

The human side of agricultural sustainability is also related to justice and labor. Family and smallholder farms are a hallmark of the majority in world agricultural production. They usually face strong constraints to sustainable production, mainly the absence of capital, education, secure land rights, and markets (Autio et al., 2021). The exposure and unpredictability of risks related to agriculture, including short-term weather and price fluctuations, in addition to the high cost associated with moving towards more sustainable practices, have led smallholders to continue disengaging from long-term sustainability. We need to ensure that these farmers have the same access to resources, training, and support if we are to develop an inclusive agricultural system that benefits all (Prajapati et al., 2025).

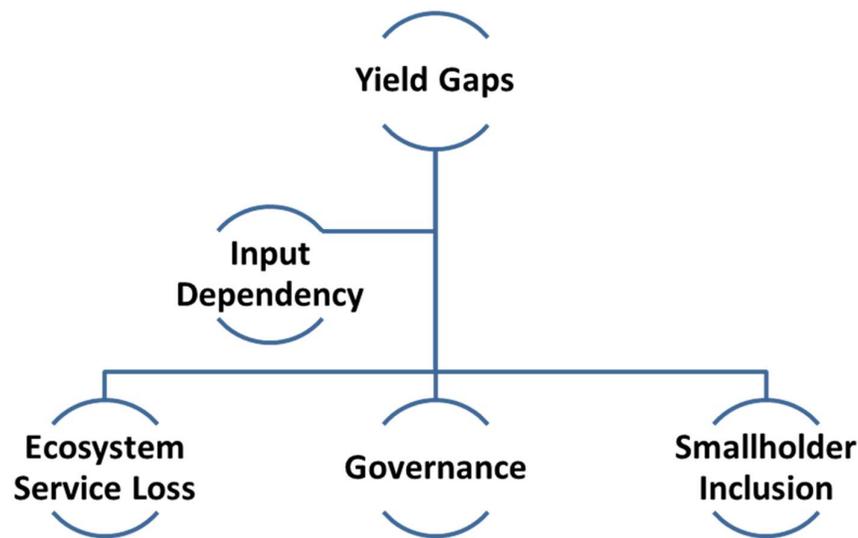


Fig. 3: Yield Gaps and Productivity.

Strategies and Practices for Sustainable International Agriculture Agroecology and Diversification

Agro-ecological approaches also focus on the use of ecological principles in agriculture, including crop–livestock integration, mixed cropping, agroforestry, and cover crops, which can improve soil health and biodiversity (Vikas and Ranjan 2024). These problems should be addressed by imitating natural systems, reducing outdoor needs, and increasing diversity on farms (Fig 4). There is some evidence that diversification helps in several ways. One of the recent meta-syntheses found that there were long-term benefits, including improved soil quality, biodiversity, and carbon sequestration. Through the promotion of ecological balance, agroecology is not only proactive in boosting farm productivity but also contributes to the integrated achievement of environmental objectives and sustainable agricultural models (Mottet et al., 2025).

Conservation Agriculture and Soil Quality

Conservation agriculture aims to maintain and improve soil health through no- or reduced-tillage, cover cropping, crop rotation, and organic inputs (Omer et al., 2024). It reduces tillage erosion and maintains soil structure, organic carbon & water holding capacity. Conservation agriculture, by building healthy soils, can increase yields in the long run and reduce farming's ecological footprint. These practices also contribute to wildlife conservation and protection against climate change influences such as droughts and flooding, which underscores the significance of soil health within sustainable agriculture (Ogwu et al., 2025).

Precision and Digital Agriculture

Advancing technologies, including remote sensing, drones, Internet of Things (IoT) sensors, machine learning, and artificial intelligence (AI), offer the potential to enhance agricultural factors and practices (Fuentes-Penailillo et al., 2024). "Precision agriculture is a concept that allows farmers to manage crops more precisely by providing them with water, nutrients and pesticides only where they are necessary – thus reducing waste and optimizing resource use in the process. These instruments are enabling growers to monitor crop health, forecast yields, and respond to conditions more quickly than ever. Thereby, precision agriculture increases the sustainability of our agricultural systems by improving on-farm productivity and environmental stewardship (Getahun et al., 2024).

