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Review

Sustainable Agriculture and Land Restoration: Insights from Bangladesh for Enhancing Global Resilience

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Abstract: Bangladesh is emerging as a key case for climate-resilient agriculture in circumstances of land scarcity and environmental stress. This review collates existing evidence towards understanding the role of sustainable agriculture practices and land restoration interventions in supporting food security and resilience. Systematic literature review following Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, integrating peer-reviewed studies and institutional reports. The system settings include four main interventions: climate-smart crop diversification, improved soil fertility management, efficient water resource management, and ecosystem restoration. Our findings demonstrate that, although these interventions led to higher productivity and adaptive capacity of beneficiaries as compared to non-beneficiaries, their effectiveness differs greatly across agro-ecological zones due to differences in access to inputs, institutional support and adoption by farmers. In addition to descriptive synthesis, this study employs a comparative and policy-oriented perspective by highlighting the technological, ecological and institutional dimensions of agricultural transformation. The results highlight that no single intervention is sufficient, and if anything, a coordinated and adaptive approach is necessary in order to make a sustainable impact. In the end, Bangladesh's experience is transferable to other climate-vulnerable areas in how integrated and goal-oriented approaches can lead to adjusted resilience outcomes for smallholder farming systems, achieving productivity vs. environment sustainability balance with strong governance systems and sound extension service delivery.

Keywords: Bangladesh; Smallholder Farming Systems; Climate-Smart Agriculture; Land Restoration; Sustainable Agriculture; Agricultural Resilience

1. Introduction

Food systems worldwide are under increasing pressure from climate change, land degradation, and rising population demands. Extreme weather events (floods, droughts, and temperature), which can disrupt agricultural productivity, threaten food security in different regions [1–3], particularly in terms of soil fertility, water resources, and environmental sustainability [4,5]. These challenges underline the need for agricultural approaches that can improve productivity while maintaining ecological stability and resilience under climate variability [6–9].

Agriculture is the most important sector in Bangladesh, as it supplies essential food crops and nutrition for much of the population [10]. In the global context, Bangladesh stands out as both a significant and highly vulnerable case [11–13]. Although agroindustry has become increasingly important, agriculture continues to play a central role in the national economy [14,15]. Bangladesh has made significant strides in enhancing crop production over the last few decades through the application of modern agricultural practices and technology [16,17]. Such gains, however, have often had a negative consequence on externalities [18,19], including an enhanced consumption of agrochemicals and degradation and/or overexploitation of land and groundwater resources [20,21]. These dynamics suggest that simple intensification is no longer sufficient.

As a response, Bangladesh has developed several sustainable and climate-smart agricultural practices, such as crop diversification, integrated farming systems (IFS), soil management, and water-efficient technologies. These interventions have been effective in enhancing resilience and restoring degraded land [22,23]. However, most exciting research focuses primarily on these practices [10,17,24] or within local contexts. Our understanding of the interactions between these interventions, their trade-offs, and how their effectiveness varies by agro-ecological and socio-economic context is limited.

Nonetheless, a growing body of literature exists on climate-smart agriculture and land restoration in Bangladesh; the integration of these two areas has, until recently, been largely overlooked. More specifically, too little is known about the comparative effectiveness, scalability, and policy implications of interventions. Additionally, a single framework has not yet been used to fully understand the interaction between technological innovation, institutional capacity, and farmer-level adoption, which is crucial for assessing how these factors can collectively enhance sustainable agricultural practices in Bangladesh. Addressing these gaps is essential to developing more cohesive and contextualized approaches to sustainable agricultural development.

Therefore, the purpose of this study is to create vital cross linkages between sustainable agricultural practices and land restoration (LRs) approaches in addressing issues of food security and climate resilience in Bangladesh. It also assesses the viability of key interventions and offers insights on constraints and trade-offs, and how Bangladesh's experience can guide scalable, adaptable solutions where climate-vulnerable regions are concerned. To do so, the study progresses beyond descriptive synthesis to formulate an integrated analytical framework linking technological innovation, ecological processes and institutional capacity. This review thus differs from existing studies, which are based on individually assessed interventions alone, by providing a comparative and systems-level insight into the ways in which multiple strategies are interplaying across heterogeneous agro-ecological conditions. The study contributes to the wider conversation around resilient food systems and sustainable land management by providing policy-relevant insights into trade-offs, scalability challenges and governance needs.

2. Methods

2.1. Strategy for Searching the Literature and Criteria for Selection

This study applies a structured qualitative synthesis approach to evaluate sustainable agriculture and land restoration practices in Bangladesh. To improve the transparency and reproducibility of the review process, the methodology was guided by principles adapted from the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework [24,25].

The search included all the major academic databases, such as Scopus, Web of Science, and Google Scholar. For contextual relevance, only selected grey literature from well-known international organizations (e.g., Food and Agriculture Organization of the United Nations (FAO), World Bank, United Nations Development Program (UNDP), International Rice Research Institute (IRRI)) was also included. We used search strategies to formulate combinations of keywords, including "sustainable agriculture Bangladesh," "climate-smart agriculture," "land degradation Bangladesh," "agricultural resilience," and "land restoration."

