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Nurturing the sustainable food systems: crafting policies and practices for crop diversification in Bangladesh

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Bangladesh's agriculture is highly rice-centric. Although economically rational, this is also risky, and arguably unsustainable. As a result, there is increasing interest in crop diversification (CD). This study examines the policy environment and the implementation of projects promoting CD in Bangladesh from 1971 to the present. An integrated analytical framework, developed by the International Wheat and Maize Improvement Center (CIMMYT) was used. Despite numerous policies and projects aimed at promoting CD, progress remains limited due to historical biases and various challenges. This research identifies a significant gap in existing approaches, which primarily focus on production aspects while neglecting market systems for new crops. Additionally, inadequate coordination among government agencies has impacted the effectiveness of projects implemented by development partners. The study highlights that CD efforts have been largely project-driven and short-lived, emphasizing the need for mainstreaming CD with dedicated annual funding to ensure long-term sustainability. Key challenges in funding, market development, and implementation are identified. The study recommends mainstreaming CD through annual budgets and enhancing market linkages. Furthermore, it provides actionable guidelines for policymakers and practitioners to effectively promote and sustain crop diversification in Bangladesh's agriculture.

KEYWORDS

sustainable agriculture, crop diversification, projects, policy provisions, Bangladesh

Introduction

In the early 1970s, Bangladesh faced a severe food deficit with a population of about 75 million. Today, the country has largely achieved self-sufficiency in rice production, which has tripled over the past three decades (Ahmed et al., 2022). The food crises of the early 1970s compelled the Bangladesh government to intensify food production efforts (Dowlah, 2006). Historically, the policy focus has been on food self-sufficiency, food security, and yield intensification (Planning Commission, 1973, 1980, 1985, 1990, 1997, 2011), resulting in significant yield growth (Bokhtiar and Samsuzzaman, 2023). Secondary crops were initially neglected in policies (Bokhtiar and Samsuzzaman, 2023). These efforts have led to a significant increase in cereal crop production. Particularly, rice production increased from 9.93 MMT in 1972 to 38.14 MMT in 2022 (Bokhtiar and Samsuzzaman, 2023), occupying nearly 80% of the crop area in 2022 (BBS, 2023). This increase in rice area has come at the expense of minor crops such as pulses, oilseeds, vegetables, fruits, and spices, which have seen reduced land allocation and insufficient research attention to support large

yield gains (Monayem Miah, 2011). The current crop production system is highly rice-centric, which is rational but also risky and arguably unsustainable (Nandi et al., 2023b). As a result of this focus on yield increase crop diversity has significantly declined over time (Bishwajit et al., 2013; Nahar et al., 2024). The intensification of agriculture, in other words, specialization (i.e., intensive modern rice monoculture in our case) has introduced numerous challenges within our food systems, potentially leading to widespread and unmanageable consequences for society (Pingali et al., 2019; Rahman, 2009). These include environmental damage, the degradation of various ecosystem services, and adverse effects on dietary diversity. Additionally, the intensive use of chemical fertilizers and pesticides has increased environmental stress, leading to soil degradation and water pollution. The focus on rice production has also neglected other crops, limiting crop diversification and reducing the agricultural sector's resilience (Farrow et al., 2024; Uddin and Dhar, 2018). Several studies have recommended the promotion of crop diversification as a crucial strategy to address the challenges posed by the intensification and to promote sustainable agriculture considering its multi-functionalities such as environmental sustainability, economic resilience, social well-being, higher incomes, and the mitigation of pedoclimatic and socioeconomic risks associated with traditional farming practices (André et al., 2024; Bijarniya et al., 2024; Kumar et al., 2024; Mzyece and Ng'ombe, 2021; Neogi and Ghosh, 2022; Rahman et al., 2024; Rukhsana Alam, 2022; Rukhsana Alam, 2021; Singh et al., 2022). Crop diversification is a process that makes a simplified cropping system more diverse in time and space by adding additional crops (Hufnagel et al., 2020). Recognizing the significant impact of intensive farming practices on food security, agriculture, and the environment, governments and development agencies have increasingly prioritized crop diversification in their policies, projects, programs, and initiatives in South Asia (Ahmed et al., 2015; Mukherjee, 2015; NPC, 2019). The prioritization of crop diversification has ascended to the forefront of the agriculture policy agenda, and it has gained traction as a promising strategy in Bangladesh (Ahmed et al., 2015; Nahar et al., 2024; Rahman et al., 2024).

