TOWARDS PRECISION AGRICULTURE: AN ASSESSMENT OF MOBILE APPLICATIONS IN BANGLADESH AGRICULTURE

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Abstract

An assessment of mobile applications in Bangladesh agriculture is yet to examine considering their functional coverage, institutional origins, adoption dynamics, and temporal sustainability. Total 28 applications were identified and categorized across crop advisory, livestock, fisheries, marketing, and fertilizer services. The ecosystem is heavily skewed towards crop advisory, which accounts for 71% of all apps, while fertilizer management and fisheries remain critically underserved despite their strategic importance to national food systems. Public-sector agencies dominate app development, lending credibility and facilitating wide dissemination, while private and commercial actors are increasingly shaping the landscape through market-linkage, financial services, and value-chain integration. Adoption patterns reveal pronounced inequality: a small group of flagship applications—Khamari, Smart Krishi, iFarmer Sofol, and Cropwise Grower Bangladesh have achieved substantial penetration (≥100,000 downloads), whereas the majority function as niche tools with limited reach and influence. Temporal analysis indicates that early entrants (2015–2018) demonstrate greater longevity, the expansion phase (2019–2020) generated the highest sustained uptake, and recent releases (2024–2025) remain largely confined to early-adoption stages. Despite growing diffusion, the technological depth of these applications remains limited. None integrate advanced digital agronomy tools such as remote sensing, geographic information systems, or image-based diagnostics, and fertilizer recommendations rely predominantly on static, location-specific datasets rather than dynamic, data-driven decision models. These gaps constrain the potential of mobile platforms to deliver precision, scalability, and adaptive decision support. Strengthening Bangladesh's digital agronomy ecosystem will require deliberate strategies that promote sectoral balance, technological integration, and long-term sustainability, enabling mobile advisory systems to evolve into robust precision agriculture platforms that enhance farmer resilience and national food security.

Keywords: Crop advisory, Digital agriculture, GIS, Mobile apps, Remote sensing,

1. Introduction

Digital technologies are rapidly transforming agricultural systems by reshaping how information, services, and markets reach farmers. Among these technologies, mobile phones have emerged as a particularly powerful tool for improving extension delivery, reducing transaction costs, and enhancing climate resilience in low-income agrarian economies (Aker, 2017; Mittal & Mehar, 2016). Mobile-based services enable near-real-time dissemination of agronomic advice, price information, weather alerts, and financial services, offering scalable solutions to long-standing constraints in conventional extension systems. In Bangladesh, where agriculture remains central to livelihoods and food security, the rapid expansion of mobile penetration and internet connectivity over the past decade has created a fertile environment for digital agritech innovations (FAO, 2021; World Bank, 2020). Capitalizing on this digital momentum, a wide range of stakeholders including government agencies, private startups, non-governmental organizations, and international development partners have launched agricultural mobile applications targeting crop management, livestock, fisheries, fertilizer use, pest and disease control, market price transparency, and weather advisories. These applications are increasingly positioned as complementary or even alternative channels to traditional extension services, particularly for smallholder farmers who face limited access to field-based advisory support. However, despite the apparent proliferation of agricultural apps, the digital agronomy ecosystem in Bangladesh remains fragmented. Adoption levels vary sharply across applications, functionality is uneven, and several strategically important domains most notably fertilizer optimization and fisheries are persistently underrepresented (Kamal & Bablu, 2023; Akter & Tan, 2024). Village-level assessments further highlight structural barriers to scale, including limited ICT literacy, intermittent connectivity, weak institutional integration with public extension, and uncertain long-term maintenance of digital platforms (Rahman & Akter, 2021; Islam et al., 2022; Akter & Tan, 2024).

Existing research on digital agriculture in Bangladesh has largely focused on single-intervention evaluations or localized adoption studies, providing valuable but partial insights. What remains largely absent is a comprehensive national-level inventory and benchmarking of agricultural mobile applications that examines sectoral coverage, adoption dynamics, and sustainability over time. Evidence from South Asia more broadly suggests that mobile agricultural services can enhance productivity and resilience, yet without systematic national benchmarking it is difficult to identify structural gaps, assess longevity, or evaluate whether the digital ecosystem is evolving toward more advanced, data-driven decision support (Aker, 2017; Mittal & Mehar, 2016). Such benchmarking is particularly critical as Bangladesh seeks to align digital agriculture with broader goals of precision farming, climate adaptation, and food system transformation.