Inclusion criteria were (i) research on agricultural sustainability, climate adaptation, or land restoration in Bangladesh; (ii) peer-reviewed journal articles, policy-oriented reports, or high-quality institutional publications; (iii) literature published predominantly after the year 2000, with earlier seminal studies included where relevant; and (iv) literature containing empirical work, analytical work, or policy-oriented analysis. Exclusion criteria included lack of methodological rigor, studies that were not specific to the agricultural sector, or those that did not present robust evidence.

An initial search returned 360 records. All duplicates were removed, and the titles and abstracts were screened, leaving 80 full-text articles for eligibility assessment. In total, 50 studies were incorporated into the qualitative synthesis. An overview of the selection procedure is depicted in **Figure 1**.

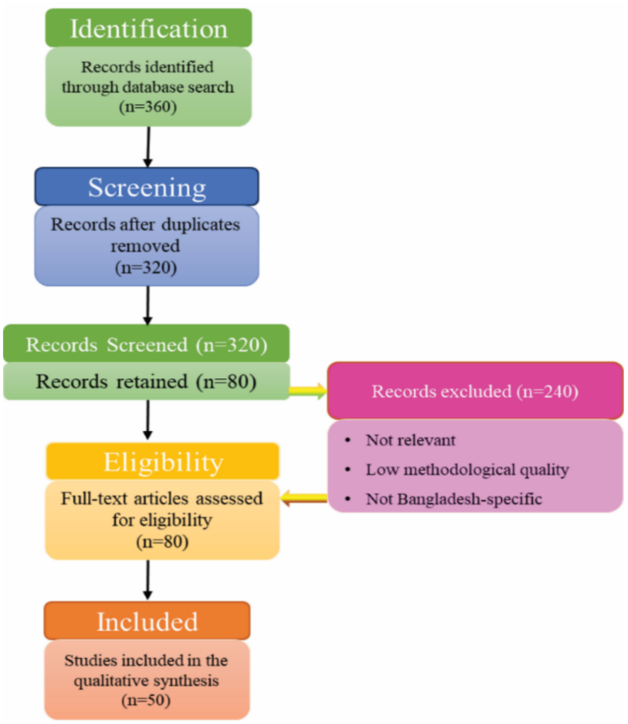

Figure 1. PRISMA flow diagram of the literature selection process.

2.2. Analytical Framework and Research Synthesis Approach

We used a realist synthesis approach to extract how and why certain types of agricultural interventions work or do not work under varying socio-ecological contexts in Bangladesh. This approach not only describes interventions but also aims at understanding the links among context, mechanisms, and outcomes [26].

We organized the selected studies by six thematic areas: (a) climate-smart crop and soil management; (b) water resource management; (c) integrated farming system; (d) ecosystem restoration; (e) disaster risk reduction and cropland buffering during extreme climate events; and (f) institutional and policy government support. Within-function analysis aimed to examine the strengths and limitations of interventions within each theme, paying attention to trade-offs among uses of different resources, scalability issues, and applicability in context.

To provide a more thorough analysis, the review also compared different agro-ecological zones and the interventions used. The study also concentrated on identifying the challenges encountered by smallholder farmers, including resource acquisition difficulties, governance issues, and other hurdles.

This approach enables the study to generate more policy-relevant insights than a purely descriptive synthesis.

3. Country Context: Agriculture and Land in Bangladesh

Bangladesh is located in the delta of the Ganges, Brahmaputra and Meghna rivers, characterized by low-lying floodplains, high population density and high land-use intensity. It's 170 million people live on about 147,000 km^2 of land, one of the highest population densities in the world, leading to extreme pressure on land and making it harder than ever to create new agricultural land and ensure long-term yields [1,2]. The country is divided into about 30 agro-ecological zones (AEZs), each characterized by differences in soil, landform, water conditions, and climate. These variations lead to clear regional differences in agricultural potential and farming practices across Bangladesh (**Figure 2**).

The agriculture sector is still one of the most important sectors in Bangladesh's economy [3], employing a large share of the labour force and playing a critical role in national food security. The adoption of high-yielding varieties, expansion of irrigation facilities, and input-intensive farming practices have contributed to the tremendous growth of crop production in Bangladesh, mainly rice [16,17]. This production model did, however, create structural vulnerabilities such as the depletion of soil nutrients, environmental degradation [18,19], and over-extraction of groundwater [21,22], threatening the sustainability of current systems. So, while intensification increased short-term productivity, it also raised long-term ecological risks.

