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Digital Transformation in Shariah-Compliant Agri-Fintech: A Case Study of The Bagh EPlatform

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Abstract: Agricultural finance in developing markets faces systemic bottlenecks, including collateral dependencies, information asymmetry, and a lack of Shariah-compliant alternatives. Grounded in the Three-Dimensional Fintech Framework and Agency Theory, this study employs a qualitative, desk-based documentary single-case study design to evaluate how the digital architecture of the Bagh eplatform modernizes traditional ethical contracts. The findings demonstrate that Bagh-e automates classical risk-sharing and asset-backed instruments, specifically *Salam* (forward sales) for working capital and *Murabahah* (cost-plus) for physical inputs, by integrating cloud databases, predictive AI risk engines, and closed-loop digital voucher routing. This infrastructure satisfies constructive possession (*qabd*) requirements and systematically mitigates principal-agent conflicts, including moral hazard and greenwashing, without requiring physical property collateral. Ultimately, this study demonstrates how digital agri-fintech aligns with the objectives of Shariah (*Maqasid al-Shariah*) and Bank Negara Malaysia's Value-Based Intermediation (VBI) framework, harmonizing commercial viability with social equity and ecological resilience.

Keywords: *Fintech, Agriculture, Digital Financing, Financial Inclusion.*

1. Introduction and Background

The global agricultural sector is undergoing a structural transformation due to digital technology and financial intermediation. Agriculture remains a vital economic engine in developing countries. It contributes around 13% to the gross domestic product (GDP) in regional hubs such as Indonesia and employs over 28% of the workforce (Luís et al., 2024). Nonetheless, Benni et al. (2025) mentioned that smallholders in these regions remain disproportionately underserved, with up to 66% of agricultural SME financing needs going unmet. This represents an annual "credit gap" of USD 54.1 billion. The gap persists mainly due to high transaction costs, climate vulnerability, and a lack of physical collateral required by most traditional financial institutions (Kashid et al., 2026; Khandker & Yamano, 2025).

To integrate these unbanked farmers into the formal financial system, digitizing cash-based agricultural payments will provide the tools essential to stabilize their seasonal incomes (Klapper et al., 2025). By leveraging technologies such as cloud computing and big data analytics, digital platforms can bypass geographical constraints and significantly lower operational costs. Ultimately, this helps to expand financial access and usage to marginalized people living in rural areas (Zhou et al., 2024). Nevertheless, in Muslim-majority countries and key Islamic finance regulatory hubs (such as Malaysia and Indonesia), these digital solutions must also consider the demand for Shariah-compliant frameworks. Conventional interest-based loans can be replaced with Islamic Fintech to help align agricultural development with religious values through ethical, asset-backed, and risk-sharing financial structures (Al-Daihani et al., 2024).

Through automated smart contracts and AI-driven Shariah verification, financial terms can now be programmed and executed automatically (Basit et al., 2026). The agricultural sector will benefit substantially from this capability. Historically, asset-backed instruments like *Salam* (forward financing) and *Murabahah* (cost-plus financing) involved heavy operational overhead. In this context, digital execution of these contracts removes that barrier (Al-Daihani et al., 2024; Khandker & Yamano, 2025). Unlike conventional interest-based debt, which imposes rigid payment deadlines regardless of harvest outcomes, structured Islamic finance instruments align directly with the volatile cash flows inherent to seasonal farming.

This study examines empirical execution through the case of Bagh-e, an agricultural fintech platform operating in Pakistan and South Asian smallholder markets. Smallholders in this region face three structural hurdles simultaneously, i.e., acute climate vulnerability, lack of documented land collateral, and reliance on predatory local moneylenders. Bagh-e bypasses these hurdles by embedding predictive analytics into a mobile platform that issues Shariah-compliant financing, specifically *Salam* for pre-harvest liquidity and *Murabahah* for critical input supplies (Harvard Innovation Labs, 2025). This operational model gained international validation after winning the Climate Resilience Track at Bank Negara Malaysia's 2025 MIFC Global Impact Challenge. This competition was an initiative organized by BNM to identify impact-driven Islamic fintech innovations globally (Bank Negara Malaysia, 2025).

Therefore, Bagh-e provides a compelling and revelatory case study for this paper because it bridges operational field deployment in developing smallholder markets with regulatory benchmarking within Malaysia's global Islamic financial framework. By analyzing Bagh-e as the primary unit of analysis, this paper evaluates how digital infrastructure modernizes Shariah mechanics, resolves agency conflicts, and advances financial inclusion in alignment with Bank Negara Malaysia's Value-Based Intermediation (VBI) and the higher objectives of Islamic law (*Maqasid al-Shariah*).