Climate-Smart Agriculture (CSA)

Climate Smart Agriculture (CSA) is a strategic tool to guide such a transition towards low-emissions, resilient development pathways, aiming to make agriculture more productive and climate-tolerant (Ahmed et al., 2025). The three main goals of CSA ATW or the World Bank) are: (i) improved agricultural productivity and income levels; (ii) reduced vulnerability to climate change; and (iii) lower greenhouse gas emissions. CSA practices can also include the use of climate-smart crop varieties, precision fertilization, conservative irrigation techniques, drought- and heat-resistant crops, and livestock feeding/ manure management. However, CSA has been noted as broad and not prescriptive enough, making it challenging to assess globally whether it is being implemented (Challinor et al., 2022).

Sustainable Intensification

Sustainable intensification seeks to raise production per unit of land while reducing the environmental footprint. This connects with optimal land use, improved on-farm water management, and structural changes in farming systems. Sustainable intensification is based on integrating different solutions to make farms more efficient, manage pests, and use inputs with caution (Deguine et al., 2021). These reviews underline the critical role of geographical context in translating sustainable intensification, since there can be no one-size-fits-all approach appropriate to diverse environmental and socio-economic conditions. In the future, to achieve more food with less land use to conserve natural forests and reduce soil erosion (Wang, 2022).

Trade, Value-Chain Upgrading and Governance

Global agricultural regimes are challenged regarding the sustainability of supply chains, e.g., standards and certification (organic; fair trade), transparency in trading practices (Giger & Musselli, 2023). Self-regulatory sustainability standards have also been shown to reduce negative environmental impacts (such as eutrophication, water footprint, and emissions). But the challenge is to see these used more widely, across a variety of regions and commodities. Institutions for ensuring fair trade, the distribution of benefits from sustainable agriculture, and sustainability must be strong. Transparency is also recognized as a facilitator in informing all actors in the chain about possible risks to be addressed, thus fostering sustainability (Udeh et al., 2024).

Policy, Financing, Capacity 106 Building and Coordination

In this case, policies that incorporate subsidy structures, incentive mechanisms, and science and education services/interfaces to sustainability requirements can shape the realization of sustainable agricultural practices. Governments need to recognize the value of sustainability in their agricultural policies, redirecting subsidies away from destructive practices toward long-term ecological health (Hilson et al., 2025). There is also a need for financial mechanisms, such as easy credit (lower cost of debt), risk-sharing tools, marketing facilities, etc., which are essential

for transitioning farmers to sustainable agriculture. Knowledge networking, training programmers, and extension services for capacity building of farmers to have the necessary set of skills, practices, and information needed to follow the above-described practices are also very essential. Supportive policies , alongside access to finance and capacity building, will drive sustainable agricultural development across the Globe (Olabinjo and Opatola, 2023).