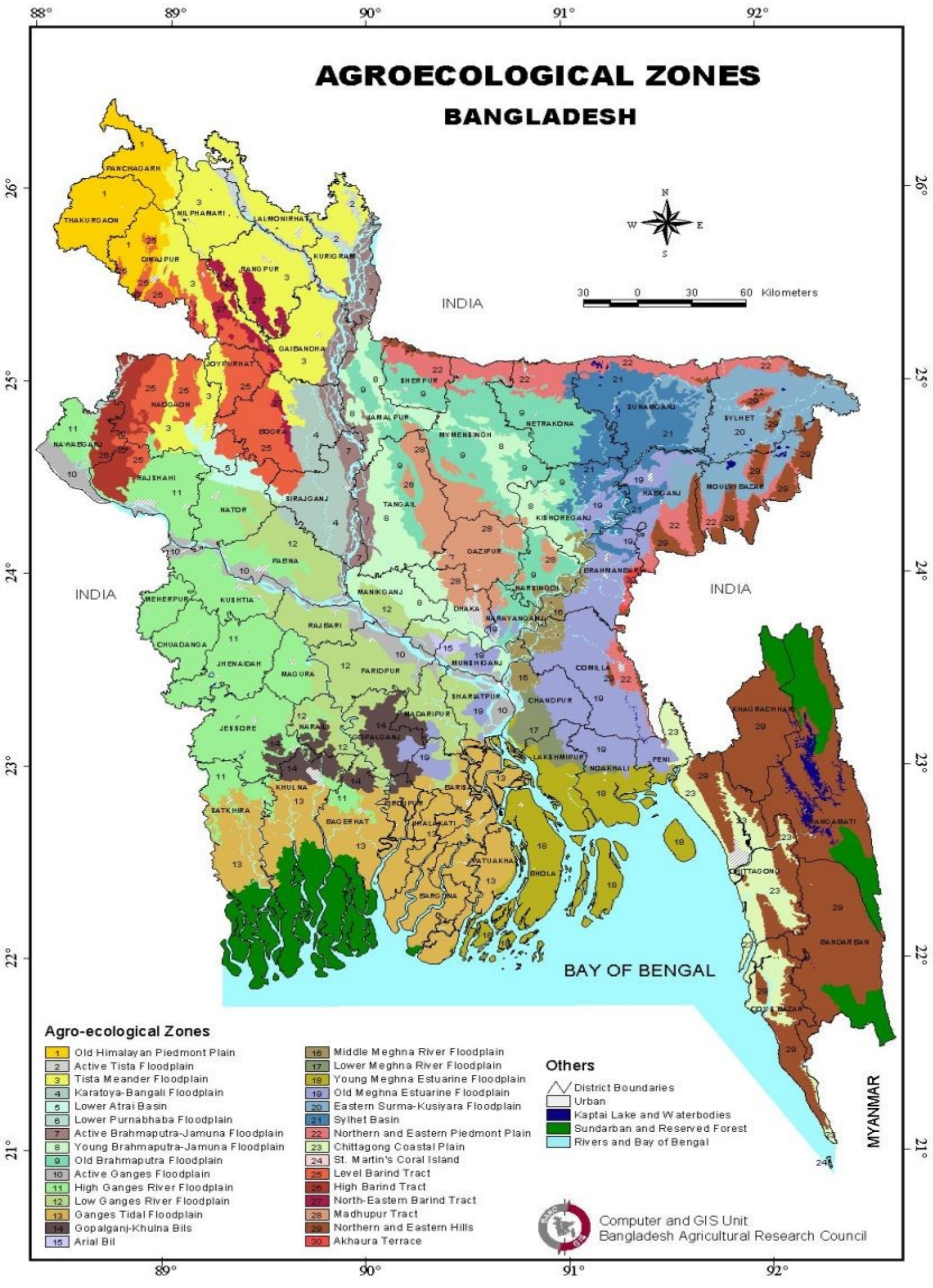

Figure 2. Agro-ecological zones of Bangladesh.

Source: Bangladesh Agro-Meteorological Information System (BAMIS), Department of Agricultural Extension, Government of Bangladesh.

The diverse agro-ecological and geographical features of Bangladesh make agricultural management more difficult. Salinity intrusion and waterlogging become increasingly prominent in coastal areas; drought and declining groundwater levels occur in upland areas; and floodplain regions are still highly susceptible to seasonal flooding and erosion of riverbanks [11–13,26]. These heterogeneous conditions imply that agricultural risks and adaptation needs diverge considerably across regions (**Figure 3**). These heterogeneous conditions imply that agricultural risks and adaptation needs diverge considerably across regions. As a result, either universal policy or technological solutions often fail to tackle the challenge, further emphasizing the necessity of place-based and adaptable approaches.