2. Literature Review

The Agricultural Credit Gap and Smallholder Vulnerability

Globally, agriculture is a vital sector, employing 25% of the world's population (Luís et al., 2024). However, despite the importance of this sector, economically disadvantaged, small-scale farmers consistently face a variety of complex challenges, primarily driven by severe capital constraints that prevent them from investing in essential productive technologies, chemical fertilizers, and high-yield hybrid seeds (FAO & IPA, 2024; Khandker & Yamano, 2025; Mapanje et al., 2023; The Farmtopia Project, 2024). Furthermore, they operate in highly vulnerable environments where they must navigate unpredictable seasonal production cycles, fluctuating agricultural prices, and sudden environmental shocks such as droughts, floods, and crop diseases (Al-Daihani et al., 2024; Mapanje et al., 2023; Touch et al., 2024).

Formal financial institutions regularly fail to serve smallholder farmers, leaving a massive credit gap fueled by mismatched expectations on both sides (FAO & IPA, 2024; Khandker & Yamano, 2025; Sharma et al., 2025). On the supply side, commercial banks demand documented credit histories and physical collateral that smallholders simply do not own (Kashid et al., 2026; Khandker & Yamano, 2025; Mahboob et al., 2025). On the operational side, debt service structures are fundamentally misaligned because regular monthly installments are incompatible with the seasonal, volatile liquidity of crop farming (Morley, 2024; Sarfo et al., 2021). In addition, smallholders also lack access to risk management products and harbor persistent distrust toward institutional lenders. Thus, the formal credit market remains practically inaccessible (FAO & IPA, 2024; Khandker & Yamano, 2025; Köster et al., 2025).

Pre-season liquidity constraints leave smallholders unable to purchase essential inputs during critical planting windows (Zewdu & Mengist, 2026). Post-harvest cash shortages then compel growers into immediate distress sales at low spot prices, forfeiting the substantial margin gains that post-harvest storage would otherwise offer (Albuquerque et al., 2024; Cardell & Michelson, 2023). Digital financing mechanisms interrupt this cycle. By injecting liquidity at key phases of the agricultural calendar, these platforms enable farmers to secure high-quality inputs, allocate field labor more efficiently, and obtain meaningful gains in both crop yield and net margins (Mapanje et al., 2023; Vasudevan et al., 2025).

Digital Inclusive Finance and the Rise of Agri-Fintech

By substituting branch infrastructure with cloud computing, mobile wallets, and big data analytics, digital inclusive finance fundamentally alters rural banking economics (Jiang et al., 2026; Mühl & de Oliveira, 2026; Pal, 2025). The shift addresses a long-standing market failure. Physical branch networks are simply too costly to sustain in low-density, remote agrarian zones (Aruwajoye & Coetzee, 2025). Modern fintech platforms circumvent these distribution barriers, aligning directly with broader United Nations Sustainable Development Goals by extending baseline financial services to unbanked rural populations at scale (Rafiuddin & Mohnot, 2026).

Digitizing financial touchpoints fundamentally changes this cost calculus. Handset-based workflows such as instant loan requests, peer-to-peer (P2P) transfers, and remote account management drive marginal servicing costs toward zero (Aruwajoye & Coetzee, 2025; Pal, 2025). Beyond lowering overhead, mobile delivery allows providers to stretch credit and savings mechanisms around actual crop calendars rather than rigid monthly schedules (Mhando, 2026). Importantly, the absence of prior credit records no longer blocks access. Platforms substitute traditional credit scores with alternative digital footprints such as mobile airtime purchases, transaction histories, and peer references to securely integrate previously excluded farmers into the formal financial system (Jiang et al., 2026; Pal, 2025).

Principles and Contracts of Shariah-Compliant Agricultural Finance

In Islamic commercial law (*Fiqh al-Muamalat*), financial transactions must adhere to core ethical precepts which are the strict prohibition of interest (*Riba*), excessive uncertainty (*Gharar*), and gambling (*Maysir*) (Iqbal, 1997; Maghrebi & Mirakhor, 2015). Conventional debt instruments, which charge compound interest regardless of crop success or failure, place an asymmetrical burden on vulnerable smallholders (Adesiyan, 2025; Orivri, 2025). Islamic finance counters this through asset-backed, ethical risk-sharing structures that align the financial returns of the funder directly with the physical yield and enterprise of the farmer (Abid & Jie, 2023; Mu'id et al., 2026).