Against this backdrop, the present study compiles and analyzes a structured dataset of 28 agricultural mobile applications operating in Bangladesh. Applications are classified across nine functional domains and evaluated using three core dimensions: adoption (measured through download tiers), temporal phase of entry (from early adoption to recent launches), and sustainability (based on update frequency and continuity of service). Beyond mapping diffusion patterns, the study critically examines the technological depth of existing platforms. A central concern emerging from preliminary evidence is the near-complete absence of advanced digital agronomy tools such as remote sensing, geographic information systems (GIS), image-based diagnostics, and dynamic fertilizer recommendation models which are essential for transitioning from generic advisory services to precision agriculture. The study is guided by the hypothesis that, despite rapid growth in the number of agricultural mobile applications, Bangladesh's digital agronomy ecosystem is characterized by functional concentration, uneven adoption, and limited technological sophistication, thereby constraining its potential contribution to precision agriculture and sustainable intensification. Accordingly, the objectives of this research are to: (i) systematically inventory and classify agricultural mobile applications in Bangladesh across functional domains; (ii) assess adoption patterns and temporal sustainability of these applications; (iii) identify sectoral and technological gaps, with particular attention to fertilizer management and data-intensive functionalities; and (iv) derive strategic insights for strengthening digital extension systems. The ultimate impact of this study lies in providing an evidence-based foundation for policy, investment, and innovation in digital agriculture. By identifying priority gaps and structural weaknesses, the findings aim to inform policymakers, extension agencies, researchers, and private developers on how mobile platforms can evolve into integrated, precision-oriented advisory systems. Such transformation is essential for enhancing farmer resilience, improving nutrient management efficiency, and advancing national food security in an increasingly climate-constrained agricultural landscape.

2. Materials and Methods

2.1 Study design and data sources

This study employed a mixed-method benchmarking approach combining systematic app identification, database compilation, and sectoral clustering. The primary aim was to construct a comprehensive inventory of mobile applications relevant to agriculture in Bangladesh and analyze their adoption, functionality, and update status. Mobile applications were identified through the following multiple sources to ensure completeness:

- Google Play Store searches using keywords in Bangla and English (e.g., "কৃষি," "Krishi," "Bangladesh agriculture").
- Government portals such as the Ministry of Agriculture, Department of Agricultural Extension (DAE), Bangladesh Agricultural Research Council (BARC), and Bangladesh Meteorological Department (BMD).

- Private and NGO initiatives including iFarmer, ACI Limited, and Syngenta.
- Academic and development literature reporting pilot projects and ICT-based extension services

2.2 Inclusion criteria

Applications were included if they met the following conditions:

- Direct relevance to agriculture in Bangladesh (crop, livestock, fisheries, market, finance, fertilizer, pest management, or weather).
- Availability on the Google Play Store or documented in official portals.
- Active or updated within the last five years (2020–2025).
- Targeted toward farmers, extension agents, or agricultural stakeholders.
- Excluded were apps not specific to Bangladesh, generic weather apps, or tools without agricultural functionality.

2.3 Data analysis and visualization

Each agricultural mobile application was systematically documented in a CSV inventory by recording its name, sector, organization type, download tier, year of starting, core functionality, data source, target user group, impact level, and last update year to ensure consistency and comparability across the dataset. Impact levels were defined by adoption and scope: high-impact apps had over 50K downloads, regular updates, and institutional support; medium-impact apps recorded 10K–50K downloads with consistent advisory functions; and low-impact apps had fewer than 10K downloads, pilot status, or limited scope.

To examine the evolution of agricultural mobile applications in Bangladesh, apps were categorized by release year and update history into four phases: Early (2016–2018), Expansion (2019–2020), Consolidation (2021–2023), and Recent (2024–2025). Download counts served as proxies for impact, classified as high (≥100K), moderate (50K+), or low (≤ 10K). Data from official app stores and developer websites were compiled into a timeline-impact matrix and visualized with a stacked column chart, enabling comparative analysis of development trends, update frequency, and user engagement across phases. The dataset was analyzed using Excel and Python-based visualization tools. Multiple graphical outputs were generated to highlight adoption, lifecycle, and sectoral coverage.