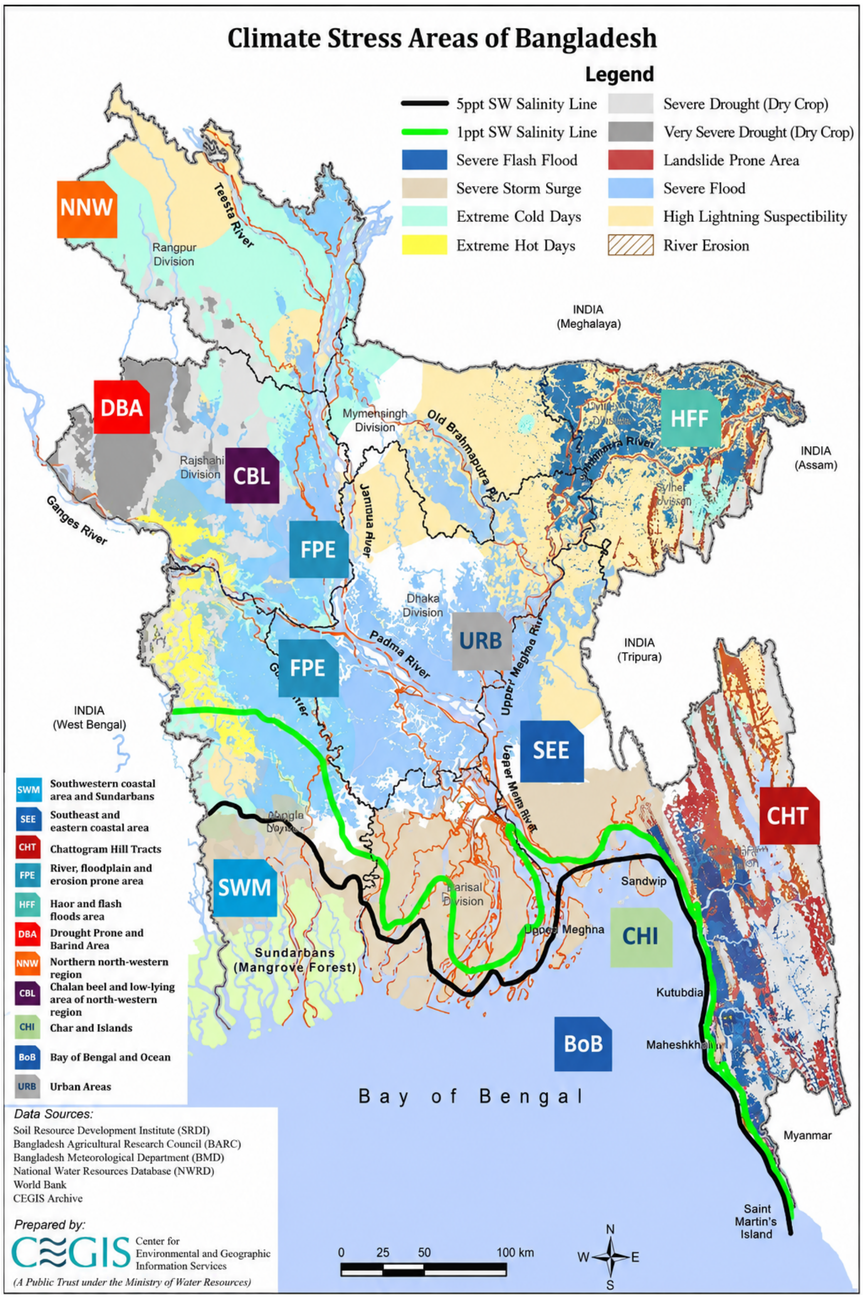

Figure 3. Climate stress zones of Bangladesh showing spatial distribution of salinity, drought, flood, erosion, and other environmental risks.

Source: Center for Environmental and Geographic Information Services (CEGIS), 2022; National Adaptation Plan of Bangladesh, Ministry of Environment, Forest and Climate Change (MoEFCC).

Systemic vulnerability is further underpinned by the dominance of rice-based monocropping systems. Even if rice is the staple of most cultivated land and consumed energy, excessive dependence on a single crop undermines resilience to climate variability and market volatility [25, 26]. This pattern of production leaves little room for diversification and can make pest outbreaks, soil degradation, and income instability more acute among smallholder farmers. Consequently, diversification and integrated farming systems represent increasingly promising pathways for achieving both resilience and sustainability.

Bangladesh has, in recent decades, started the shift to sustainable agriculture practices, such as climate-smart agriculture, water management, and ecosystem-based land restoration approaches [9,27]. These efforts are also a reflection of the systematic realization that sustainable agricultural growth needs to be based on productivity and conservation of resources in tandem. However, the effectiveness of these strategies relies heavily on institutional support, access to inputs, and adoption at the farmer level, each of which varies from region to region, indicating that tailored approaches are necessary to meet the specific needs and challenges faced by farmers in different areas. Hence, addressing environmental limitations, technological solutions, and socio-economic issues together is crucial for developing scalable and sustainable agricultural systems.

4. Review of Interventions in Sustainable Agriculture and Land Restoration

Sustainable agricultural development in Bangladesh is a composite of technological, ecological, and institutional interventions. These strategies aim to boost productivity in climate-stressed periods and combat land degradation and resource constraints. But their effectiveness widely varies by agro-ecological condition, input access and extension system strength. Here we analytically study some prominent intervention domains, focusing on performance, limitations and broader implications.