In agricultural finance, two classical Islamic contractual structures offer distinct functional advantages:

***Salam* (Forward Sales Contract):** Under this structure, the financier provides full advance cash payment for a predetermined quantity and specification of crops to be delivered at a future harvest date. Because capital arrives prior to sowing, farmers secure essential working liquidity for seeds and fertilizers without taking on debt-servicing stress (Kalimullina & Orlov, 2020; Shaikh, 2024).

***Murabahah* (Cost-Plus Sale):** This framework substitutes cash lending with asset procurement. The institution purchases required inputs (machinery, fertilizers, or seed stock) from commercial suppliers and transfers title to the producer at acquisition cost plus a transparent markup, with settlement deferred to post-harvest installments (Abd Rahman et al., 2022).

To satisfy Shariah validity and eliminate *Gharar* (uncertainty), contracts like *Salam* mandate exacting verification of crop grades, quantities, and delivery milestones (Al-Daihani et al., 2024; Mahboob et al., 2025). Managing these conditions manually across thousands of remote, fragmented smallholders, however, generates prohibitive operational overhead for institutional banks (Kashid et al., 2026). Possession presents an even steeper logistical hurdle. Traditional lenders struggle to verify physical asset existence and establish valid legal ownership (*qabd*) at reasonable cost. In traditional *Murabahah*, this requirement is uncompromising as the financier must assume actual physical custody (*qabd haqiqi*) of the inputs before transferring title to the farmer.

Three digital interventions resolve these operational and jurisprudential bottlenecks. To replace physical collateral, alternative credit algorithms evaluate borrower solvency directly from agronomic performance, satellite weather tracking, and historic yield records. Contractual compliance is delegated to software. By deploying blockchain smart contracts, disbursement and settlement occur autonomously upon verified receipt of goods, cutting out intermediary settlement delays (Benni et al., 2025; Kashid et al., 2026; Zhang, 2024). Crucially, this infrastructure reconciles Shariah custody rules. Platforms fulfill the mandate of constructive possession (*qabd hukmi*) by acquiring enforceable legal title through digital registries and tokenized, closed-loop voucher mechanisms rather than expensive physical storage (Basit et al., 2026; Mahboob et al., 2025).

Fostering Sustainable Agriculture and Economic Resilience

Green Islamic fintech merges digital delivery rails with ethical Shariah standards and ESG metrics, rechanneling institutional capital toward climate-resilient farming (Widiastuti et al., 2026). The theological justification is clear. Rather than treating agriculture solely as an extractive venture, Islamic economic philosophy designates food production as a collective societal duty (*fardu kifayah*) bound to active stewardship. Because Shariah doctrine strictly forbids waste and ecological destruction of natural habitats, its underlying principles align seamlessly with modern biodiversity conservation (Zaina et al., 2024). Pairing this legal tradition with institutional ESG criteria enables financial intermediaries to screen and deploy capital toward sustainable rural farming at scale (Widiastuti et al., 2026; Zaina et al., 2024).

Real-time data streams translate these theological stewardship principles into measurable field practices. By combining Internet of Things (IoT) soil-moisture probes and localized weather stations with satellite imagery, platforms track crop development and microclimate volatility continuously (Aruwajoye & Coetzee, 2025; Rana et al., 2025). This data enables smallholders to transition to precision agriculture, optimizing the application of water and fertilizer with pinpoint accuracy. Empirically, precision farming technologies have been shown to cut chemical inputs by 15% to 20% and reduce resource wastage without compromising crop yields (Aruwajoye & Coetzee, 2025).

Agri-fintech platforms reinforce these practices financially via dynamic eco-credit scoring. Rather than relying solely on static solvency checks, underwriting algorithms tie interest markups, borrowing ceilings, and repayment terms directly to verified environmental stewardship, granting preferential capital access and rates to sustainable producers (Tinsley & Agapitova, 2018). Linking credit pricing to continuous field data converts ecological compliance from an overhead burden into a direct balance-sheet advantage, buffering vulnerable producers against escalating climatic shocks.