3. Results

3.1 Characterization of agricultural apps

The characterization of 28 agricultural mobile applications in Bangladesh highlights the diversity of target users, data sources, and service patterns across the ecosystem (Table 1). Farmers are the primary beneficiaries, with most apps designed to deliver general crop

advisory, fertilizer guidance, pest and disease management, and market information. Specialized services extend to livestock keepers (Digital Khamari, Khamar Guru), fish farmers (Aquaculture WMS), and climate-vulnerable communities (BAMIS), reflecting attempts to broaden digital agronomy beyond staple crops. Data sources vary considerably. Government platforms (e.g., Krishoker Janala, Krishi App, SRDI Fertilizer Recommendation) rely on official extension manuals, soil fertility maps, and crop calendars, ensuring scientific credibility and consistency. Research institutions contribute diagnostic datasets (Rice Profile, Dhan Sorokha), while commercial companies integrate proprietary agronomic R&D, weather APIs, and fintech data (Fosholi, Cropwise Grower Bangladesh, iFarmer Sofol). Private initiatives often combine government extension data with ICT integration (Krishi Totho, Hater Mutoy Krishi), creating hybrid advisory services. Service patterns reveal following three dominant clusters:

- Comprehensive advisory apps offering bundled services (crop practices, fertilizer, pest/disease, market prices, weather forecasts).
- Specialized diagnostic tools focusing on single functions such as pest/disease identification or fertilizer recommendation.
- Market and finance apps linking farmers to price information, input suppliers, and credit (Bazardor, iFarmer, Folon).

Compared to crop advisory, fertilizer and fisheries apps remain underserved, underscoring the need for targeted innovation in these critical areas. Importantly, none of the apps employ modern technologies such as remote sensing, GIS, or image-processing for real-time crop monitoring. Fertilizer advisory tools rely on static, site-specific datasets rather than dynamic, crop demand-based models.

3.2 Functional distribution

The functional distribution of agricultural mobile applications in Bangladesh demonstrates a strong emphasis on general crop advisory services. As shown in Fig. 1, exactly 20 apps (71%) provide crop-related guidance, while livestock advisory accounts for 4 apps, fisheries advisory for 1 app, agricultural marketing advisory for 3 apps, and fertilizer advisory for 2 apps. This concentration reflects the prioritization of staple crop production systems in digital extension. However, the analysis also reveals a critical gap in advanced technology-based solutions: none of the apps employ remote sensing, GIS, or image-processing algorithms for real-time crop monitoring or precision farming. Fertilizer advisory tools (Khamari, SRDI Fertilizer Recommendation) rely on static, site-specific datasets rather than dynamic, crop demand-based models, limiting their adaptability to changing field conditions.

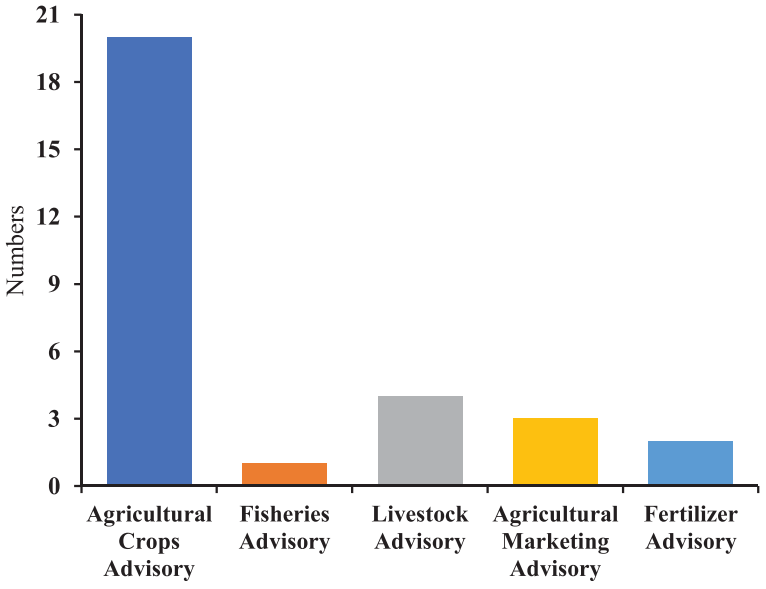

Fig. 1 Distribution of agricultural mobile applications by functional category

3.3 Organizational Distribution

The organizational distribution of app developers reveals the dominance of government institutions. As illustrated in Fig. 2, government agencies are responsible for 12 apps, private initiatives for 9, commercial companies for 6, and academic institutions for only 1. The strong government presence ensures credibility and wide dissemination, yet the relatively low academic contribution suggests untapped potential for research-driven innovation. Private and commercial actors are increasingly active, particularly in market linkage and fintech-enabled advisory services, indicating diversification of the ecosystem.