Research is carried out to understand the policy environment and implementation of projects promoting crop diversification in Bangladesh from 1971 to date. This policy brief provides valuable insights into the nation's crop diversification landscape, including key policies, implementation strategies, challenges, and opportunities. This study provides valuable insights for making informed decisions for future policies and operational endeavors, ultimately improving the success of crop diversification efforts in Bangladesh. An integrated analytical framework, developed by the International Maize and Wheat Improvement Center (CIMMYT) (Nandi et al., 2023a), was used. The framework and the method followed can be accessed.[1]

Policy options and implications

Rice-centric production system

In Bangladesh, rice is not only a staple food crop but also a cultural icon and a significant driver of the agricultural economy (Al Mamun et al., 2024; Al Mamun et al., 2021). Rice stands as the primary dietary staple for the people of Bangladesh, and it is at the center of the overall life of Bengalis, whether it is culture, politics, or the economy (Raihan, 2013). According to the Bangladesh Bureau of Statistics (BBS, 2022), the country boasted an impressive rice production of 38.8 million metric tons (MMT), ranking as the third-highest rice producer in the world. The *per capita* rice consumption in Bangladesh is the highest in the sub-continent. Rice production has increased by 4.41 percent annually since 1970 to 2022–23 (Figure 1). Supportive government policies have been instrumental in propelling the rapid expansion of the cereals sector in Bangladesh, with a particular emphasis on rice production. Historically, the government's agricultural policies have favored rice cultivation (Nandi et al., 2023b).

For example, the government launched an input support program to boost Aus rice cultivation, offering farmers seeds, fertilizers, and cash incentives (Jamal et al., 2023; Uddin and Dhar, 2018). The introduction of high-yielding varieties (HYVs) and the Green Revolution in the 1960s and 1970s further solidified rice's dominance in the agricultural landscape (Bokhtiar and Samsuzzaman, 2023; Nandi et al., 2023b; Uddin and Dhar, 2018). By the 1990s, rice production had tripled compared to the early 1970s, transforming Bangladesh from a food-deficit country to one of the largest rice producers globally (Yang, 2019).

Insights into Bangladesh's crop diversification policies

Policy priorities have transformed Bangladesh from a country with recurrent food shortages to one on the verge of being free from hunger and poverty. Since 1971, a supportive policy environment enabled this significant shift. In the early to mid-1980s, policies (1st to 3rd Five-Year Plans through Phase I & II reforms) focused on increasing crop production and productivity (Planning Commission, 1973, 1980, 1985). However, the third phase of reforms in the late 1990s and 2000s emphasized crop diversification, recognizing the negative impacts of intensive crop production. The National Agricultural Policy (NAP) 1999 stressed Crop Diversification Programs (CDP) to improve nutrition and promote sustainable farming practices (Ministry of Agriculture, 1999). Post-1971, successive governments prioritized food security by increasing rice production, initially neglecting secondary crops. The 4th Five-Year Plan (FYP; 1990–95) marked the first significant policy emphasis on crop diversification (Planning Commission, 1990). International development agencies had already invested in crop diversification projects before the Government of Bangladesh's policy shift. The crop diversification project from 1989 to 99, supported by CIDA (Canada) and the Netherlands, was one of the earliest initiatives by the Department of Agricultural Extension (DAE) focused on crop diversification (Miah et al., 2013; Rahman and Kazal, 2015). Subsequent FYPs continued to prioritize crop diversification (Figure 2), leading to significant improvements in the yields of maize, pulses, oilseeds, potatoes, and vegetables. During the 5th FYP, a financial outlay of around 120 million USD (Tk 1900 million) was allocated exclusively for crop diversification (Planning Commission, 1997). The 6th FYP aimed to achieve self-sufficiency in rice production while prioritizing wheat to reduce import dependency. It emphasized crop intensification in specific regions and diversification toward high-value crops, considering market receptivity and a conducive

