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Global Sustainable Agriculture: Challenges, Strategies, And Future Pathways

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ABSTRACT

Internationally sustainable agriculture is a critical approach to facing both the challenge of food demand growth and environmental deterioration. As the global population is estimated to be increased to 9-10 billion in 2050, agricultural systems need to raise LIAM production without significant depletion of resources, loss of land and emission of carbon. This review takes the view of sustainable agriculture on a worldwide scale and also draws attention to integrated approaches to adjusting productivity together with ecological and social criteria. We consider key drivers, such as climate change, restrictions on land use, and world food demand growth among others, and implications for both industrialized countries as well developing nations. Particularly, the review focuses on environmental, economic and social challenges which limiting extensive scaling up of sustainable practices as depend largely on high-input, industrial farming system; resource depletion; and limited technology and finance accessibility. We have heard of a number of more sustainable agricultural practices like 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 some key research gaps and propose future perspectives for achieving the sustainability of world 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 necessity of human life is food and it's effective production in respect for a country food safety under their social-economic conditions and quality environment (Farooq et al., 2025). However, the industry is faced with numerous obstacles to supply and meet the increasing global demand for food resulting from population increase, urbanization and changes in dietary habits (Daszkiewicz et al., 2022). Moreover, it causes over 70 per cent of all environmental damages -lehabd (i.e. losses) like land use, water distress, biodiversity depletion as well as GHG waste-5(Jafari et al., 2030; Sarhadi et al., 2023). The very fact that we have a population on the planet that will reach 9-10 billion by 2050 means no better time to look for an urgent, radical form of agriculture than now (Wijerathna-Yapa & Pathirana 2022).

There's been a great deal of excitement about ecological agriculture as the option for densely populated planet in 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 be able to have their food needs met and not have a negative impact on or deplete it. (Jha and Sharma 2025). Sustainability in agriculture: A never ending umpteen number of possibilities for soil health, reduced water use (beyond just the necessary) and minimal residue building up of pesticide and fertilizers, peaking level of bio-diversity with a trade-off upliftment in livelihoods - because your social welfare escalates with sustainable farming (Sharma et al., 2024).

Sustainability is a complex and multi-dimensional 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 has to move away from damning but as well-established way 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 which 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).

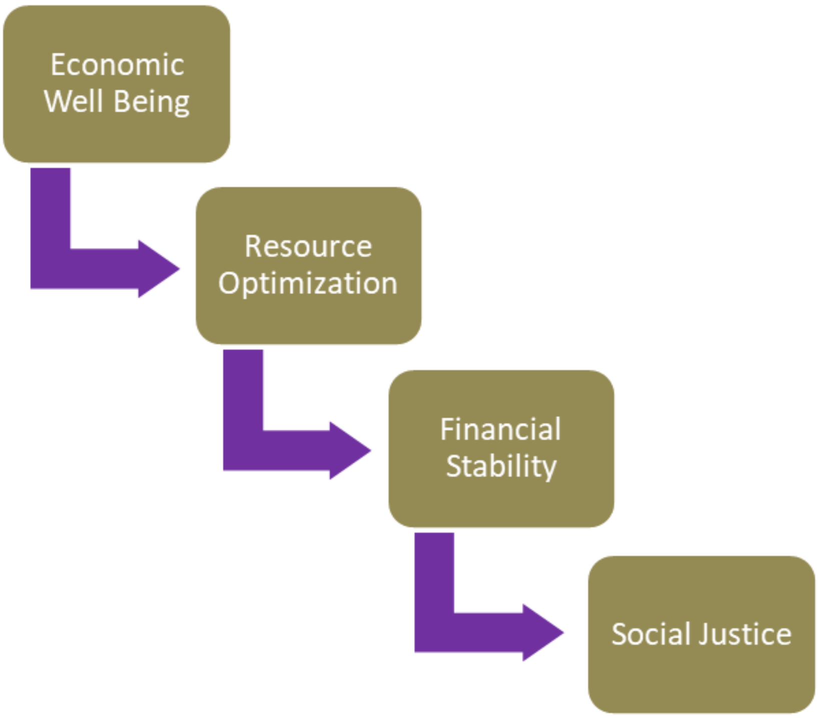
This paper examines the global dimensions of sustainable agriculture, with reference to key driving forces, challenges and opportunities. Issues such as the use of techniques; opportunities for new techniques, and actors in new methods in agro ecology, precision agriculture and climate smart agriculture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

Defining Sustainable Agriculture and Its Dimensions

One of the challenges in the literature is reaching a 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.