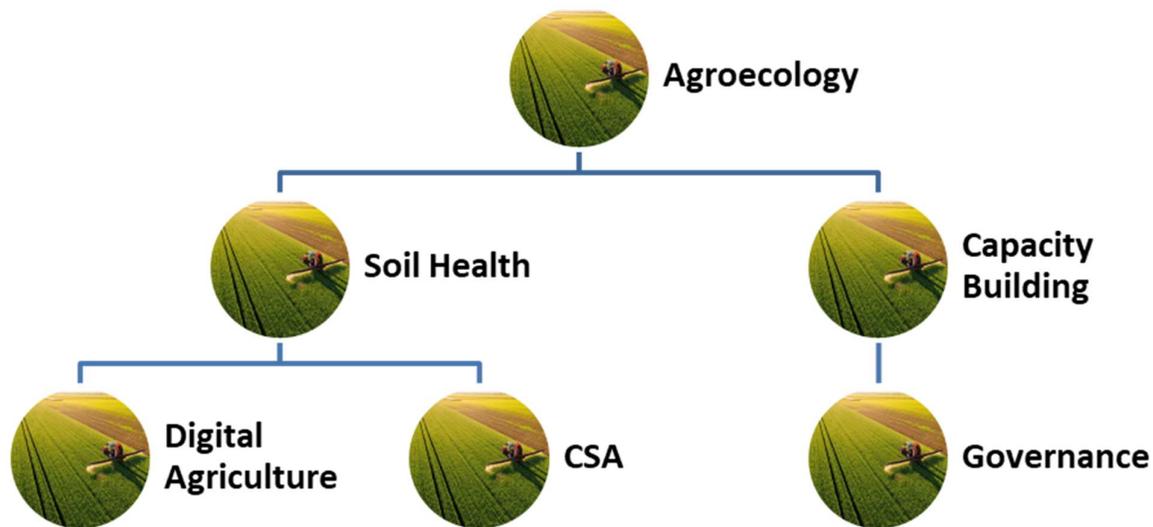


Fig. 4: Strategies and Practices for Sustainable International Agriculture.

Regional and International Dimensions

Developed countries

Their sustainability issues are related to the shift from high-input monocultures, pollination reduction or other students taking supports, emissions and supply chain adaptation. Precision agriculture and digital farming are becoming accessible to more, but concerns remain about jobs, land concentration and biodiversity (Tahir, et al., 2024).

Developing countries

Here, two challenges face action: increasing output and incomes while respecting resource constraints. Smallholder farming dominates; land tenure, access to credit and extension services, as well as infrastructure and markets are often inadequate. Context: Appropriate sustainable interventions should be locally developed for small-scale, high-risk settings (Nyambo et al., 2022).

Trade and cross-border global impacts

Considerations of international trade in commodities and value chains as an opportunity to advance sustainable development: SDG linkages: Food security (SDG 2); Water for productive use (SDG 8). Production in one location (such as commodity crops or livestock feed) can lead to environmental and social problems elsewhere. Here, there are concepts such as "virtual land use" and "embedded emissions." These externalities should be governed by international policy and supply chain management (Rauw et al., 2023).

International research and collaboration

Research of an international nature could involve a broad spectrum of activities that take place outside the researcher's home country, such as participation in international collaborative work on any climate issue—ranging from assistance with technical protocols to detailed case studies that other countries can use to make better decisions regarding choices they face for addressing the problem at hand, or general information sharing by researchers from the home country and colleagues local to their host country.

Networks such as the China-- UK Sustainable Agriculture Innovation Network (SAIN) facilitate cross-border research and collaboration (e.g., between China and the UK). It is imperative to focus on developing global capacity, exchanging best practices, and local strategies (Wu et al., 2025).

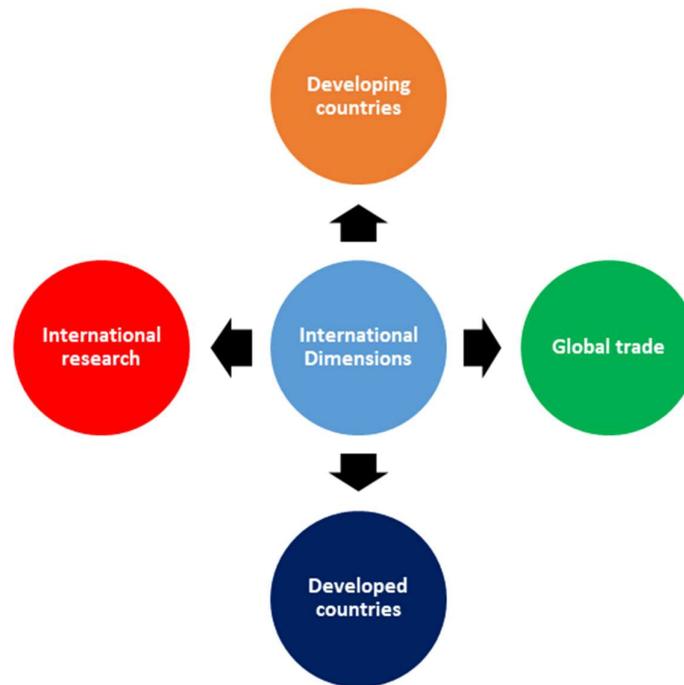
Synthesis of Evidence and Empirical Trends

Recent comprehensive reviews lend empirical endorsement to as much:

- Sharma (2024) consolidates the sustainable agriculture practices like permaculture, agroforestry, crop rotation, water management and precision agriculture.