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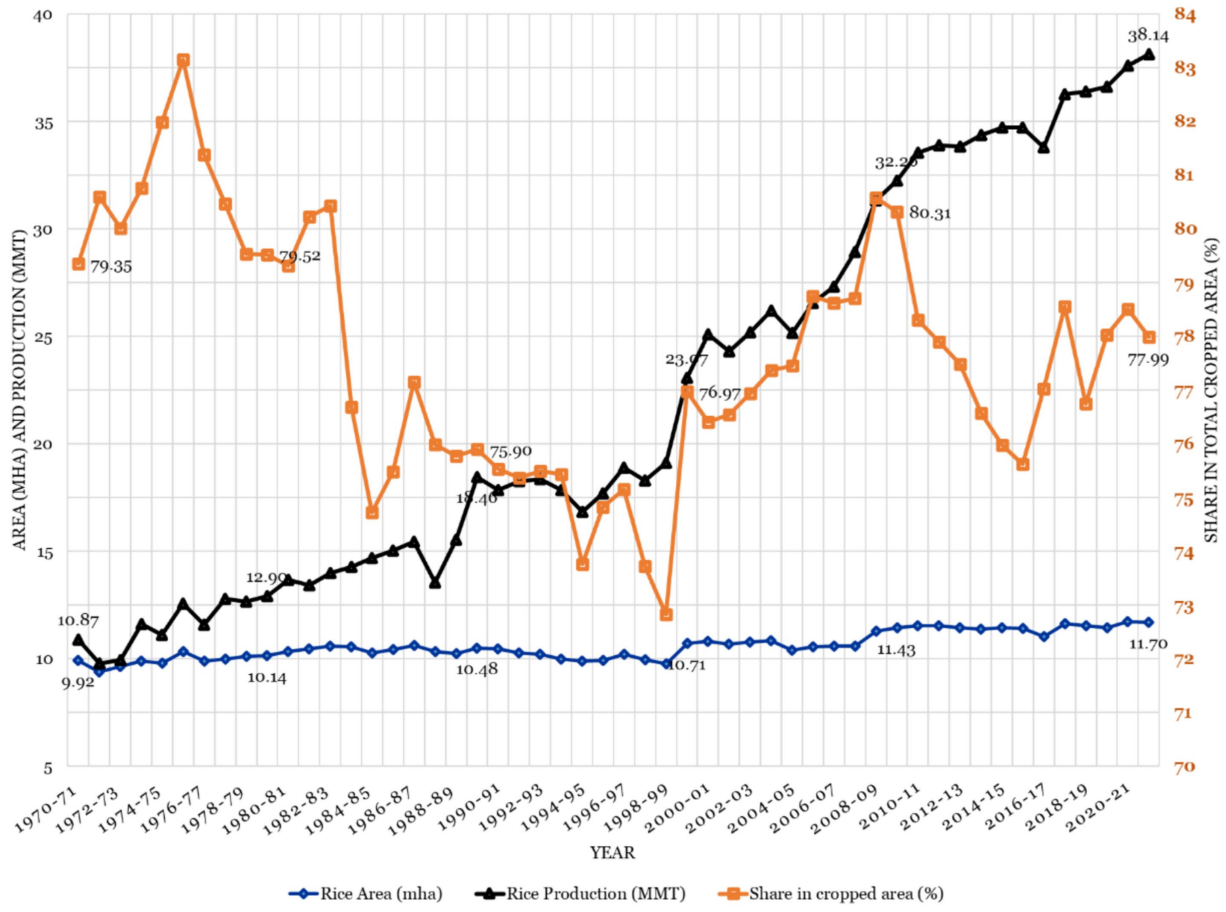

FIGURE 1
Rice area, production, and share in the total cropped area (1971–2021). Source: BARC, 2023.

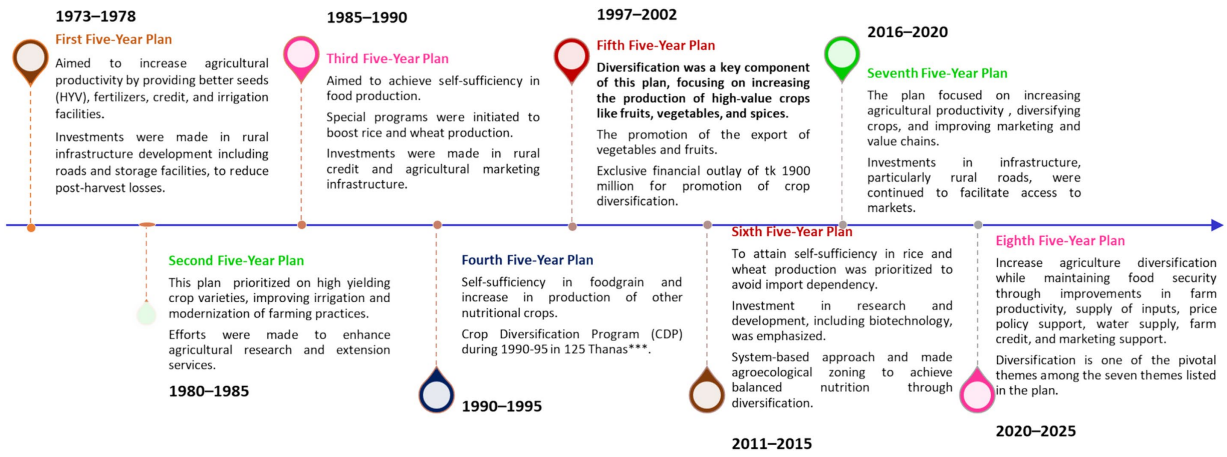

FIGURE 2
Overview of the Five-Year Plans of Bangladesh from a crop diversification perspective.