A number of 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 and efficient use of energy, nutrients and water.
- Economic sustainability – Enterprises must be financially viable in order to ensure that uptake remains over time.
- Social equity & livelihoods: Enhancing the well-being of farmers, rural communities, fair labor and inclusion.



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 such 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 9–10 billion by2050) and per capita consumption, especially of animal products, vegetable oils and processed foods leading to rapid rises in the demand for foodstuffs will lead to increased 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

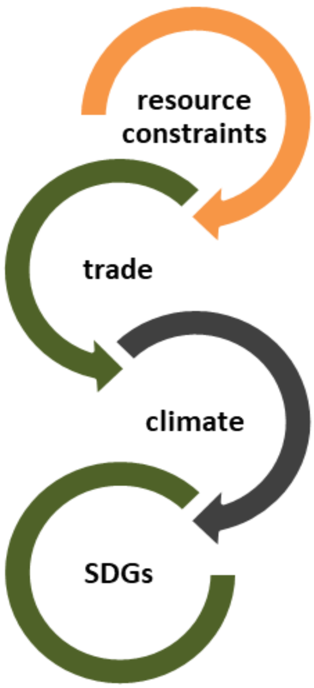
Agriculture both contributes to, and is directly affected by, climate change. AFOLU are typically deemed to account for 20-30% of global anthropogenic GHG emissions. But increasing temperature, variability in precipitation, extreme weather events and acidification of soils put yield under risk especially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

Land and resource constraints

A large proportion of land used in agriculture has been taken over from natural ecosystems. Depletion of degraded land, soil erosion and water scarcity represents the main bottleneck in 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) as well as other multilateral organizations that agriculture is in line with SDGs Zero Hunger (SDG2), Climate Action (formerly rare factor – SDG13), Life on Land (SDG15) as well Responsible Consumption and Production (SDG12). Agriculture is a global industry, so sustainability doesn't stop at the national boundary.



Key Challenges in International Sustainable Agriculture

Yield Gaps and Productivity vs. Sustainability Trade-offs

Farm productivity in many (not all) parts of the developing world is well below potential, which suggests that there may be significant scope for rises here without requiring any more water. But closing these productivity gaps may require resorting to high-input practices of the past at an environmental cost. The challenge is to make a trade-off between more output and less harm to the environment (Shi & Umair, 2024). Therefore, increased yield should be accompanied by sustainable production practices to prevent further decline of the ecology 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 irrigation and fossil fuel (De Vente et al., 2023). These inputs, which have been responsible for increasing agricultural yields, with the potential to come however, at a great investment of financial and natural resources. Chemical fertilizer (synthetic) misuse such as nutrient leaching and soil acidification causes an increase in greenhouse gas emission [4]. So does the excessive consumption of irrigation, depleting stocks of fresh water and saturating soil with salt. These practices also threaten with the long-term resilience of agro-ecosystems, 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 decline in the 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 into a 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 of such ES directly diminishes the sustainability of agriculture and drive towards more ecologically friendly agricultural practices (Rehman et al., 2023).