4.1. Climate-Smart Crop and Soil Management

The role of stress-tolerant crop varieties (e.g., salinity, flood, and drought-resistant rice) in stabilizing production in vulnerable regions is well documented [9, 10]. These varieties enable cultivation in previously marginal areas and help decrease yield variability under climatic stress [10,19,26]. While they do perform well, they are often restricted due to access to good-quality seeds, uneven distribution, and variability within micro-environments. Moreover, increased reliance on better varieties in the absence of diversification may result in reduced agrobiodiversity and greater long-term system vulnerability.

Crop diversification has become a complementary strategy for farmers seeking to reduce reliance on rice monoculture while maintaining stable incomes. Introducing crops like maize, pulses, oilseeds, and vegetables has also improved productivity/resilience [24]. But diversification requires reliable access to markets, extension services and availability of inputs, which are unevenly distributed across the country. Without these enabling conditions, adoption will remain siloed and limited.

Practices that revive soil health, such as nutrient management, composting and green manuring, can help improve nutrient use efficiency. These practices improve soil organic matter and hydration, which support sustained productivity [18, 20]. Nevertheless, their adoption is often constrained by labour needs, availability of organic inputs and uncertainty in immediate yield. This highlights a trade-off between short-term economic returns and long-term soil sustainability.

4.2. Water Management and Irrigation Innovations

Significant agricultural and productivity advancements, primarily from expanded irrigation and improved drainage systems resulting from water management interventions in Bangladesh, have brought critical benefits to communities. Salinity intrusion has been alleviated, and multiple cropping has been permitted in sensitive areas through coastal embankments, as well as by polder systems [6]. Similarly, small-scale irrigation technologies have allowed for crop production in the dry season in drought-prone regions.

At the same time, these introduce important trade-offs. The widespread adoption of groundwater-based irrigation led to cropping intensification [21, 22] but caused declining water tables and high energy costs [24, 28]. Moreover, poorly administered embankment systems can just shift the flood risk somewhere else instead of eliminating it, leading to increased vulnerability for other areas that may not have been previously at risk. These results suggest that where water control infrastructure increases productivity, its actual implementation in farming systems should be controlled to limit unexpected environmental repercussions [22,23].

The most sustainable alternatives, such as harvesting rainwater, using surface water for households and communities, and engaging in community-based water governance approaches to manage shared resources, are now emerging. These approaches aim to improve water-use efficiency and reduce dependence on groundwater resources. Therefore, water management is no longer just a technical matter in Bangladesh; it has also become a governance issue.

4.3. Integrated Farming Systems and Livelihood Diversification

Depending on the balance between greater income stability and better resource efficiency, integrated farming systems such as rice-fish culture, crop-livestock integration, and homestead-based production are showing tremendous potential. These systems promote nutrient cycling, decrease reliance on external inputs, and improve resilience to climate shocks [25,29].

However, the adoption of identified best practices is inconsistent in relation to their higher labor requirements, knowledge gaps, and market uncertainty [30–32]. Smallholder farmers may struggle with complex production systems without sufficient technical assistance, which can hinder their ability to implement sustainable practices effectively and reduce their overall productivity. This means that integrated systems are ecologically responsible, but their scalability hinges on access to training, credit, and market linkages.

4.4. Ecosystem Restoration and Nature-Based Solutions

Ecosystem-based approaches, such as coastal afforestation [25] and agroforestry and watershed restoration [29], for example, stabilize degraded landscapes while improving biodiversity [33,34]. These interventions have multiple co-benefits, including erosion control, carbon sequestration, and improved microclimatic conditions, in addition to impacts on plant productivity. As shown in **Figure 4**, these nature-based solutions enhance key ecosystem processes such as soil stabilization, nutrient cycling, and water infiltration,

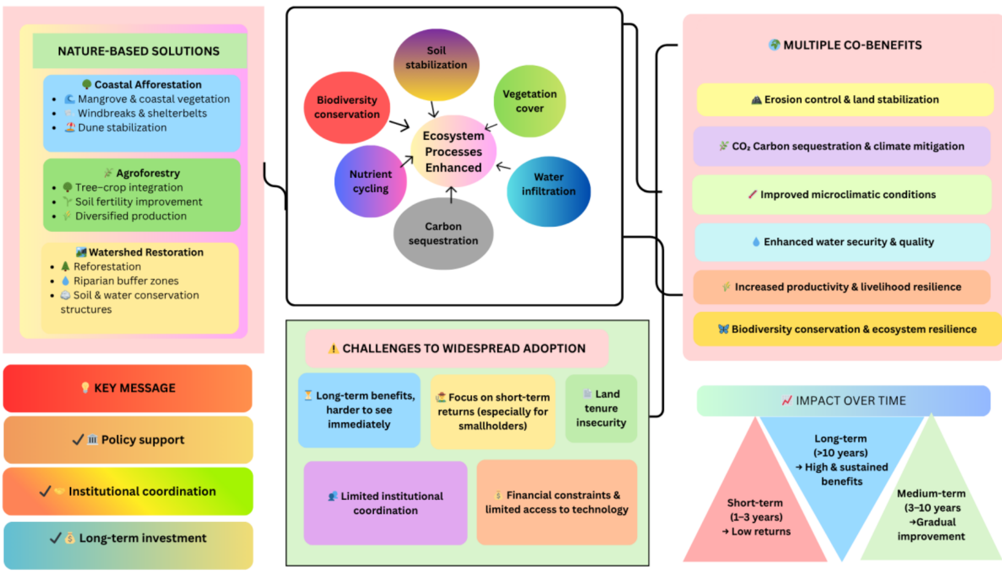

Figure 4. Ecosystem Restoration Pathways: Processes, Benefits, and Adoption Challenges.