policy environment (Planning Commission, 2011). The 7th FYP aimed to transition agriculture from semi-subsistence farming to a more commercialized model, focusing on boosting productivity, fostering diversification, and adding value to agricultural products. Crop diversification was highlighted to enhance food security and reduce the agriculture sector's vulnerability to climate change impacts (Mzyece and Ng'ombe, 2021; Planning Commission, 2015). These diversification efforts continued into the Eighth FYP (8th FYP), with agricultural diversification as one of the key priorities. The agricultural research vision for 2030 also significantly emphasizes diversification

(Planning Commission, 2020). The details about each FYP are given in Annexure I.

Following the FYPs and the agricultural research vision, Bangladesh has implemented numerous policies to promote crop diversification, demonstrating a commitment to fostering a resilient agricultural sector. A detailed review of agricultural policies from 1971 to 2023, identified 12 policies focused on crop diversification. A list and brief of these policies are provided in Annexure II. The Crop Diversification Program (CDP), launched in the 1980s, was pivotal in diversifying Bangladesh's agriculture, marking a significant shift from subsistence farming to a more commercially oriented approach (Enamul, 2022; Nahar et al., 2024; Rahman, 2009). The Bangladesh government has formulated a comprehensive agriculture policy to transition from a 'rice-centric' approach to a more diversified and sustainable production system. This strategic shift aims to improve farmers' incomes and ensure long-term agricultural sustainability. To achieve these objectives, the government has initiated various projects, such as the 'Thana Cereal Technology Transfer and Identification' and the 'Crop Diversification Program' (Ahmed et al., 2015). These projects encourage diversification by incorporating a broader range of crops, including pulses, vegetables, fruits, and potatoes. This approach enhances produce variety, increases farmers' earnings, supports agricultural resilience, and reduces dependency on a single crop. It benefits farmers and contributes to the nation's overall food security and sustainable economic development. Despite government support for crop diversification, levels have remained low over the years, primarily due to a lack of technological advancement (Monayem, 2011). However, various studies show the positive effects of specific interventions. For instance, (Rahman, 2009) found significant increases in the production of potatoes, oilseeds, pulses, fruits, and vegetables in regions participating in a specific program compared to non-participating areas. Between 1960 and 1996, crop diversity rose by 4.5%, as indicated by two agricultural censuses. Similarly, (Alam, 2005) observed a modest increase in potato production, attributed to growth in acreage and yield. The adoption of improved practices also increased yields of pulses and oilseeds. The policies reviewed lack comprehensive analyses and have notable deficiencies. They continue to emphasize cereal production and superficially address diversification and commercialization. These terms are used interchangeably in the policy documents, which overlook the agriculture market system as a key factor for successful crop diversification (Nandi et al., 2023b).

Insights into Bangladesh's crop diversification projects and programs

In response to the government policies, the government and international development agencies have developed and implemented several projects aimed at promoting crop diversification in Bangladesh. To date, the Government of Bangladesh (GoB) and international development partners have implemented 18 projects, investing approximately USD 475 million in the past 30 years. Whereas, excluding the recent World Bank and International Fund for Agricultural Development (IFAD)-Funded USD 500+ million 'Program on Agricultural and Rural Transformation for Nutrition, Entrepreneurship, and Resilience (PARTNER). Among these, 19 projects explicitly mentioned crop diversification as one of their objectives, while 62 projects included crop diversification as an indirect focus but not as a specific objective. The summary of all 81 projects is presented in Annexure IV, and a brief about 19 projects with a specific focus on crop diversification is presented in Annexure III.