Adaptation to and Resilience against Climate Change

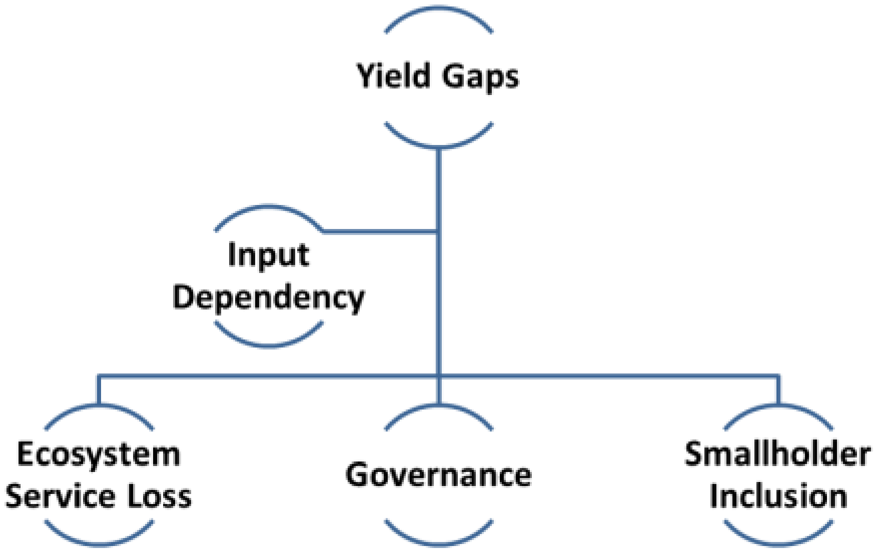
The prospect of climate change affecting agriculture is particularly worrying in poorer regions, where farms are on the edge and have no margin to spare. Variability in the climate characterized by varying rainfall patterns, temperature fluctuations and extreme conditions such as droughts is observed to increase agricultural risks, with implications for livelihoods and food security (Kipkemboi et al., 2021). We need to design climate smart agriculture systems that are resilient to such changes as well as able to adapt and mitigate the ongoing climate chock. Adaptation strategies such as the breeding of drought-resistant crops, improvement in water use efficiency and adjustment to 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 as well for technology transfer among countries; on the other, it tends to concentrate economic benefits while externalizing environmental off-setting costs (Anderson et al., 2022). Governance in many developing countries is poor, incentives are frequently misaligned and the gains from global agricultural trade remain unequally shared in many instances. Moreover, farmers may not access 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 modifications 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 small holders farms are a hallmark of the majority in terms of world agriculture production. They usually face strong constraints to follow sustainable production, mainly absence of capital, education and secure land rights and markets (Autio et al., 2021). The exposure and unpredictability of risks related to agriculture, including weather and price fluctuations on short term, in addition to the high cost associated with moving towards more sustainable movements have led smallholders to continue disengaging from long-term sustainability. We need to make sure that these farmers have the same access to resources, training and support if we are to develop an inclusive agriculture system that benefits all (Prajapati et al., 2025).



Strategies and Practices for Sustainable International Agriculture

Agroecology and Diversification

Agro-ecological approaches also focuses the use of ecological facets in agriculture, which include principles such as crop–livestock integration, mixed cropping, agroforestry and cover crops that can improve soil health and biodiversity (Vikas and Ranjan 2024). These problems should be imitated natural systems, reduced outdoor needs and increasing diversity on farms. There is some evidence that diversification helps in several ways. One of the recent meta-synthesis found that there were long-term profits, improved soil quality and biodiversity and carbon sequestration. Through the promotion of ecological balance, agro ecology is not only proactive in boosting farm productivity but besides contributes to the integrated achievement of environmental objectives and sustainable agriculture models (Mottet et al., 2025).

Conservation Agriculture and Soil Quality

Conservation agriculture aims at maintaining and increasing soil health through no or reduced tillage, cover cropping, crop rotation as well as through organic inputs (Omer et al., 2024). It reduces tillage erosion, and keeps soil structure, organic carbon & water holding capacity. Conservation agriculture, through building healthy soils, can increase yields in the long run and reduce farming's eco-footprint. These practices also contribute to wildlife conservation and protection against climate change influences such as droughts and flooding this proves 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 the health of their crop, 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 with improved environmental stewardship (Getahun et al, 2024).

Climate-Smart Agriculture (CSA)

Climate Smart Agriculture (CSA) -It is a strategic tool, to guide such transition towards low emissions, resilient development pathways with the aim of helping 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-smarter 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 such that it is challenging to assess globally whether or not CSA is being done (Challinor et al., 2022).