However, their impacts are long-term and may be harder to see immediately. This makes giving up existing practices difficult to adopt, especially for resource-constrained farmers with a focus on short-term returns [30,32]. Moreover, in addition to land tenure challenges and limited institutional coordination, there may be other challenges, such as financial constraints and lack of access to technology, that impede the widespread application. These findings imply that ecosystem restoration is going to take sustained policy support and long-term investment.

4.5. Institution Support and Policy Structure

Institutional capacity is essential for the sustainability of agricultural interventions [30,31]. Extension services, farmer training programs and policy incentives have been key to helping advance climate-smart practices and to increasing adoption. More recently, knowledge transfer and access to resources have also been improved through collaboration between government bodies, NGOs and international organizations [14,27,35,36].

In practice, institutional limitations often constrain the effectiveness of these interventions. Interventions at scale are often inefficient due to uneven extension coverage, lack of financial incentives/constraints, and weak monitoring systems. Moreover, policy fragmentation may also result in uneven implementation across regions. Such struggles demonstrate the need for integrated governance frameworks that pair technological innovation with institutional support. **Table 1** summarizes key interventions, their potential benefits, limitations, and trade-offs.

Table 1. Summary of Key Interventions, Benefits, Limitations, and Trade-Offs in Sustainable Agriculture in Bangladesh.

Intervention Category	Specific Practices	Key Benefits	Major Limitations	Associated Trade-Offs	References
Climate-smart crop management	Stress-tolerant varieties (salinity, drought, flood)	Yield stability under climate stress; expanded cultivation areas	Limited access to quality seeds; uneven adoption	Potential reduction in agrobiodiversity	FAO [7], Feder and Umali [9], Moher et al. [31]
Soil fertility management	Composting, green manuring, balanced fertilization	Improved soil health; enhanced nutrient efficiency	Labour-intensive; limited organic inputs	Short-term yield uncertainty vs. long-term sustainability	Lal [34], Godfray et al. [12]
Water management	Groundwater irrigation, embankments, drainage systems	Increased cropping intensity; improved productivity	Groundwater depletion; infrastructure risks	Increased energy cost; environmental stress	Brauman et al. [4], Mirza [30]
Integrated farming systems	Rice-fish systems, crop-livestock integration	Diversified income; nutrient recycling; resilience	Knowledge-intensive; labour demand	Adoption barriers among smallholders	Feder and Umali [9], Ministry of Finance [24], Garnett et al. [11]
Ecosystem restoration	Agroforestry, coastal afforestation, watershed management	Biodiversity conservation; ecosystem services	Delayed economic returns; land tenure issues	Requires long-term investment and policy support	Meijer et al. [23], OECD [32]
Institutional support	Extension services, policy incentives, farmer training	Increased adoption; improved knowledge transfer	Weak governance; uneven implementation	Policy fragmentation; limited scalability	OECD [32], Page et al. [37], Pawson et al. [38], Pingali [39]

4.6. Synthesis of Interventions

The evidence demonstrates that no single intervention was sufficient to achieve sustainable agricultural transformation in Bangladesh. Although individual strategies enhance productivity and resilience, there is context-dependent interaction between ecological, technological, and socio-economic factors. Importantly, many of the interventions entail trade-offs between short-term productivity gains and long-term environmental sustainability. This highlights the importance of integrated, system-based approaches that align innovation efforts with solid institutional support and are adapted to the local context. The next section uncovers these dynamics with a critique of their wider ramifications. Key interventions, mechanisms of effect, outcomes, and associated trade-offs are synthesized in **Figure 5**.