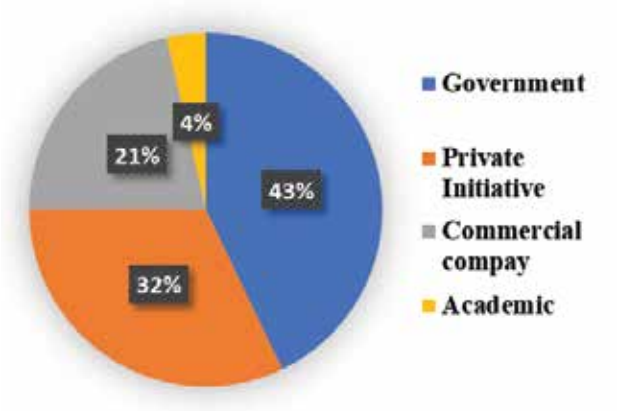

Fig. 2 Organizational distribution of app developers

Table 1. Characterization of existing mobile apps for farmers in Bangladesh, with emphasis on target users, data sources, and service patterns

Sl. No.	App Name	Name (Bengali)	Organization	Type of services	Source of Data	Target User
1	Khamari	খামারি	Gov - BARC	Fertilizer recommendations; crop suitability; seed quantity; yield estimation	BARC soil fertility maps; crop calendars	Farmers, Researchers, Extension Workers
2	Krishoker Janala	কৃষকের জানালা	Gov - Ministry of Agriculture	Crop calendar; pest/disease control; livestock & fisheries advisory	Govt extension services	General farmers across crops
3	Fosholi	ফসলি	Commercial Company	Crop suitability; pest alerts; weather forecasts; input access	ACI agronomic R&D; weather APIs	Commercial crop farmers; input buyers
4	Digital Khamari (BAU)	-	Academic - BAU	Disease detection; treatment guidelines; vaccination info	BAU veterinary research	Smallholder livestock farmers
5	Aquaculture WMS		Commercial Company	Pond monitoring; sensor data; alerts	IoT sensors; aquaculture datasets	Fish farmers using pond aquaculture
6	Bazardor	কৃষি পণ্যের বাজারদর	Gov - Department of Agricultural Marketing	Real-time commodity prices; district-wise market rates	DAM official data	Farmers and traders checking daily prices
7	BARI App	কৃষি প্রযুক্তি ভান্ডার	Gov - BARI	Crop variety info; soil & crop management; pest/disease solutions	BARI research datasets	Crop farmers adopting BARI technologies
8	Agro Tech Study	-	Commercial Company-Door Media	Learning platform; crop-specific guidance; weather forecasts; forums	Expert tips; weather APIs	Students; progressive farmers seeking training
9	Smart Krishi	-	Gov - Smart Bangladesh	Crop practices; daily price info; success stories	Govt extension data	Farmers, Researchers, Extension Workers
10	SRDI Fertilizer Recommendation	-	Gov - SRDI	Site-specific fertilizer recommendations based on soil test data; exportable PDF reports	SRDI soil test labs; national soil fertility database	Farmers, Researchers, Extension Workers

11	iFarmer Sofol	সফল	Commercial Company	Crop advisory; fertilizer recommendations; pest/disease solutions; weather forecasts; market price info	Registered Farmer data;	Farmers, Researchers, Extension Workers
12	Folon	ফলন	Commercial company-iFarmer Bangladesh	All-in-one farming support: expert guidance; farming services; community; market linkage	iFarmer advisory datasets; fintech integration	General farmers nationwide
13	Rice Profile	-	Gov/Research - BRRI	Diagnostic tool for rice pests/diseases; management recommendations	BRRI rice research datasets	Rice farmers
14	Dhan Sorokha	ধান সুরক্ষা	Gov/Research - BRRI	Diagnostic tool for rice pests/diseases; management recommendations	BRRI rice research datasets	Farmers, Researchers, Extension Workers
15	Krishi Totho	কৃষি তথ্য	Private initiative	Agricultural information; extension services; crop advisory; hotline integration	Govt extension data; ICT Division	General farmers needing info hotline
16	Cropwise Grower Bangladesh	-	Commercial company-Syngenta	Image-based pest/disease diagnosis; pesticide spraying windows; crop ROI optimization	Syngenta agronomic R&D; weather APIs; image recognition	Crop farmers (rice
17	Pesticide Assistant	বালাইনাশক সহায়িকা	Private initiative	Provides pesticide use guidelines; safe handling; recommended doses; pest control methods	DAE crop protection manuals	Crop farmers using pesticides
18	(Krishoker App)	কৃষকের এপ	Gov-DG Food Department	Govt Farmer information management services	Reregistered farmers information	Gov. benefiters farmers
19	(Krishi App)	কৃষি এপ	Gov - ICT Division	General crop advisory; fertilizer use; pest/disease solutions; hotline integration	Govt extension data	Smallholder farmers