Sustainable Intensification

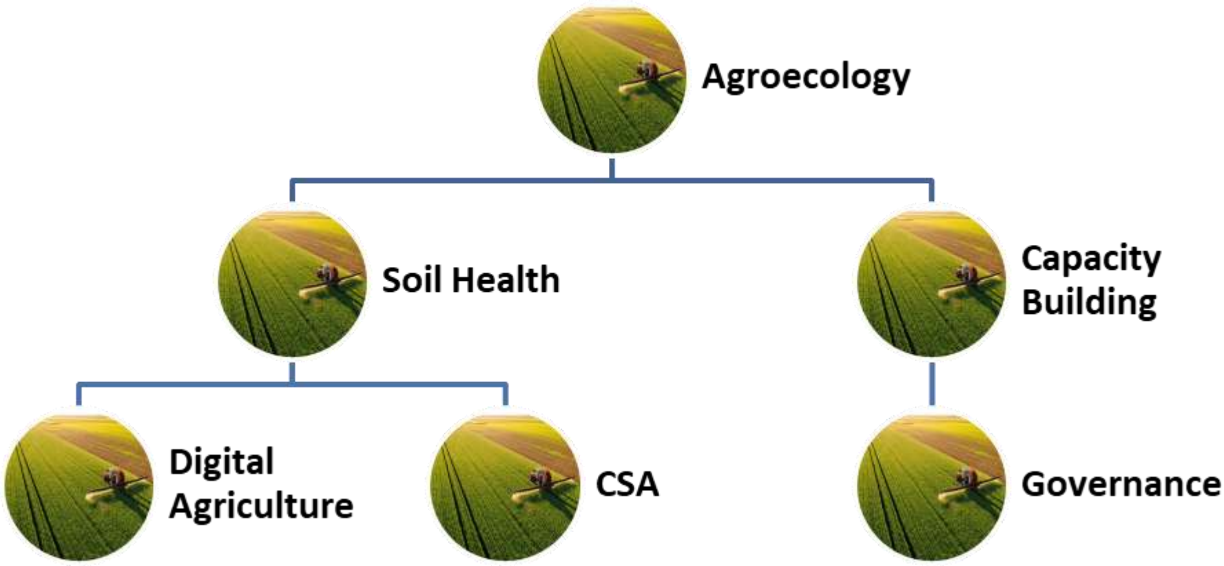
Sustainable intensification seek to raise production per unit of land while decreasing the environmental footprint. This connects with optimal land use, improving on-farm water management and structural changes of farming systems. Sustainable intensification is based on integrating different solutions for making farms efficient, managing pests and putting inputs together 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 in order to conserve natural forest and reduce soil erosion (Wang, 2022).

Trade, Value-Chain Upgrading and Governance

Globaloligical agricultural regimes are challenged in relation to 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 seen to decrease negative environmental impacts (such as eutrophication, water footprint and emissions). But the challenge is to see these more widely used, and across a variety of regions and commodities. Institutions for ensuring fair trade, distribution of benefit from sustainable agriculture, and sustainability must be strong. Transparency is also recognized as a facilitator to get all the actors in the chain informed 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 structure, incentives' mechanisms science and education services/interfaces to the sustainability requirements can possibly shape sustainable agriculture practices realizations. Governments need to recognize the value of sustainability as part of their agricultural policies, redirecting subsidies away from destructive practices toward long-term ecological health (Hilson et al., 2025). There is also a requirement of financial mechanisms, such as easy credit (reduced cost of debt), risk-sharing tools, marketing facilities etc., which are essential for transitioning the farmers to practicing 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 above described practices is also very essential. Supportive policies alongside access to finance and capacity building will drive sustainable agriculture development across the Globe (Olabinjo and Opatola, 2023).



Regional and International Dimensions

Developed countries

Their sustainability issues are related to the shift from high-inputmonocultures,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, value chains an opportunity to advance sustainable development SDG linkages: Food security (SDG2) Water for productive use (SDG 8).

Production in one location (such as commodity crops, feed for livestock) can lead to environmental and social problems elsewhere. Here there are such things 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.