- (Saikanth et al. 2023) advocate for digital and biotech applications, local/traditional knowledge, and stress that adoption needs training and policy support.
- (Robinson et al. 2024) provide a comprehensive review of sustainable agriculture and land management practices across the world.

Although many case studies are available, a number of gaps and approaches for improving impact remain, mainly in terms of long-term monitoring of outcomes, socio-economic studies of adoption behavior, harmonization of metrics used to measure sustainability as it relates to trade-offs between yield and environmental targets, and scaling from pilot to system level.



Critical Assessment: What Works, What Doesn't

Success factors

- Context-specific approaches: practices tailored to the ecology, soils, and socioeconomics.
- Inclusiveness - stakeholder diversity: farmers, researchers and scientists, policy makers, actors in the supply chain process.
- Knowledge, training and extension access.
- Commission structures promoting the deployment of sustainable solutions (e.g., Payments for Ecosystem Services, certification).
- Long-term promise and investment.

Constraints and failures

- There is frequently no substitute for one-size-fits-all prescriptions; unawareness of local heterogeneity.
- The high cost at startup and the labor requirements may limit adoption among small farmers.
- Institutional and policy perverse incentives: subsidies are allocated to intensive production rather than sustainable options.
- Market access, infrastructure, and value-chain bottlenecks reduce returns from sustainable practices.
- Poor long-term data; trade-offs (e.g., between yield versus biodiversity or carbon) not well negotiated.

Trade-offs and unintended consequences.

Transitioning to sustainable practices may carry a yield penalty in the short term, unless innovations are also developed and disseminated. In addition, some "sustainable" tags may disguise unsustainable practices (greenwashing). For instance, the court's definition of CSA may limit accountability (Zwagerman, 2024).

PATH FORWARD AND NEXT STEPS

Integrating Food Systems Approach

Sustainability in agriculture can be related to food systems that extend beyond farm practices and include processing, distribution, consumption, and waste (Zhang et al., 2024). From a food systems perspective, it ensures that agricultural sustainability is not limited to production but also encompasses reducing loss and waste and enhancing nutritional quality while making optimal use of resources throughout the supply chain (Fig 5). Sustainability could be understood in a broader perspective by also looking at on-farm waste and post-harvest losses, consumption patterns, and circular economy concepts (e.g., the recycling of food waste and composting). This holistic, integrated approach also optimizes the efficiency and sustainability of food systems, where every operation within the food supply chain enhances environmental and societal well-being (Abonyi et al., 2024).



Fig. 5: Integrating Food Systems Approach.

Scaling and Mainstreaming Sustainable Practices

Scaling up and out for sustainable agriculture to make a mark on the planet (Fig 6), what works in pilot projects has to take off or be brought into the mainstream (Kirina et al., 2022). This would depend on policy, financial mechanisms, farmer networks, and the infrastructure needed for adoption. It is also claimed that agricultural policy instruments should be aligned with sustainability objectives and motivate farmers to adopt more sustainable practices. In this sense, modular frameworks that allow for the incremental integration of new methods as they are developed can become particularly relevant. It provides a more flexible way for farmers to move toward sustainable system change, thus minimizing resistance to change and maintaining productivity and profitability (Bhagat et al., 2024).

Innovation, Digitalization and Technology

The potential of technologies such as precision agriculture, remote sensing, artificial intelligence (AI), robotics and biotechnology far outweighs the environmental footprint of tomorrow's modern agriculture. Precision agriculture techniques offer reduced environmental footprints by more targeted use of inputs such as water, fertilizers, and pesticides (Getahun et al., 2023). However, the widespread success of these technologies will depend on how accessible and affordable they are, especially in developing regions where technology implementation often lags due to expense and infrastructure limitations. Thus, technological advances must be locally applicable and cost-effective within individual regions and corresponding agricultural systems (Dhillon and Moncur 2023).