20	Fosholer Chikitsha	ফসলের চিকিৎসা	Private initiative	Diagnostic tool for crop diseases; treatment recommendations; pesticide advisory	Govt extension data	Rice and vegetable farmers
21	Hater Mutoy Krishi	হাতের মুঠোয় কৃষি	Private initiative	Provides crop production technologies; fertilizer guidelines; pest/disease management; irrigation practices	Govt extension manuals	General farmers needing mobile advisory
22	BAMIS		Gov - BMD & Ministry of Agriculture	Provides agro-meteorological forecasts; crop-specific weather advisories; early warning for floods/droughts; SMS alerts	BMD weather data; Ministry of Agriculture crop calendars	General farmers nationwide (especially climate-vulnerable areas)
23	Amader Krishi Bangladesh	আমাদের কৃষি বাংলাদেশ	Private initiative	Provides crop production technologies; fertilizer guidelines; pest/disease management; market price info; farmer community support	Private extension datasets; market surveys	General farmers nationwide
24	Banglar Krishi	বাংলার কৃষি	Private initiative	Crop advisory; fertilizer recommendations; pest/disease solutions; weather forecasts; market price info	Govt extension data; weather APIs	General farmers nationwide
25	khamarGuru	খামারগুরু	Gov-BLRI	provide livestock feed, health, and disease management information	BLRI research finding data	Livestock growers
26	krishi hat boi	কৃষি হাত বই	Private initiative	Crop advisory; fertilizer recommendations; pest/disease solutions; weather forecasts; market price info	Govt extension data; weather APIs	Farmers, Researchers, Extension Workers
27	Khamar bondho	খামার বন্ধু	Private initiative	Provides Livestock disease info; vaccination schedules; advisory	Govt extension data; weather APIs	General farmers nationwide
28	Krishi Master	কৃষি মাস্টার	Commercial Copany	Livestock disease info; vaccination schedules; advisory	Govt extension manuals	Livestock producers

3.4 Temporal distribution and duration

The temporal distribution of apps, along with their duration of activity, is presented in Fig. 3. Early launches (2015–2018), such as Krishoker Janala and Hater Mutoy Krishi, have sustained long durations (7–9 years). Expansion-phase apps (2019–2020), including Khamari, Fosholi, and Smart Krishi, show moderate durations (5–6 years). Consolidation-phase apps (2021–2023), such as Folon, Agro Tech Study, and Dhan Sorokha, exhibit shorter spans (2–3 years). Recent launches (2024–2025), including Digital Khamari (BAU) and Aquaculture WMS, remain in their initial stages.

3.5 Adoption and download impact

Adoption levels, measured by download counts, vary widely across applications. As shown in Fig. 4, high-impact apps (≥100K downloads) include Khamari, Smart Krishi, iFarmer Sofol, and Cropwise Grower Bangladesh. Moderate-impact apps (50K+) include Krishoker Janala, BAMIS, and Banglar Krishi. The majority of apps fall into the low-impact tier (≤10K downloads), including specialized tools such as SRDI Fertilizer Recommendation, Rice Profile, and Fosholer Chikitsha.