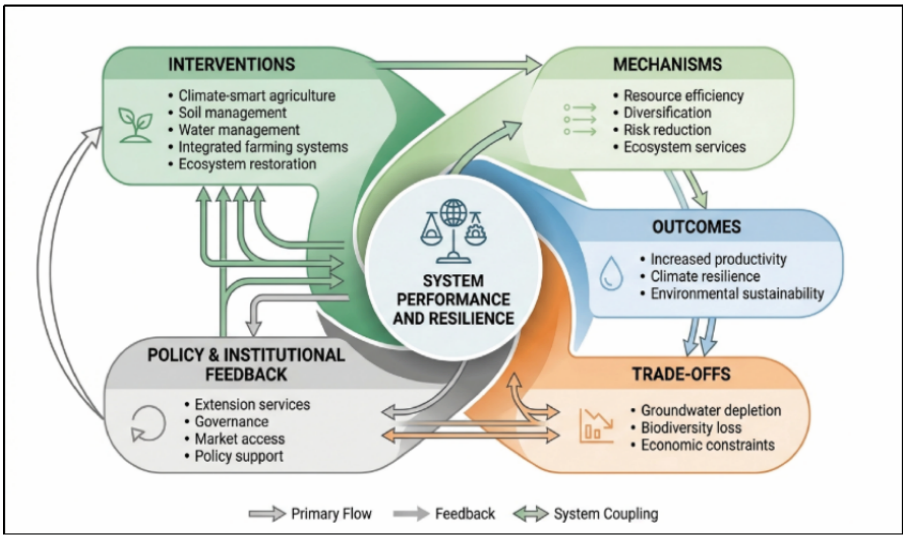

Figure 5. A conceptual framework linking sustainable agricultural interventions, outcomes, trade-offs, and policy feedback in Bangladesh.

5. Global Implications: Lessons from Bangladesh for the World

Bangladesh's experience may prove helpful to other climate-vulnerable regions searching for that balance between agricultural productivity and environmental sustainability. One key lesson is that integrated approaches tailored to further climate-smart agriculture, soil management, water-use efficiency, and diversified farming systems are more effective than stand-alone interventions [7,8]. This strengthens the emerging consensus that designing a sustainable agriculture typically requires systems-based, not single-technology solutions.

A further key finding is that there are inherent trade-offs within agricultural intensification pathways. Irrigation expansion is one of the most important elements in productivity increments, but it has also triggered aquifer depletion and so increased environmental costs [22,23]. The introduction of high-yielding and stress-tolerant crop varieties is another case. These results underscore that sustainable agricultural practices must balance productivity gains with the considerations for resource conservation over time.

The Bangladesh case also demonstrates the interactions between the effects of agricultural interventions and enabling conditions such as institutional capacity, extension services, inputs and market integration [30,37]. This perspective is especially pronounced in regions such as South Asia and Sub-Saharan Africa, where a greater extent of structural and institutional constraints determines agricultural outcomes.

Furthermore, the local knowledge-scientific innovation link quickly becomes key to effective adaptation. Evidence illustrates that participatory and location-specific approaches perform better than standardized models for a broad range of agro-ecological and socio-economic environments, particularly in addressing the unique challenges faced by farmers in these regions. This further highlights the need for more adaptive policy frameworks that can offer flexibility in implementation.

In sum, the Bangladesh example reveals that sustainable agriculture is a dynamic and adaptive process intertwined with environmental conditions, technological innovation, and governance systems interaction [40–42]. However, despite these differences and the idiosyncrasies of different countries, these lessons provide practical insights into how to design scalable agricultural approaches for climate-resistant agriculture in other vulnerable regions facing similar climate challenges.

6. Discussion

Bangladesh's progress in sustainable agriculture and land restoration reflects the combined influence of multiple strategies adapted to local conditions rather than a single uniform approach. This supports wider evidence that integrated and diversified agricultural systems contribute more to resilience than isolated interventions [7,8]. But the success of these strategies is not homogeneous across agro-ecological zones, and their scaling up will depend on site-specific tailoring rather than a global blanket approach.

A key pattern emerging from this review is that sustainable agricultural progress depends on the combined and location-specific application of multiple interventions rather than reliance on any single strategy. For example, the expansion of irrigation has substantially increased cropping intensification and stability of yields with respect to droughts [21,22]. However, overreliance on groundwater resources can pose long-term sustainability issues such as lowering of the water table and increasing energy requirements [23,28]. Such trade-offs have been documented within the broader context of food-water systems, where productivity gains may be associated with losses in environmental sustainability [22,23]. Just as stress-tolerant and high-yielding crop varieties will improve short-term productivity, their widespread use without diversification could limit agrobiodiversity and increase susceptibility to systemic shock [29]. These findings underscore the need for balanced approaches that link productivity to ecological sustainability.

Another important factor is how ongoing institutional governance mechanisms impact agriculture interventions. New evidence suggests that effective implementation correlates highly with access to extension services, farmer training and coordinated support by both government and development agencies. This is consistent with previous literature indicating that adoption of technology in smallholder farming systems is influenced by both institutional capacity and the dissemination of information [30,31].

Farmer-level decision-making plays a crucial role in shaping the adoption and sustainability of agricultural practices. Farmers' decisions to adopt new technologies or new management practices depend strongly on economic constraints, perceptions of risks, and access to resources [31,32]. Other means of building soil include integrated farming systems and organic management, which may have higher upfront costs but offer long-term benefits. Smallholder farmers, however, may be reluctant to adopt these practices without financial incentives or risk mitigation mechanisms in place. This pattern is commonly observed in developing-country contexts, where resource constraints, limited access to finance, and higher levels of uncertainty influence farmers' decisions regarding technology adoption [32].