Finance and incentive systems/ governance reforms

Reforming finance and governance are key steps to achieving sustainability in agriculture. Governments need to move subsidies away from environmentally damaging practices such as fertilizer-pesticide overuse and toward more sustainable farming (Damania et al., 2023). Innovations involving PES, carbon credits for agriculture, and other economic incentives can also be used to promote sustainable land management. In addition, securing land tenure rights, promoting market access, and enabling environments for smallholders are essential to drive the scaling up of sustainable practices, especially in developing countries (Li et al., 2024).

International Cooperation and Trade Regulation

We need to ensure that agricultural trade and supply chains promote sustainability globally. If we are to succeed in this required cooperation, we need international organizations that prevent situations in which trade externalizes environmental or social costs. Improving global governance mechanisms and implementing fair trade, certification standards, and transparent sustainability frameworks help support sustainable farming activities around the world (Giger and Musselli 2023). International trade rules ought to promote production systems that are environmentally and socially responsible, creating a context in which producers are encouraged and incentivized to be sustainable on the world market. Cross-border cooperation is also important in addressing common problems, including soil degradation, water scarcity, and climate change (Khan et al., 2024).

Monitoring, Metrics, and Research

Standardized measures of sustainability outcomes are needed to monitor and evaluate progress toward sustainable agriculture (Wolfert et al., 2022). Such dimensions should include fundamental aspects such as soil health, biodiversity, and carbon footprints. Long-term research and evidence-based data are essential for assessing the effects of sustainable investments over time and across contexts. A consistent monitoring and evaluation system enables policymakers, practitioners, and researchers to make sense of what works and address areas that need improvement. C Aspects of sustainability Research also need to focus on the social and economic dimensions of sustainability and understand how different societies adopt sustainable practices and encounter challenges in making them successful (Hariram et al.).

Adaptation to Climate Change

"With the pressures of climate change on agricultural productivity, systems have to be designed with resilience for shocks and stress due to climate. Alternative cropping systems, improved water-use efficiency, and the cultivation of climate-resilient varieties will be part and parcel of adaptive farming practices. Decentralized, localized systems of food production that empower smallholder farmers to mitigate risk and adapt to local conditions will play a major role in making people more resilient. Agriculture can be resilient to climate change by using agroecosystem management to adapt effectively (Holt-Giménez et al., 2021).