Theoretical Framework

To capture the structural complexity of agri-fintech, this study combines two complementary perspectives namely the Three-Dimensional Fintech Framework by Fethallah (2025) and classical Agency Theory. Fethallah's model approaches fintech not as an isolated tool, but as the convergence of three distinct operational domains. The first, Finance, governs contract structuring, capital allocation, and transactional clearing. The second, Technology Management, oversees foundational technical architecture, such as cloud-hosted applications and distributed database systems. Finally, Innovation Management addresses organizational engineering, designing collaborative business models that align dispersed supply chain actors and foster institutional trust in unbanked rural markets. By evaluating Bagh-e through this three-dimensional lens, we can analyze how its Finance dimension (executing Shariah-compliant contracts like *Salam* and *Murabahah*) is successfully automated by its Technology Management dimension (utilizing cloud computing and big data), and scale-optimized by its Innovation Management dimension (integrating isolated rural smallholders, input providers, and investors into a single, cohesive and collaborative digital value chain).

Agency Theory provides a suitable lens for evaluating default risk and contractual breakdown in smallholder finance (Chien et al., 2025; Mhlongo et al., 2025). Agency Theory models the relationships, misaligned incentives, and conflicts of interest that emerge between principals (such as financial lenders or investors) and agents (such as borrowing farmers) under conditions of information asymmetry. In sustainable finance, this friction manifests as greenwashing in which producers misstate their ecological practices to access subsidized credit. Agri-fintech platforms solve this agency problem through end-to-end value chain visibility. By encoding Shariah stipulations into blockchain-based smart contracts, execution occurs automatically against verified, third-party triggers like electronic warehouse receipts or satellite-validated harvests. Automating these milestones eliminates discretionary enforcement, curbing opportunistic defaults while independently confirming sustainability claims.

3. Research Methodology

Research Design

This study employs a qualitative, desk-based documentary single-case study design (Yin, 2018) to analyze the Bagh-e platform. A descriptive-interpretive documentary case study approach is appropriate for evaluating fast-evolving, proprietary fintech platforms where direct primary field access is constrained, relying instead on the systematic qualitative triangulation of public corporate disclosures, regulatory records, and third-party industry whitepapers (Mahboob et al., 2025; Pal, 2025). Recent methodological literature underscores that desk-based documentary case studies offer a rigorous, objective framework for examining how digital architectures operationalize complex financial and legal structures across emerging markets without introducing primary field respondent bias (Mu'id et al., 2026; Luís et al., 2024; Pal, 2025).

Nonetheless, this study recognized a limitation of potential for self-reporting and social desirability biases inherent in platform-disclosed materials, which naturally emphasize operational success and technological optimization while downplaying ground-level friction. To mitigate this issue, we employ rigorous documentary

triangulation (Yin, 2018). Platform claims are systematically cross-verified against third-party regulatory evaluations (notably Bank Negara Malaysia's MIFC challenge criteria), independent fintech market monitors (such as the Global Islamic Fintech Report), and empirical benchmarks documented in multilateral agrarian development literature (Benni et al., 2025; Khandker & Yamano, 2025).

Case Selection and Justification

The Bagh-e platform was selected as the unit of analysis using purposive, revelatory case sampling based on its geographic relevance, digital architecture, regulatory significance, and high data transparency.

Geographically, Bagh-e's ground-level operational deployment targets smallholder agrarian communities in South Asia (specifically Pakistan), a market characterized by severe structural financial exclusion where over 80% of smallholders operate without formal bank accounts, face recurring extreme climate hazards such as devastating floods and droughts and remain trapped in predatory informal credit cycles due to a lack of physical land titles as collateral. This specific operating market serves as a critical empirical context for agri-fintech intervention because it exhibits acute pre-harvest liquidity shortages and an urgent demand for non-exploitative, Shariah-compliant alternatives (Adesiyan, 2025; Klapper et al., 2025; Shaikh, 2024). Second, it explicitly embeds traditional Islamic agricultural contracts, specifically *Salam* for advance working capital and *Murabahah* for asset input procurement, directly into its digitized mobile architecture (Al-Daihani et al., 2024).

Third, the platform's operational model has been externally validated by major regulatory bodies, notably winning the Climate Resilience Track of the Malaysia International Islamic Financial Centre (MIFC) Global Impact Challenge in 2025, organized by Bank Negara Malaysia (2025). This award directly connects Bagh-e's field deployment in South Asian smallholder markets with Malaysia's global Islamic finance regulatory and Value-Based Intermediation (VBI) framework. Lastly, it offers an extensive and transparent public audit trail, including operational whitepapers, app interface workflows, and verified regulatory filings (Harvard Innovation Labs, 2025). While recognizing that secondary materials originating from pitch environments are designed to demonstrate commercial viability and scalability, cross-referencing these artifacts against external regulatory filings provides an empirical baseline to evaluate the platform's architecture without requiring primary field access.