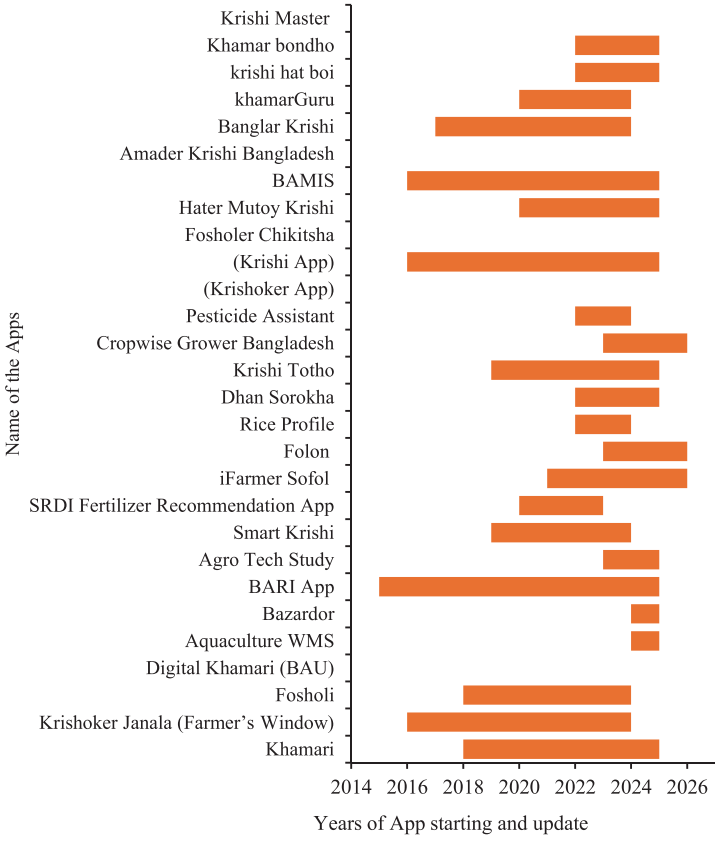

Fig. 3 Timeline of app starting years and durations

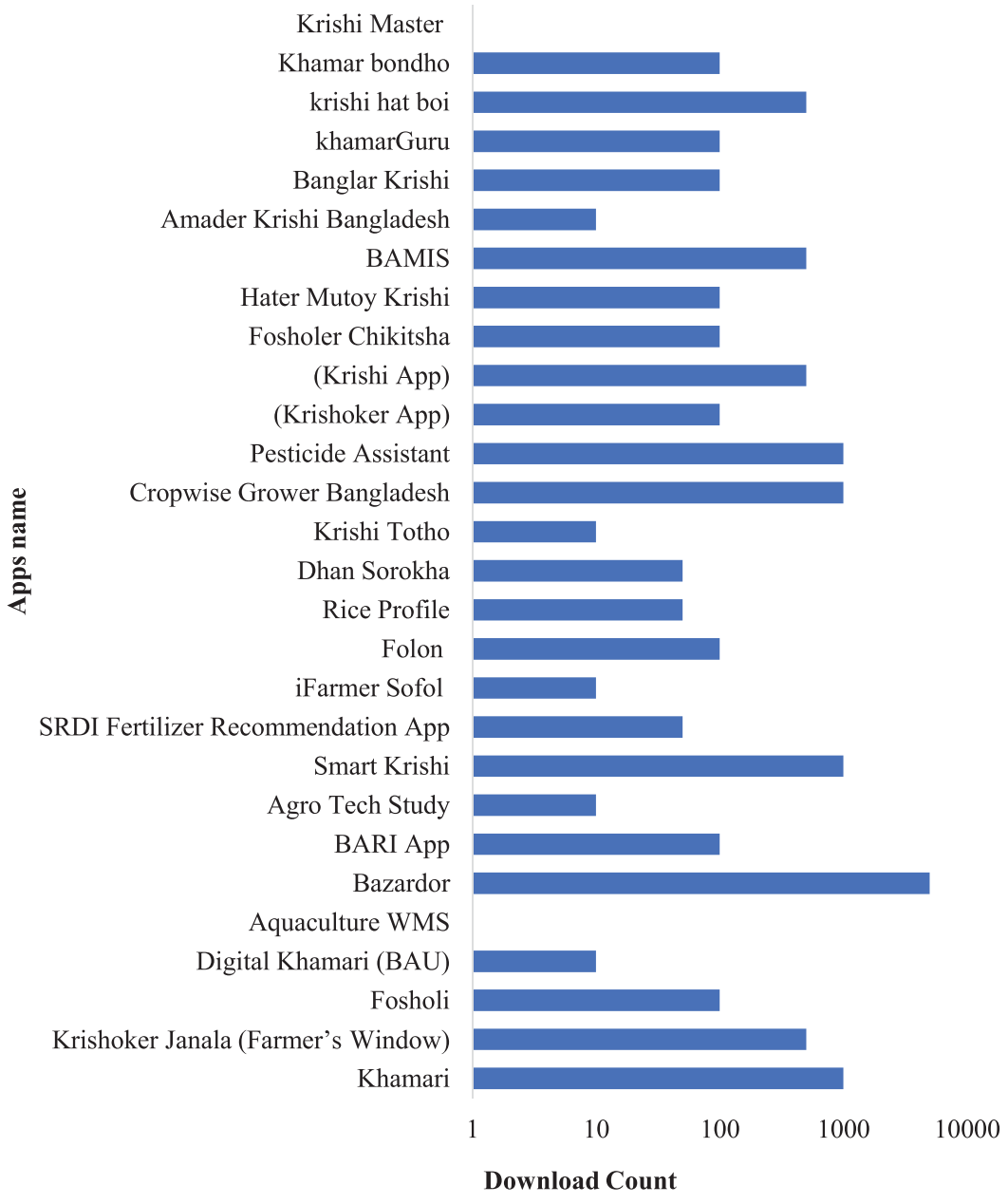

Fig. 4 Download-based adoption tiers of agricultural apps

3.6 Phase-wise impact distribution

Fig. 5 presents the phasewise distribution of agricultural mobile applications in Bangladesh segmented by download tier, offering insights into temporal trends in user engagement and app impact. The Early phase (2016–2018) shows a balanced mix, with one highimpact app (≥100K downloads), three moderateimpact apps (50K+), and two lowimpact apps (≤10K), reflecting the initial experimentation with digital agronomy tools. The Expansion phase (2019–2020) is comparatively modest, with one highimpact app and three lowimpact apps, but no moderateimpact entries, suggesting uneven uptake despite continued development. The Consolidation phase (2021–2023) demonstrates stronger traction, with two highimpact apps, one