More broadly, Bangladesh's experience highlights the importance of combining local knowledge with scientific innovation. Innovative methods leading to adaptive, participatory learning have shown great potential in bypassing diverse agro-ecological impediments [5,6]. The modalities highlighted in these approaches are site-specific rather than generic, as they initiate more sustainable action pathways compared with standardized models [7,8]. At the same time, entrenched barriers, including unequal access to resources, weak long-term environmental monitoring and decision-making fragmentation, persist as challenges hampering effective interventions. Similar challenges are seen in global assessments on the sustainability of food systems that highlight the role of integrated governance and systemwide change [40–42].

More importantly, this study demonstrates that sustainable agriculture in Bangladesh must be conceived as a dynamic socio-ecological system influenced by the interplay of environmental, technological and socio-economic factors. Instead of one best approach, the findings imply flexible, integrated and context-sensitive solutions that respond to emerging climatic and developmental pressures.

7. Gaps and Future Research

Although there is a developing literature on sustainable agriculture and land restoration in Bangladesh, a knowledge gap persists. The key knowledge gaps and consequent future research priorities, as determined in the analysis from this study, are presented in **Table 2**.

Table 2. Key Knowledge Gaps and Future Research Directions in Sustainable Agriculture and Land Restoration in Bangladesh.

Major Knowledge Gap	Evidence Limitation	Suggested Research
Lack of system-level analysis	Isolated studies	Integrated modelling
Lack of long-term data	Short-term focus	Longitudinal studies
Regional variation	Limited comparison	Cross-zone studies
Institutional gaps	Weak adoption studies	Policy-focused research

First, these studies tend to focus on specific types of intervention (e.g., crop improvement, irrigation) but fail to explore the effect of multiple interventions or the overall aggregated interventional effects [10,43]. This impedes understanding of how various practices engage with and affect aggregate agricultural sustainability.

Second, there is limited long-term empirical evidence on the environmental and socio-economic impacts of these interventions [44]. Several studies only report short-term gains in productivity without considering, or sufficiently evaluating, trade-offs that affect soil health [45], water resources [46], and ecosystem services over the longer term [47]. This emphasizes the importance of longitudinal and multi-scale studies.

Third, regional variability in agroecological conditions and socio-economic contexts is still understudied [48]. Data analysis is needed to compare effectiveness, as interventions often produce very different outcomes in coastal, floodplain, and drought-prone regions. Future studies should focus on location-specific research but develop frameworks for comparing across regions.

Moreover, the investment in institutional/incentive and governance mechanisms related to adoption and scalability merits further exploration [30,31]. Knowledge of how to structure policy, provide extension services, and create access to markets can guide farmers in implementing these innovations at a larger scale.

Potential research directions could combine agronomy, environment, socio-economics, and policy analyses in interdisciplinary approaches [49]. In addition, the deployment of advanced tools (e.g., modelling and remote sensing) or data-driven decision support systems can be used to optimize our understanding of complex agricultural systems [50]. Closing these gaps will thus be crucial to implementing more effective, scalable, and climate-resilient agricultural strategies in Bangladesh as well as beyond.

8. Limitations of the Study

This review has limitations despite attempts to ensure rigor. While grey literature is important for informing policy, it can also introduce variation in the quality of method use.

Moreover, qualitative synthesis entails interpretative judgement, which can vary among researchers, leading to potential biases in the findings and conclusions drawn from the data. Owing to temporal limitations, the most recent publications may be excluded. These constraints must be considered when analyzing the results.

9. Conclusions

This study reveals that Bangladesh's experience offers an important perspective on how a well-integrated, regionally differentiated approach to sustainable agriculture and land restoration can increase resilience to climate-related stressors while also addressing short- and long-term food security issues. The integration of climate-smart practices, improved resource management and institutional support are also identified in the study as potentially enhancing both productivity and resilience, although there is heterogeneity around outcomes across farming systems and regions.

Emerging results divulge that climate-smart practices, effective management of resources and input use and supported institutions are essential to enhance agricultural productivity, whereas their use depends on the agro-ecological and socio-economic setting. These lessons learned can inform policymakers and development practitioners on how to design equitable, climate-resilient agricultural systems in other climates threatened by similar risks.

Author Contributions

Conceptualization, methodology, and synthesis, R.K.S. and M.N.I.M.; data collection and visualization, R.K.S., A.T., and M.J.N.; manuscript drafting, critical review, and final approval, R.K.S. All authors have read and agreed to the published version of the manuscript.

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Not applicable.

Informed Consent Statement

Not applicable.

Data Availability Statement

This study is based on published peer-reviewed and grey literature. All information analyzed during this review is presented within the article. No new datasets were generated. Additional details can be provided by the authors upon reasonable request.

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Conflicts of Interest

The authors declare no conflict of interest.

AI Use Statement

AI-assisted tools were used solely for language refinement and clarity improvement. The authors reviewed and edited all content and take full responsibility for the integrity and originality of the manuscript.

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