Secondary Data Corpus

The analysis evaluates a systematic corpus of secondary qualitative data, detailed in Table 1 below:

Table 1: Secondary Data Corpus Analyzed

Data Category	Document / Source Type	Specific Artifacts & Scope	Purpose in Analysis
Platform Artifacts	Primary disclosures by Bagh-e	Bagh-e app architecture specifications, user interface workflows, whitepapers, press releases (Harvard Innovation Labs, 2025).	Evaluating the Finance, Technology, and Innovation dimensions (Fethallah, 2025).
Regulatory Records	Central Bank & Industry Reports	Bank Negara Malaysia (BNM) MIFC Challenge 2025 listings; Global Islamic Fintech Report 2025/26 (Basit et al., 2026).	External validation of compliance, climate resilience, and governance.
Macro Data	Multilateral Institutions	Food and Agriculture Organization reports (Benni et al., 2025), World Bank Findex (Klapper et al., 2025), ADB agricultural reports (Khandker & Yamano, 2025).	Contextualizing agrarian credit gaps and smallholder demographics in Southeast Asia.
Academic Literature	Peer-reviewed Journals	Studies on *Salam*, *Murabahah*, and VBI frameworks (Al-Daihani et al., 2024; Mu'id et al., 2026).	Theoretical pattern-matching and construct triangulation.

Analytical Protocol and Coding

Documentary evidence underwent qualitative content analysis and deductive pattern matching to reconcile operational platform data with theoretical assumptions (Mahboob et al., 2025; Pal, 2025). Analysis proceeded through a three-stage sequence:

Stage 1 (Structural Coding): Extracting all functional and financial features of the Bagh-e platform (e.g., crop-specific funding, risk assessment, digital credit) from platform-specific materials.

Phase 2 (Theoretical Pattern-Matching): The Three-Dimensional Fintech Framework and Agency Theory are used to map the extracted features.

Phase 3 (Triangulation and Verification): The analysis cross-examined platform performance metrics against external benchmarks, triangulating self-reported claims with Bank Negara Malaysia's (BNM) climate resilience evaluations and established Shariah auditing criteria.

4. Findings

Analyzing the Bagh-e platform through the lens of qualitative content analysis (Mahboob et al., 2025; Pal, 2025) reveals that its digital transformation of agricultural lending operates as a cohesive socio-technical system. The platform's architecture structurally aligns with the three core dimensions of the Three-Dimensional Fintech Framework: (1) Shariah-compliant financial contracts, (2) advanced technology and risk management databases, and (3) collaborative value-chain innovation management.

The Finance Dimension: Shariah-Compliant Structural Alignment

The first dimension of the platform concerns the creative adaptation of classical Islamic contracts (*Fiqh al-Muamalat*) to fulfill the specific working capital and asset-acquisition requirements of smallholders (Al-Daihani et al., 2024; Kalimullina & Orlov, 2020). Traditional rural credit programs frequently fail because rigid, interest-based repayment schedules clash with the volatile, seasonal nature of crop yields. Bagh-e replaces this with two primary Shariah-compliant structures:

Digital *Salam* Contracts (Forward Sales) Workflow: To supply critical upfront working capital for planting, Bagh-e facilitates digital Salam agreements. Under this framework, investors purchase a predetermined portion of the farmer's expected harvest at an agreed-upon, discounted price, with the cash disbursed immediately to fund pre-harvest preparations. This upfront liquidity solves the severe resource crunch farmers experience at the start of the planting season without trapping them in interest-based debt (Harvard Innovation Labs, 2025; Kalimullina & Orlov, 2020; Shaikh, 2024).

Digital *Murabahah* (Cost-Plus) Workflow: When farmers require physical capital assets such as tractors, certified seeds, or specialized fertilizers, the platform arranges a *Murabahah* structure. To avoid selling goods before ownership, the platform establishes constructive possession (*qabd hukmi*) and ownership risk transfer through a sequential four-step execution:

Step 1 - Promise to purchase (*wa'd*): The farmer submits an input financing request via the mobile app, executing a unilateral promise to purchase the required items.

Step 2 - Platform procurement and constructive possession (*qabd hukmi*): Bagh-e acquires the specified asset from a trusted supplier. Digital inventory allocation and voucher generation establish the platform's legal title, disposition rights, and initial ownership.