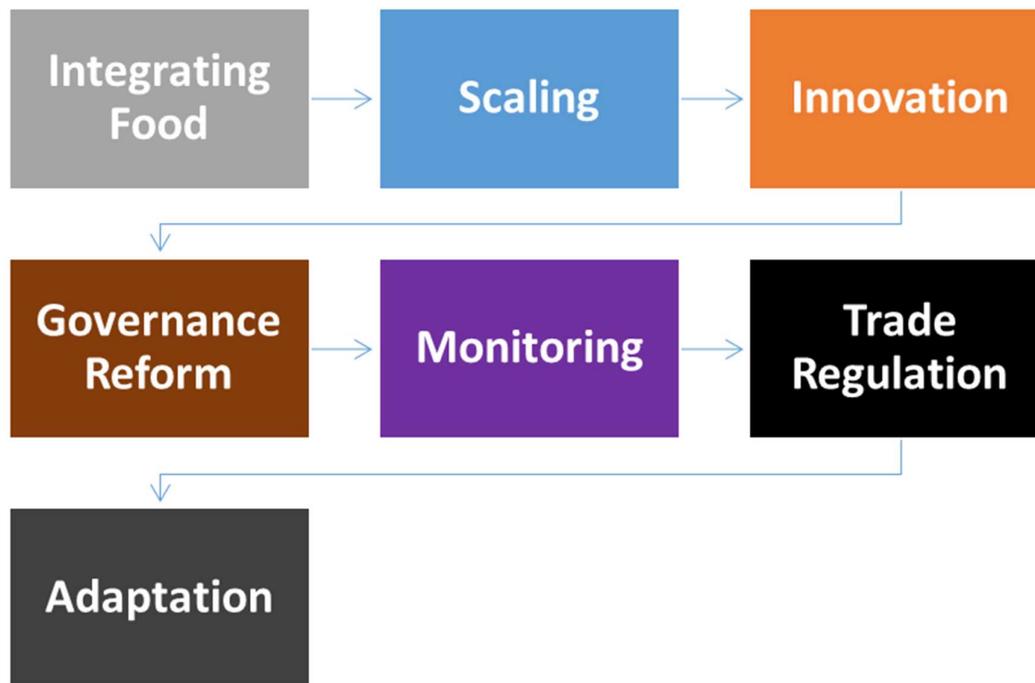


Fig. 6: Scaling and Mainstreaming Sustainable Practices.

Sustainable international agriculture is needed to meet immediate needs for food, environmental conservation, and social justice, in light of the expanding global population and the ongoing influence of climate change. Although much progress has been made towards establishing and supporting sustainable agricultural practices, the pathway forward remains intricate and diverse. Sustainability hinges on recognizing that agriculture is a linked system, in which the practices of individual farms are interwoven with food system policies and global-level governance.

As discussed in this review, sustainable agriculture is not an isolated circle. It needs to think about the whole food system, from production to consumption, including food waste, postharvest loss and circular economy principles.

With a more integrated approach, we would not only produce more food, but also have less negative environmental impact, better nutrition and fairer access to food resources for all. It is important to scale up successful innovations such as agroecology, precision agriculture, and climate-smart practices. These methods should be backed by strong policies, financing instruments, and a system that would help farmers adopt such practices in the long run.

Innovation and technology do play a role. Digitalization, AI, and biotech offer significant potential to increase productivity without extracting more resources or causing further harm to the environment. However, their availability and cost remain obstacles, particularly in low-income nations. It is thus essential that technological innovations be developed in ways that are flexible and scalable, considering the economic and social conditions across various agricultural systems. In addition, reform of governance and financial systems is key. Reallocating subsidies from resource-intensive to sustainable practices, paying for ecosystem services, and securing land tenure and market access are critical drivers of long-term change.

Conclusion

International collaboration will also be crucial for the sustainability of agriculture worldwide. Economic Ideology is, however, the demands of global trade and agricultural supply chains allow for the easy externalization of environmental and social costs, jeopardizing attempts at local sustainability. By ensuring greater due diligence on international covenants, transparency levels, and fair trade programs, it is possible to achieve greater congruence between global agricultural practices and sustainability goals. Moreover, there is a critical need to harmonize sustainability outcome metrics (soil health, biodiversity, and below-ground carbon emissions) to ensure that progress can be efficiently measured and tracked.

Climate change is likely the greatest challenge agriculture will confront in the next several decades. Resilient agricultural systems that not only cope with but also withstand climate shocks through diversity, water management, and the development of climate-resilient crops are key. "You can't rely on distant and sluggish governance to drive people's behavior in the face of fast-moving challenges." Localized, devolved solutions will be crucial to supporting smallholder farmers in managing risk and adjusting quickly to changing conditions. The future of sustainable agribusiness relies on developing a more resilient, adaptive and inclusive ecosystem that brings together diverse efforts (locally, nationally or globally) for long-term sustainability.

But above all, we should realize that agriculture's path towards sustainability is not a matter of choice – it is a necessity for the future survival of our planet and its life forms. It is going to take joint action at various levels of society — from farmers and consumers to governments and international institutions. By focusing on sustainability across all food systems and value chains, adopting technological advancements, enacting inclusive policies, and adapting to climate change, we can produce food systems that not only meet today's demand but also allow future generations to inherit an environment that is both productive and healthy. The task is daunting, but with concerted worldwide efforts, sustained agricultural progress is within reach.

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Conflict of Interest

Authors have no conflict of interest.

Data Availability

Data will be available from the corresponding author upon request.

Authors' Contribution

Ali Hussnain Arif; Conceptualization, Data Curation, Methodology, Writing Original draft, Abdullah Riaz; Writing, Review and Editing, Data Analysis, Arooj Akhlaq; Reviewing, Editing & Writing.

Generative AI Statements

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