Among the 19 projects listed in Annexure III, 12 are supported by development partners, while seven are funded by the Government of Bangladesh (GoB), with co-funding provided by GoB in cash or kind. All these projects are dedicated to promoting crop diversification. Figure 3 maps all crop diversification projects against their respective budgets over the years, differentiating projects by funding sources: donor-funded (red circles) and GoB-funded (blue circles). Most projects are donor-funded, while fewer are funded by the Bangladesh government. Budget allocation has increased over the years, with the highest budgets allocated post-2010. Notably, 2000 and 2012 saw peaks in donor funding, with the "Second Crop Diversification Project (SCDP)" in 2000 receiving $66.2 million and the "Integrated Agricultural Approach for Ensuring Nutrition and Food Security Project" in 2012 receiving $41.18 million. In contrast, GoB funding appears more consistent, without significant peaks or troughs. GoB-funded projects generally have smaller budgets compared to donor-funded ones. For instance, in 2012, a donor-funded project had a budget of $41.18 million, while a GoB-funded project had a budget of $9.3 million. The PARTNER project in 2023 is the largest in Bangladesh's history, with a major objective of crop diversification. GoB-backed projects typically have a budget of around $9 million, modest compared to the $106 million average for those supported by development partners. GoB projects generally span 3–7 years, averaging 4 years, while projects funded by development partners typically run 4–10 years, with an average duration of six and a half years. Thus, GoB projects tend to be more compact in both budget and duration.

There is an increasing trend of budget over the years, indicating a growing emphasis on crop diversification initiatives. Figure 4 illustrates the distribution of crop diversification projects across various districts of Bangladesh. The map delineates the intervention areas and project density. Diversification has been targeted in stress-prone and high-poverty areas such as Satkhira and Bagerhat (southern coastal saline regions, primarily aquaculture), the river erosion and low-lying, poverty-stricken Northern Rangpur region, the drought-prone northeast region of Rajshahi, and the depressed region of greater Mymensingh in central to northern Bangladesh, known for fishing during the monsoon and cropping, mainly rice, during the rest of the year.

While some regions have embraced crop diversification extensively, others lag. This data can help policymakers and stakeholders identify areas needing more attention and resources. Until 1995, the Department of Agricultural Extension (DAE) managed relatively few projects. In recent years, the number of projects implemented by DAE has increased notably. However, DAE's alignment with group dynamics, regional social contexts, behavioral science, conflict resolution, and rural sociology is notably absent. The current organizational structure of DAE lacks dedicated space for accommodating farmers' groups, as the Training Wing oversees most training activities.

Crop diversification in Bangladesh (1971–2021)

Historical records of crop diversification are valuable for analyzing spatial and temporal trends in crop species diversity at