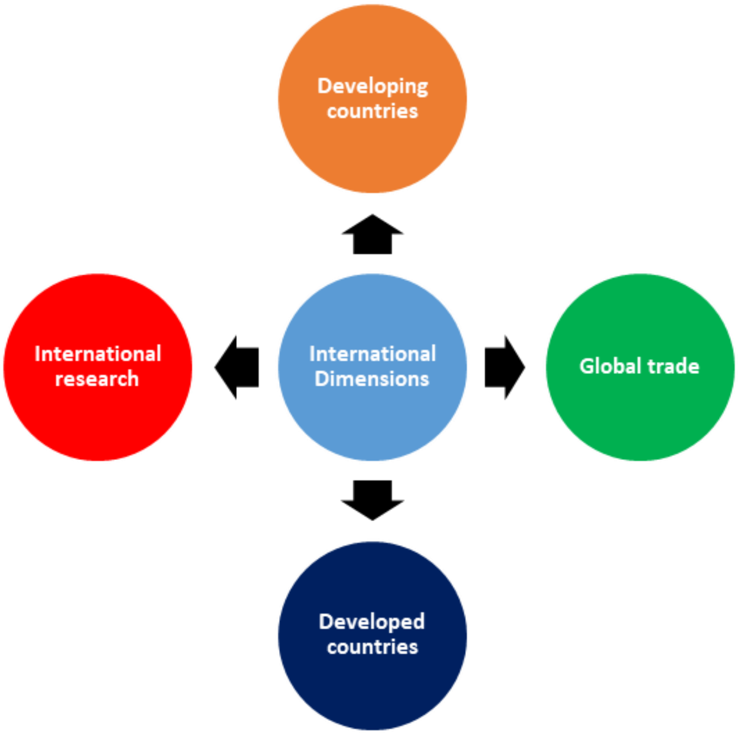
Networks such as China-UK Sustainable Agriculture Innovation Network (SAIN) facilitate cross-border research and collaboration (e.g. between China and UK). It is imperative to focus on developing worldwide capacity, exchanging of best practices and local strategies (Wu et al., 2025).

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 impacts, mainly in terms of long-term monitoring of outcomes, socio-economic studies of adoption behavior, harmonization in metrics used to measure sustainability as it relates to trade-offs between yield and environmental targets, 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.
- High cost at startup and labor requirement may limit adoption by 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 the 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 cost penalty in terms of yield at least in the short term unless innovations are also developed and disseminated. In addition, some "sustainable" tags may disguise unsustainable practices (green washing). For instance the court definition of CSA may restrict accountability (Zwagerman, 2024).

PATH FORWARD AND NEXT STEPS

Integrating Food Systems Approach

Sustainability in agriculture can be related to the food systems that extends beyond the practices within farms, and includes processing, distribution, up to 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 reduction of loss and waste and enhancement of nutritional quality while making the optimal use of resources throughout the supply chain. Sustainability could be understood in a broader perspective by also looking at on-farm waste and post-harvest losses, consumptions patterns and circular economy concepts (e.g., the recycling of food waste, 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).

Scaling and Mainstreaming Sustainable Practices

Scaling up and out For sustainable agriculture to make a mark on the planet, what works in terms of pilot projects has to take off or be brought into the mainstream (Kirina et al., 2022). This would be dependent on policy, financial mechanisms, farmer networks and the infrastructure needed for adoption. It is also claimed that the agricultural instruments of policy should be tuned to sustainability objectives and seek to motivate farmers towards more sustainable practices. In this sense, modular frameworks which allow for the integration of new methods incrementally 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 outweigh 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 trails due to expense and infrastructure limitations. Thus, it is critical that technological advances are locally applicable and cost-effective both 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 achieve sustainability in agriculture. Governments need to move subsidies out of environmentally damaging practices like fertilizer-pesticide overuse and into 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 is essential to drive the scaling up of sustainable practices, especially in developing countries (Li et al., 2024).