Step 3 - Murabahah execution: Bagh-e formally executes the sale with the farmer at cost plus a disclosed mark-up which will be paid post-harvest, thereby issuing a restricted closed-loop voucher to the farmer's dashboard.

Step 4 - Physical delivery and risk transfer (*qabd haqiqi*): The farmer redeems the voucher at the trusted supplier's vendor. Physical possession (*qabd haqiqi*) is transferred to the farmer, which then triggers an automated financial settlement to the vendor (Basit et al., 2026; Harvard Innovation Labs, 2025; Kalimullina & Orlov, 2020).

The Technology Management Dimension: AI Risk Analytics and Digital Vouchers

The second dimension of Bagh-e is its advanced digital infrastructure, which automates and secures the execution of these Shariah contracts at scale. Traditional banks avoid rural agricultural lending because manual

monitoring of thousands of geographically dispersed, unbanked smallholders creates excessively high transaction and screening costs (Kashid et al., 2026; Khandker & Yamano, 2025). Bagh-e overcomes these brick-and-mortar limitations through two integrated technology systems:

AI Agronomic Risk Engine: Bagh-e leverages a cloud-hosted, predictive AI data engine that integrates real-time satellite imagery, localized weather station feeds, and historical crop yield analytics. This system constructs dynamic credit profiles based on verified agronomic capacity rather than physical property titles, allowing smallholders who used to be excluded to access formal finance. During the cultivation cycle, the AI continuously monitors vegetation health and pest threats. Proactive alerts are then sent to protect the farmer's yield and the investor's capital (Benni et al., 2025; Harvard Innovation Labs, 2025; Pal, 2025).

Closed-Loop Digital Voucher System: To ensure funds are only used for its intended purposes, Bagh-e manages disbursement through a closed-loop digital voucher system. Approved financing is issued as restricted digital vouchers directly to the farmer's mobile dashboard. The farmer redeems these vouchers with verified suppliers, and Bagh-e automatically settles the payment with the supplier once the delivery is verified (Basit et al., 2026; Harvard Innovation Labs, 2025; Nielsen et al., 2026). From a *Fiqh* perspective, this architecture provides a guarantee of real-asset backing. As the capital is locked within a verified merchant network, the voucher ensures that credit is converted into tangible productive inventory, directly honoring the Islamic finance tenet that money must serve as a medium of exchange rather than a commodity (Mu'id et al., 2026).

The Innovation Management Dimension: Value-Chain Integration and Socio-Technical Trust

The final dimension of Bagh-e's operational success is its innovative value-chain business model, which coordinates diverse ecosystem stakeholders and actively builds user trust. Because smallholder communities often exhibit low initial trust toward digital financial systems and formal banking institutions, technological access alone is insufficient. Bagh-e addresses this structural barrier through two key trust-building innovations:

Embedded Agronomic Advisory Services: Bagh-e directly integrates real-time agronomic consulting into its mobile platform, providing farmers with free, continuous access to certified agricultural officers and automated, localized soil-management guides. This pairing of agronomic training with financial credit ensures that farmers possess the practical capabilities necessary to convert capital into optimized yields (Harvard Innovation Labs, 2025; Vasudevan et al., 2025).

Ecosystem Disintermediation: Bagh-e constructs a unified digital marketplace that directly connects smallholder producers, input suppliers, and ethical investors. By facilitating transparent, direct-to-market sales connections, the platform prevents price exploitation by local agricultural brokers, allowing smallholders to capture the true market value of their harvest (Harvard Innovation Labs, 2025; Mapanje et al., 2023).

Discussion

Bagh-e's operational model demonstrates that Shariah compliance and predictive data systems can actively reinforce each other rather than trade off against operational speed. The platform moves beyond theoretical intent. It puts Malaysia's Value-Based Intermediation (VBI) framework into direct practice, steering Islamic finance away from tick-box, form-over-substance compliance toward tangible triple-bottom-line impact (Bank Negara Malaysia, 2019; Miras, 2025). Analyzing this implementation through the synthesized theoretical framework illuminates the platform's real-world socio-technical performance, exposing systemic frictions alongside its potential for global scalability.

Alignment with Maqasid al-Shariah and Bank Negara Malaysia's VBI

Bagh-e challenges the prevailing assumption that financial viability requires compromising on social safeguards. Instead of pursuing rapid portfolio expansion through indiscriminate loan volume, the platform calibrates facility sizes directly to the seasonal capacity of rural farmers. This operational discipline brings the foundational VBI principle of "attaining benefit and preventing harm" to life, subordinating short-term margin maximization to non-exploitative financing terms (Bank Negara Malaysia, 2019; Miras, 2025; Shafruddin & Shahimi, 2025). That distinction is critical for agrarian policy. Without deliberate risk-mitigation buffers,

unrestricted commercial microfinance has historically trapped unbanked farming families in severe, recurring debt distress (Duggan, 2016; van Rooyen et al., 2012).