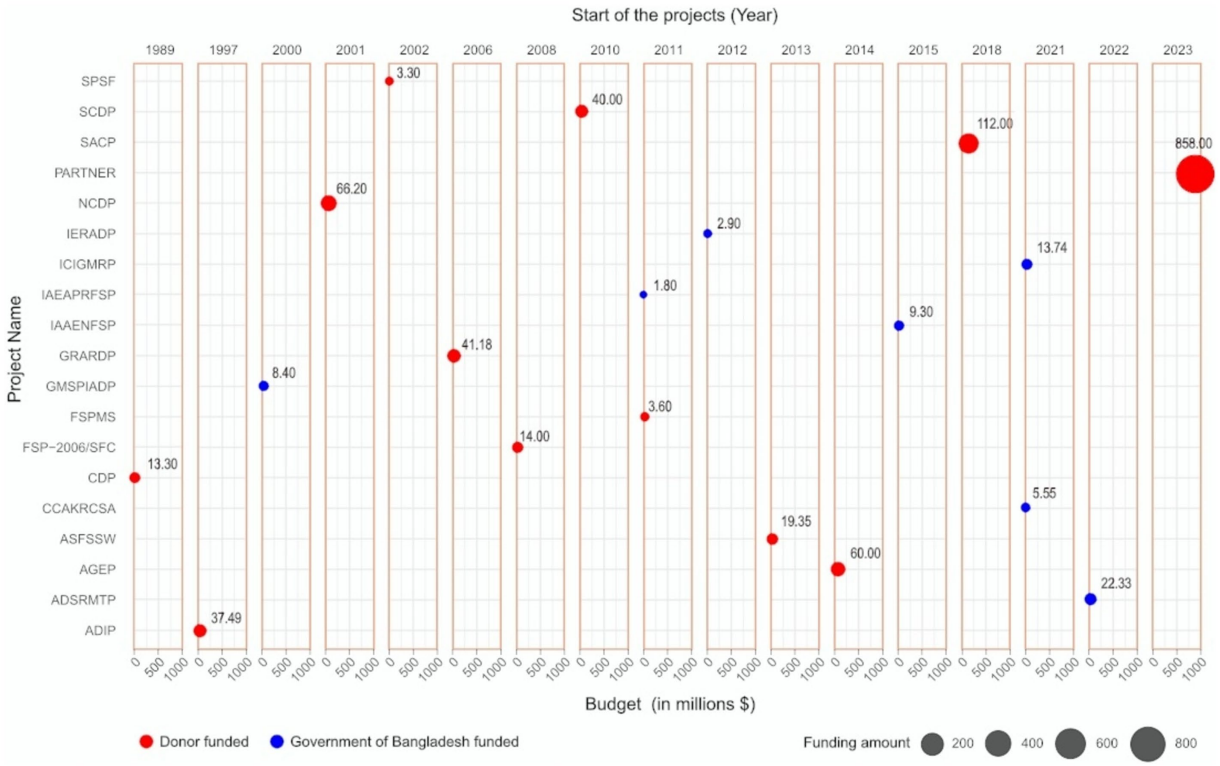

FIGURE 3
Overview: funding and duration of crop diversification projects in Bangladesh. *Elaboration of project names can be found in Annexure III.

regional, national, or global levels (Smith et al., 2019; Vannoppen et al., 2021). Historical crop data from Bangladesh was used to evaluate changes in crop species diversification at the national level from 1971 to 2021. The Herfindahl–Hirschman Index (HHI) measured crop diversification (Kumar Sharma, 2017). The findings indicated that the crop diversification index ranged from 0.64 in 1971 to 0.58 in 2021, with the lowest HHI value of 0.54 observed in 2000 and the highest of 0.69 in 1977 (Figure 5). Despite government policies and initiatives to promote crop diversification, HHI values have consistently indicated low diversification levels (Figure 5). This persistent low diversification can be attributed to a continued preference for rice cultivation, insufficient efforts and funding toward promoting crop diversification, and a lack of incentives for farmers to cultivate crops other than rice.

Actionable recommendations

Crop diversification is a cost-effective strategy to reduce uncertainties in farmers' incomes, ensure food and nutrition security, increase farmer income, and lower the agricultural sector's vulnerability to risks, especially for poor smallholder farmers in Bangladesh (De Pinto et al., 2019; Enamul, 2022; Rahman et al., 2024). Despite numerous government policies and projects, crop diversification remains low (Barman et al., 2022; Makate et al., 2016; Nandi et al., 2023b). The reasons for low crop diversity include a historical policy bias toward rice, insufficient efforts and funding for crop diversification, and a lack of incentives for farmers to grow crops other than rice (Nahar et al., 2024; UN, 2021). Although the focus on rice has been rational, it is risky and arguably unsustainable (Nandi et al., 2023b).

Specific recommendations are outlined below:

- Most policies and projects that promote crop diversification, appear to largely focus on the production side, neglecting the market system for new crops (such as fruits, and vegetables). Therefore, the fundamental strategy for the Government of Bangladesh should be crop diversification to promote sustainable growth through resource allocation (regular budget allocation), infrastructure development (market, storage), and encouragement of the private sector along the value chain of new crops.
- Crop diversification initiatives have typically been driven by short-term projects, resulting in temporary arrangements. To ensure long-term sustainability and effectiveness, these efforts should be integrated into annual government budgets with dedicated and consistent core funding, implemented in a mission-driven approach.
- In agricultural development, the Ministry of Agriculture (MoA) distributes inputs such as improved seeds, fertilizers, and machinery through various projects. However, effective utilization can be compromised if beneficiaries receive similar benefits from multiple projects. Therefore, it is crucial to coordinate among agencies responsible for selecting beneficiary farmers to ensure a strategic and efficient allocation of resources.