International Cooperation and Trade Regulation

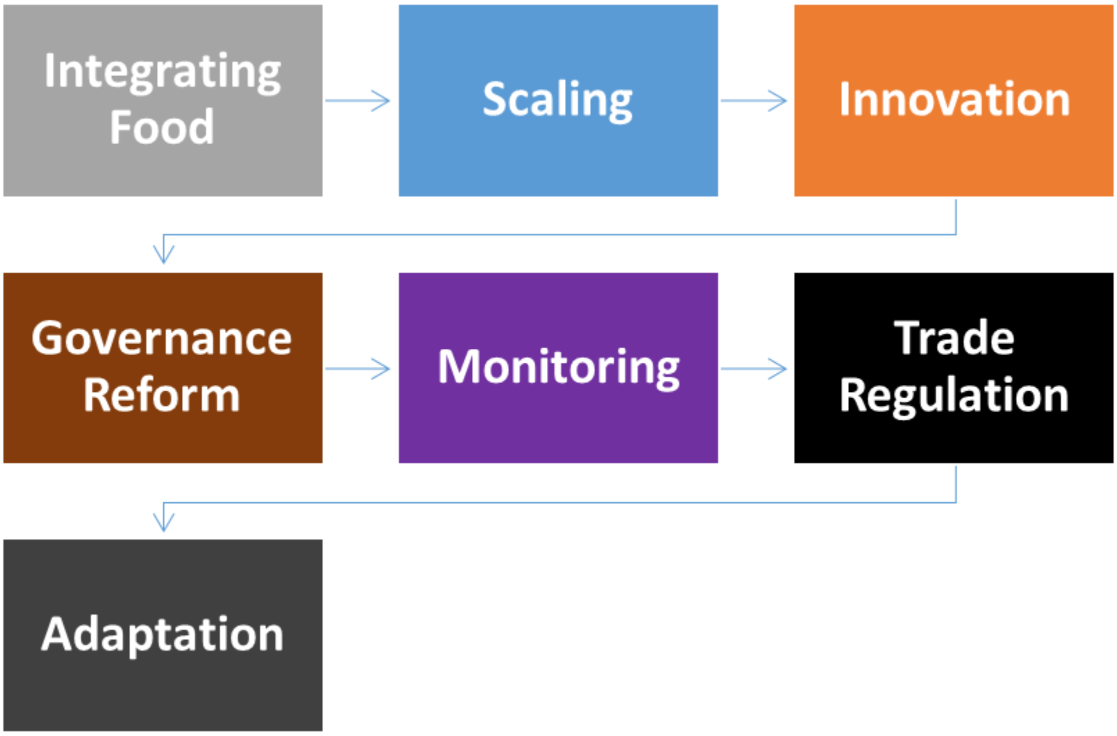
We need to ensure that agricultural trade and supply chains promote sustainability globally. If we are to succeed in this required cooperation, we need international organizations that prevent a situation where trade would externalize environmental or social costs. Improving global governance mechanisms and implementing fair trade, certification standards, and transparent sustainability frameworks help to 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 dealing with 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 like soil health, biodiversity and carbon footprints. Long-term research and evidence-based data are essential to assess the effects of sustainable investments over time and across contexts. Consistent monitoring and evaluation system enable policymakers, practitioners and researchers to make sense of what works as well as address areas that need improvement. C Aspects of sustainability Research also needs to focus on the social, economic dimension of sustainability and understand how different societies adopt sustainable practices and encounter challenges in making it 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, better water use efficiency and cultivation of climate resilient varieties will be the 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 are going to play a major role in making people more resilient. Agriculture can be resilient against the changes in climate by using agroecosystem management to effectively adapt (Holt-Giménez et al., 2021).



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

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, we'd have less negative environmental impact too; better nutrition and generate fairer access to food resources for all. It is important to upscale successful innovations like agro ecology, precision agriculture and climate-smart practices. These methods should be backed by strong policies, financing instruments and a system which would help farmers to take up such practices in the long run.

Innovation and technology do have a role to play. Digitalization, AI and biotech offer a great potential for increased productivity without extracting more resources or causing further harm to the environment. However, their availability and cost are still obstacles, particularly in the low income nations. It is thus essential that technological innovations are developed in ways that are flexible and scalable, considering the economic and social conditions in various agricultural systems. In addition, reform of governance and of 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 too will be crucial for the sustainability of agriculture around the world. 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 towards local sustainability. By ensuring more due diligence will be made on international covenants, transparency levels and fair trade programs, it is possible to achieve an increasing congruence between global agricultural practices and sustainability directions. Moreover, there is a critical need to harmonize sustainability outcome metrics (soil health and biodiversity the below-ground carbon emissions) to ensure that progress can be efficiently measured and followed.

Climate change is likely the greatest challenge agriculture will confront in the next several decades. Resilient agricultural systems that not only cope with but are also resilient to, climate shocks through diversity, water management and development of climate-resilient crops is 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 manage risk and adjust quickly to changing conditions. The future of sustainable agribusiness relies on developing a more resilient, adaptive and inclusive ecosystem that brings together different (locally, nationally or globally) efforts for long-term sustainability.

But above all, we should realize that agriculture's direction towards sustainability is not a matter of choice – it is an issue of necessity for the future survival of our planet and its life forms. It is going to take joint action at various scales of society — from farmers and consumers to governments and international institutions. By focusing on sustainability throughout all food systems and value chains, adopting technological advancements, enacting inclusive policies and adapting to climate change, we can produce food systems that will not only provide for 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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Generative AI Statements: The authors declare that no Gen AI/Deep seek was used in the writing/creation of this manuscript.

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