By substituting conventional interest-based debt with equity-like *Salam* and asset-backed *Murabahah* contracts, Bagh-e demonstrates how digital platforms operationalize the core goals of Islamic law (*Maqasid al-Shariah*) and Bank Negara Malaysia's Value-Based Intermediation (VBI) initiative.

Table 2: Bagh-e Alignment with *Maqasid al-Shariah* and VBI

Maqasid Dimension	Operationalization in Bagh-e Platform	Aligned VBI Underpinning Thrust
Preservation of Wealth (*Hifz al-Mal*)	Replaces interest-based debt with equitable risk-sharing (*Salam*) and cost-plus sales (*Murabahah*), successfully dismantling predatory rural lending structures (Mu'id et al., 2026).	Entrepreneurial Mindset & Best Conduct (Shafruddin & Shahimi, 2025)
Preservation of Livelihood (*Hifz al-Nafs*)	Combines crop financing with AI agronomic advisory to shield smallholders from catastrophic yield losses, preserving rural household incomes and supporting local food security (Benni et al., 2025).	Community Empowerment (Shafruddin & Shahimi, 2025)
Promotion of Well-being (*Maslahah*)	Democratizes financial access for underserved populations, actively mitigating regional wealth disparities and supporting long-term economic resilience (Mu'id et al., 2026).	Inclusive Growth (Shafruddin & Shahimi, 2025)

Most importantly, the realization of these *Maqasid* dimensions and VBI thrusts is not an automatic outcome of deploying the Bagh-e platform. In field operations, translating ethical intent into genuine welfare protection (*Hifz al-Mal* and *Hifz al-Nafs*) is highly dependent on the realities on the ground level. If operational failure points to disrupt platform execution, the intended risk-sharing benefits can quickly revert into default distress.

Mitigating Principal-Agent Conflicts and Environmental Risks

Under traditional financing models, severe information asymmetry between lenders (principals) and borrowing farmers (agents) regarding crop health and creditworthiness leads to moral hazards, default risks, and high interest rates (Khandker & Yamano, 2025). This information barrier poses a distinct threat to green finance because it enables greenwashing, allowing producers to capture preferential green capital through unsubstantiated environmental claims.

The Bagh-e architecture neutralizes this agency friction at the data layer. By replacing titled land requirements with AI credit profiling driven by satellite crop telemetry, underwriting transitions from subjective gatekeeping to objective agronomic scoring (Nielsen et al., 2026). Deployed IoT field sensors close the monitoring loop. Tracking resource consumption and canopy development in real time produces auditable proof of sustainable management, shielding ESG-oriented capital from false compliance claims while maintaining a reliable operational ledger (Aruwajoye & Coetzee, 2025).

Operational Vulnerabilities, Failure Points and Policy Scalability Pathways

A rigorous critique must look past curated platform metrics to confront operational realities on the ground. The rural digital divide remains a primary vulnerability. Because low financial literacy and unfamiliarity with smartphone operating systems prevent many older farmers from navigating digital applications independently, theoretical disintermediation breaks down in practice. Without dedicated field staff to guide profile registration and input voucher processing, digital financial inclusion fails to materialize for the exact marginalized populations it targets (FAO & IPA, 2024). Second, remote-sensing data transmission can be disrupted by heavy cloud cover during the monsoon season, while weak rural internet connections can affect the real-time transmission of soil-sensor data (Aruwajoye & Coetzee, 2025). Third, moral hazard may still

happen when input suppliers and farmers collude to exchange digital vouchers for cash at a discount without providing the actual farm inputs. Even with digital restrictions, input voucher systems remain vulnerable to diversion and secondary market leakage (Jayne et al., 2018; Ricker-Gilbert et al., 2013). Beyond logistical friction, climate shocks represent a profound systemic blind spot. Because severe droughts or flash floods destroy yields on a macro scale, smallholders face involuntary default, unable to fulfill contracted crop quantities under a classical *Salam* contract. Unless the platform embeds micro-Takaful underwriting to cover catastrophic harvest failures, severe weather anomalies can rapidly compromise their balance-sheet stability.