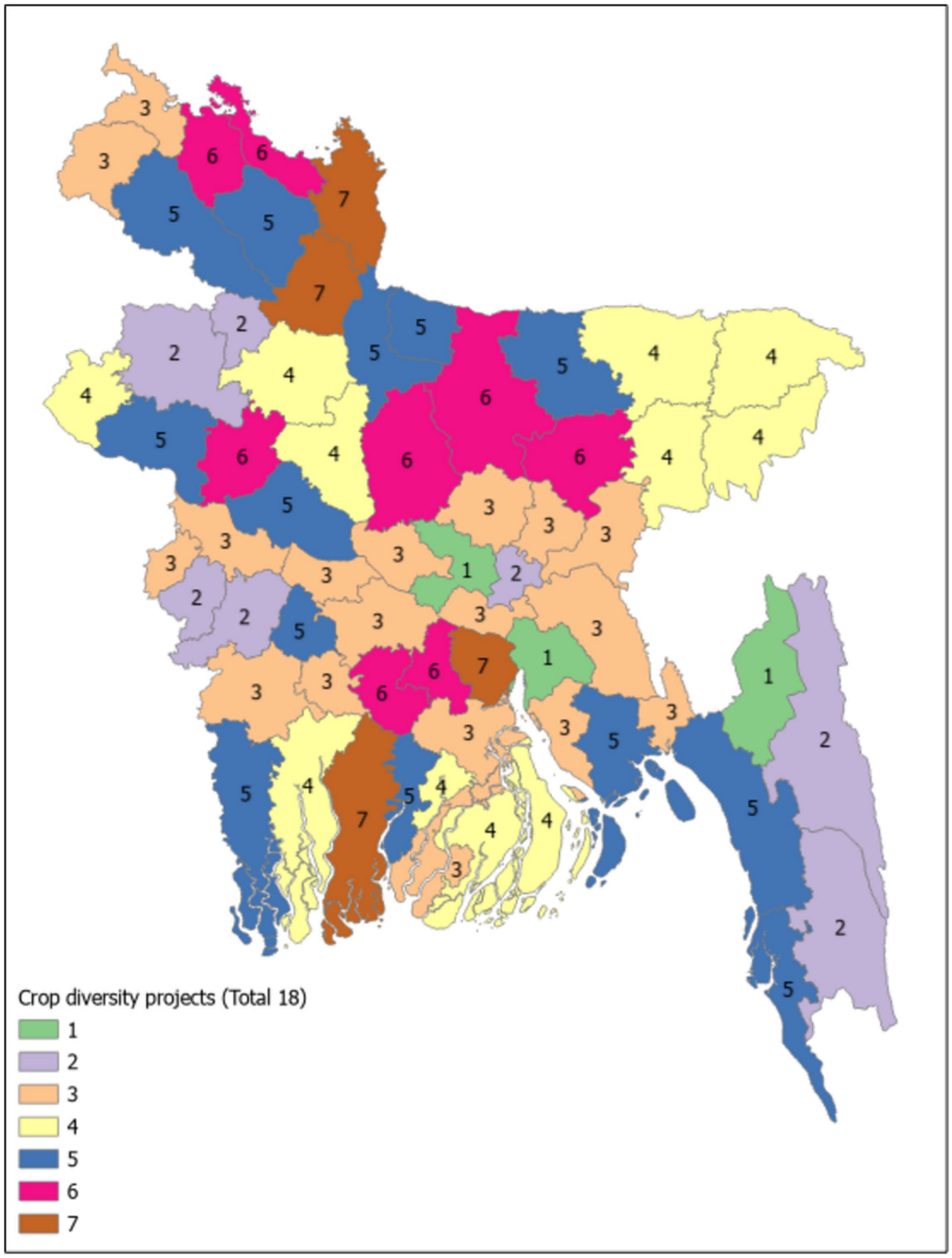

FIGURE 4
Crop diversification projects implemented across Bangladesh.

- Policy guidelines in agriculture, health, and nutrition often call for interdepartmental collaboration to achieve goals in crop diversification, health, and nutrition. However, such integration is rarely implemented in practice. To enable effective field-level coordination, it is essential to establish convergence or synergy at the planning, policy, or ministry level.
- The Department of Agricultural Extension (DAE) is currently implementing a substantial number of projects within the agriculture sector, highlighting the need for new, dedicated institutional frameworks. These frameworks should focus on supporting sustainable agriculture through comprehensive research, development, training, and capacity-building initiatives that promote innovative agricultural methods.
- Existing frontline staff may lack the capacity to implement and disseminate innovative agricultural methods and techniques to farming communities. Therefore, it is crucial to establish a new cadre of personnel specifically trained in advancements within the sector, particularly in sustainable agriculture, crop diversification, and farming diversification. This can be achieved through new institutional arrangements, such as the creation of a dedicated unit focused on these areas.