moderateimpact app, and three lowimpact apps, indicating gradual improvement in both scale and diversity of adoption. The Recent phase (2024–2025) records the highest number of launches, with two highimpact apps, three moderateimpact apps, and seven lowimpact apps, highlighting a surge of new initiatives still in early adoption stages. These findings underscore that while app development has accelerated in recent years, sustained user engagement remains concentrated in select tools, emphasizing the need for strategic dissemination, farmercentric design, and longterm support to convert recent launches into highimpact platforms.

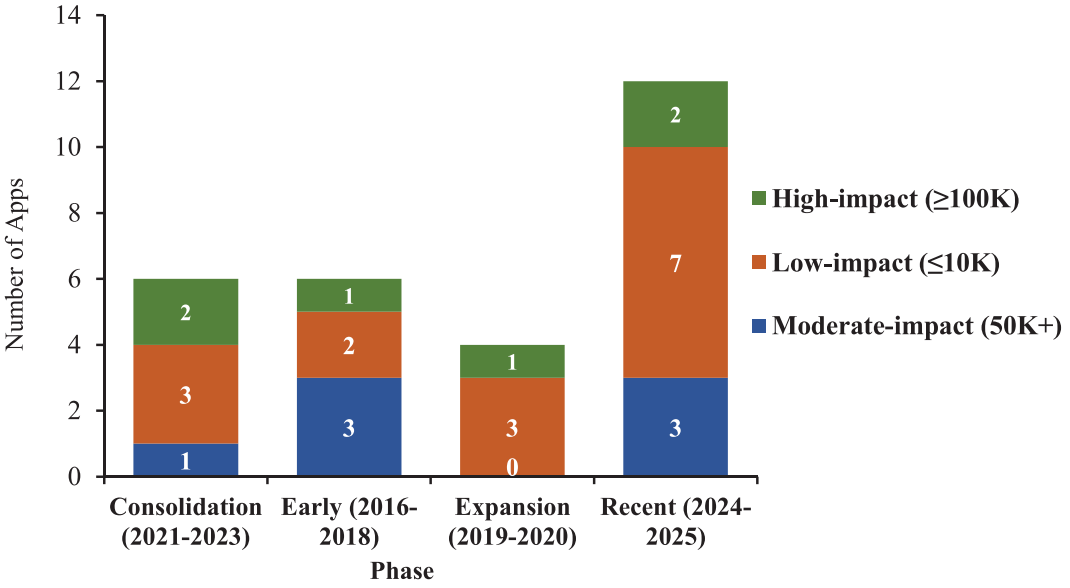

Fig. 5 Phase-wise distribution of agricultural apps by download tier

4. Discussion

The characterization of agricultural mobile applications in Bangladesh reveals both progress and persistent gaps in digital agronomy. The dominance of crop advisory services