Beyond localized operational failure points, scaling Bagh-e's digital architecture across ASEAN (such as Malaysia and Indonesia) and other OIC markets requires overcoming regulatory fragmentation and divergent Shariah interpretations of classical agricultural contracts (Basit et al., 2026). To address these hurdles and facilitate regional scalability, central banks should establish tailored regulatory sandboxes that permit the testing of digital risk-sharing models under proportional capital requirements (Chien et al., 2025). Furthermore, standard-setting bodies such as AAOIFI and IFSB must develop standardized, digitized Islamic contract templates across ASEAN and OIC states to minimize compliance friction, facilitate cross-border capital flows, and unlock institutional investment for rural resilience (Basit et al., 2026).

5. Conclusion

Analyzing the operational architecture of Bagh-e reveals how Shariah-governed agri-fintech bypasses the structural frictions that have long entrenched rural credit deficits. The empirical evidence indicates that the historical barrier to deploying contracts like *Salam* and *Murabahah* at scale was administrative rather than conceptual. When executed through predictive data analytics, cloud infrastructure, and self-enforcing smart contracts, these asset-backed instruments transition from operationally cumbersome ideals into efficient, scalable financial products. Replacing physical collateral with continuous agronomic scoring and programmable voucher routing resolves core principal-agent dilemmas without alienating non-literate borrowers. Ultimately, this integration charts a workable path away from interest-based credit models toward an asset-anchored ecosystem capable of buffering smallholders against escalating market and climatic volatility.

These findings address a persistent disconnect in emerging-market finance, i.e. the rift between classical *Fiqh al-Muamalat* jurisprudence and scalable digital execution. By examining Bagh-e through the Three-Dimensional Fintech Framework, this study illustrates how the Technology Management dimension operationalizes complex risk-sharing. Where commercial banks perceive prohibitive credit exposure, automated workflows transform cumbersome *Salam* and *Murabahah* structures into viable, low-cost instruments. The research further refines Agency Theory in sustainable finance. Rather than demanding physical property titles to secure compliance, the model demonstrates that pairing satellite imaging and predictive AI scoring with closed-loop voucher routing eliminates information asymmetries. This programmatic transparency directly curtails moral hazard, capital diversion, and greenwashing at the source.

These findings translate into concrete operational pivots for Islamic Financial Institutions (IFIs) and agri-fintech engineers. Cash micro-lending should be removed in favor of closed-loop digital vouchers. Restricting capital redemption strictly to authorized input vendors enforces authentic asset-backing and eliminates diversion risks before they occur. Underwriting frameworks require an equivalent overhaul. By replacing immovable property collateral with alternative data footprints, platforms can accurately profile unbanked smallholders. Lastly, liquidity alone is insufficient. Project managers must bundle credit facilities and Takaful coverage directly with real-time agronomic advisory feeds, as financial access translates into regenerative practice only when producers receive ongoing technical guidance.

Across ASEAN and wider OIC jurisdictions, translating these findings into real-world resilience requires dismantling legacy regulatory friction. Financial watchdogs and agricultural ministries should begin by establishing sector-specific regulatory sandboxes. Providing controlled testing environments with proportional capital adequacy rules allows digital *Salam* frameworks and P2P risk-sharing platforms to prove operational stability without being crushed by commercial banking mandates. In parallel, multilateral standard-setting bodies, specifically AAOIFI and the IFSB, must establish standardized digital Shariah

governance templates. Uniform contract protocols compress legal due diligence expenses across borders, reassuring institutional ESG allocators seeking compliant rural deployments. Crucially, software cannot outrun its physical rails. State planning must reclassify rural telecommunications and mobile broadband as non-negotiable public utilities rather than discretionary market luxuries.

These conclusions must be interpreted within clear methodological and geographic limitations. The qualitative single-case design anchors the findings to Pakistan's specific agrarian economy, where unique land-tenure patterns and informal credit monopolies shaped platform adoption; immediate transferability to other regulatory or macroeconomic environments remains unproven. Methodologically, reliance on secondary documentation and award evaluations introduces potential survivorship bias, offering limited visibility into ground-level operational breakdowns or localized user resistance. Subsequent scholarship can address these limitations through two distinct empirical routes. First, researchers should execute quantitative impact evaluations that measure farm-gate productivity, household income volatility, and repayment default over consecutive crop cycles. Second, comparative policy inquiries are needed across ASEAN jurisdictions to determine how varying sandbox stringencies and Shariah governance frameworks dictate the international scalability of digital agricultural platforms.

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