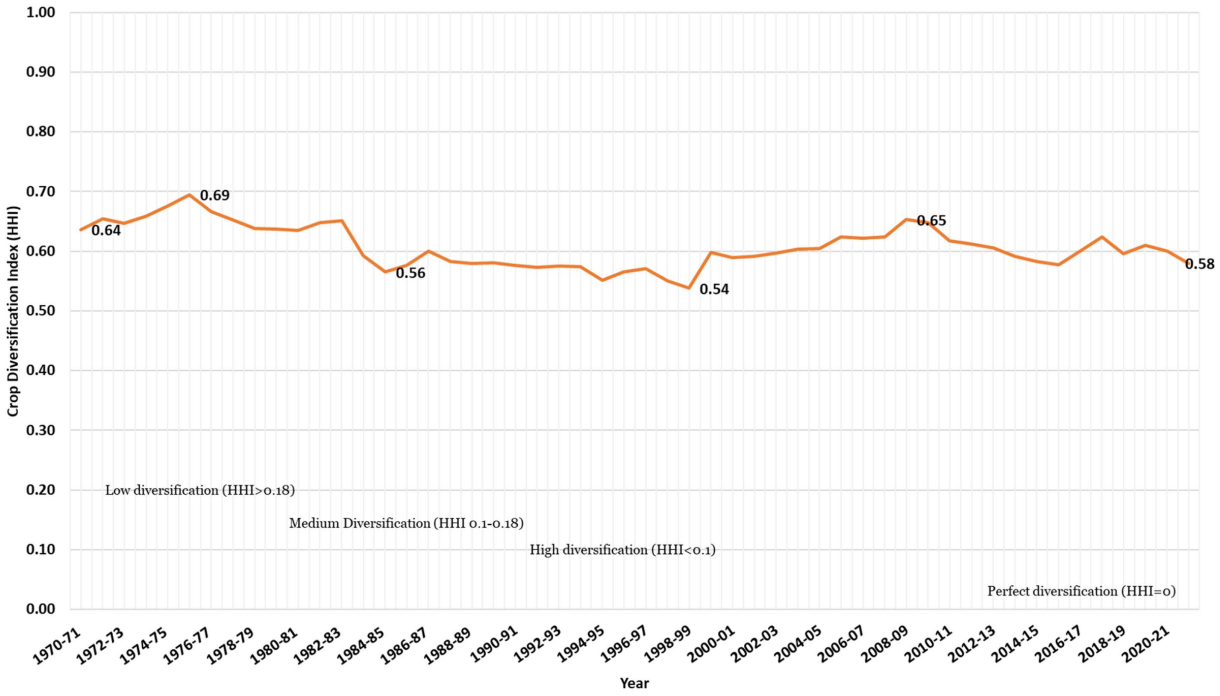

FIGURE 5
Crop diversification in Bangladesh (1970/71–2020/21). Source: Author's compilation based on the data from various government sources.

- An institutional mechanism should be established to monitor, assess, and archive projects, ensuring efficient use of development funds by international partners and avoiding duplication. This mechanism should emphasize unbiased and expert-led project monitoring and evaluation and maintain comprehensive archives of past projects.
- Crop research institutes are encouraged to partner with crop diversification projects to enhance research-extension linkages and promote new crops among farmers. While such partnerships exist in some projects, there is potential for wider implementation.
- Crop diversification programs should utilize the developed crop zoning (suitability) map as a decision support tool for identifying Upazilas for intervention (BARC, 2022).
- Government-funded projects often lack external audits, which can improve transparency and accountability. It is recommended that these projects undergo external technical and financial audits, with findings submitted to a dedicated professional team or institution within the government for better oversight and accountability.
- Implementation Monitoring and Evaluation Division (IMED) financial updates and site visits help maintain effective control, but internal control systems in various ministries need improvement. Despite advancements in health, education, and public works, these ministries struggle due to the absence of comprehensive guidelines, operational independence, and specialized internal audit expertise. Enhancing staffing and addressing these issues would greatly strengthen their internal audit capabilities.

Conclusion

The promotion of crop diversification remains a critical element of Bangladesh's agricultural policy and development strategy. This approach aims to ensure food and nutrition security, increase farmers' incomes, and build resilience in the agricultural sector. To mainstream and sustain crop diversification, securing core annual funding, enhancing market linkages, and making concerted efforts are crucial. The study provides actionable guidelines for policymakers and practitioners to effectively promote and sustain crop diversification within Bangladesh's agriculture.

Author contributions

RN: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Validation, Visualization, Writing – original draft, Writing – review & editing. TK: Conceptualization, Funding acquisition, Writing – review & editing. WK: Investigation, Validation, Writing – original draft, Writing – review & editing. TJ: Project administration, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fsufs.2024.1459526/full#supplementary-material

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