reflects national priorities in staple production, consistent with earlier findings that extension systems in South Asia remain crop-centric (Kumar & Rosegrant, 2019). However, the limited presence of fertilizer and fisheries apps underscores structural imbalances, echoing concerns that digital agriculture risks reinforcing existing sectoral biases (Sarker et al., 2021). Government agencies continue to lead app development, ensuring credibility and wide dissemination, but the relatively low academic contribution suggests untapped potential for research-driven innovation. Similar patterns have been observed in other developing contexts, where public institutions anchor digital extension while private and commercial actors diversify services through fintech and market linkage (Aker et al., 2016).

Temporal analysis highlights sustainability challenges. Early apps such as Krishoker Janala have demonstrated resilience, aligning with evidence that institutional support and farmer trust are critical for long-term adoption (Kumar & Rosegrant, 2019). In contrast, recent launches remain in early adoption stages, raising questions about continuity and service commitment. The uneven adoption patterns, with only a handful of flagship apps achieving high download counts, mirror global findings that digital tools often struggle to scale beyond pilot phases (Jensen, 2007; Aker & Mbiti, 2010). The Expansion phase (2019–2020) emerged as the most influential, with diverse apps achieving sustained farmer uptake. This period coincided with rapid smartphone penetration and national digitalization initiatives (World Bank, 2020; FAO, 2021), suggesting that timing and enabling infrastructure are critical determinants of success. These findings suggest that while app development has accelerated in recent years, sustained farmer engagement remains concentrated in Expansion-phase tools. Importantly, the absence of modern technology-driven apps and the reliance on static fertilizer datasets highlight a structural limitation: most tools remain advisory in nature rather than enabling precision agriculture or real-time decision support. The ecosystem lacks modern technology-based solutions such as remote sensing, GIS, and image-processing apps that could enable precision farming. Fertilizer advisory tools rely on static, site-specific datasets, failing to capture real-time crop nutrient demand. Policy frameworks should incentivize the development of dynamic, data-driven apps capable of integrating satellite imagery, IoT sensors, and predictive analytics. Greater collaboration with academic institutions could enhance research-driven innovation and evidence-based advisory services.

4.2 Farmers' adoption behavior

Adoption patterns reveal uneven engagement, with only a handful of flagship apps achieving high download counts. Farmers prefer apps offering bundled advisory services rather than specialized tools. The absence of advanced technology-based tools limits precision decisions. Evidence suggests that apps integrating remote sensing and GIS data achieve higher adoption when they provide actionable, location-specific insights (Ghosh & Saha, 2020). Without such features, Bangladeshi farmers remain dependent on generalized advisory services.

4.3 Sustainability and future directions

Ensuring sustainability requires not only institutional support but also technological innovation. Early apps have demonstrated resilience, but their advisory nature limits long-term impact. Future directions should be prioritized considering the following issues:

- Integration of modern technologies (remote sensing, GIS, image-processing).
- Dynamic fertilizer advisory models responsive to real-time crop demand.
- Sectoral balance by expanding underserved areas such as fertilizer and fisheries.

5. Conclusions

This study provides a comprehensive assessment of agricultural mobile applications in Bangladesh, analyzing functionality, organizational origins, adoption, and sustainability. Crop advisory services dominate, while fertilizer optimization and fisheries remain underrepresented. Government agencies lead development, ensuring credibility and dissemination, but private and commercial actors increasingly diversify the landscape through market linkage and fintech enabled advisory services. A critical limitation is the absence of advanced technologies: none of the apps employ remote sensing, GIS, or image processing for precision farming, and fertilizer tools rely on static datasets that fail to capture dynamic nutrient demand. Phase analysis highlights the Expansion period (2019–2020) as most influential, with diverse apps achieving sustained uptake, whereas recent launches remain in early adoption, raising concerns about continuity. Future strategies must prioritize sectoral balance, technological innovation, dynamic fertilizer advisory, and institutional collaboration to transform advisory tools into precision agriculture platforms, strengthening farmer resilience and national food security.

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Conflicts of Interest

The authors declare no conflicts of interest regarding publication of this paper.

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