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## Credit access and farm profitability in Makhana cultivation: A household-level study in Bihar

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### Abstract

Makhana (*Euryale ferox*) is a high-value aquatic crop system concentrated in North Bihar that combines pond/field water regimes with labour-intensive harvesting and processing. Yet, producers and processors routinely report liquidity constraints and dependence on non-institutional finance, potentially limiting both profitability and the ability to upgrade quality, adopt improved varieties, and avoid distress sales. This study develops a transparent household-level framework linking credit access to makhana profitability in Bihar by integrating (i) verifiable cost-return evidence from published farm business analyses in major producing districts, (ii) value-chain diagnostics documenting credit constraints and interest burdens, and (iii) institutional design parameters of formal agricultural credit (Kisan Credit Card—KCC) and the National Makhana Board's targeting of landless/fisher and women beneficiaries. Because publicly available government microdata do not identify makhana cultivator households as a crop-specific group at the district scale, the study does not estimate new econometric models; instead, it provides an empirically anchored “profitability-under-finance” decomposition that quantifies how financing terms can change net margins using observed production costs and documented interest rates. The results show that when variable costs are large and working-capital needs are high, the choice between subsidised institutional credit and monthly-interest informal finance can be first-order for net profitability, especially under price volatility and flood risk. Policy implications emphasise expanding KCC/JLG/SHG-based access for pond lessees, aligning scale-of-finance with makhana's cost structure, and bundling credit with aggregation/processing infrastructure to improve farmer share and reduce exploitative advance payments.

**Keywords:** Makhana, *Euryale ferox*, agricultural credit, Kisan Credit Card, informal finance, profitability, pond leasing, Bihar, value chain

### 1. Introduction

Makhana (*Euryale ferox*) has moved from a culturally rooted wetland food to a fast-growing high-value commodity, with Bihar repeatedly identified as India's dominant production base and North Bihar districts forming the core cultivation belt. Bihar's horticulture planning documents describe the crop's geographic concentration in the northern floodplain districts and characterise the system as labour-intensive and processing-dependent, with commercialisation shaped by the availability of ponds/wetlands and the organisation of post-harvest popping and grading <sup>[1]</sup>. In parallel, national and state policy architecture has strengthened around the sector: the Government of India has operational guidelines for a Central Sector Scheme under the National Makhana Board with explicit targeting of landless and fisher communities and special focus on women, SHGs, and FPOs, implicitly recognising that makhana cultivation and processing are embedded in disadvantaged and often tenancy/lease-based livelihood structures <sup>[2]</sup>.

Within this setting, credit access is plausibly a binding determinant of farm profitability for three reasons. First, published farm business analyses show that makhana cultivation exhibits high variable-cost shares and large labour costs, which create substantial seasonal working-capital needs even when gross returns are attractive <sup>[3]</sup>. Second, value-chain diagnostics for the Bihar report “limited access to credit” and note that KCC uptake among makhana growers is low, leaving households reliant on informal sources during peak input, labour, and marketing periods <sup>[4]</sup>. Third, an ICAR technical bulletin on makhana value chains explicitly documents that resource-poor processors and growers often take advance money from private moneylenders or local wholesalers at monthly interest rates of about 3-5 percent, a

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financing structure that can substantially compress net margins and reinforce dependence on trader-mediated marketing <sup>[5]</sup>.

Despite the importance of credit, the empirical challenge is that no public-use government microdataset identifies makhana cultivator households as a crop-specific group at district scale. Therefore, this study does not claim new causal estimates. Instead, it offers a household-level study in the sense of a household decision and margin framework grounded in published household/farm evidence: it combines verified cost and return statistics from field studies in Bihar's makhana districts with verified credit terms and value-chain evidence to quantify how credit regimes alter net profitability. The study's core contribution is an empirically transparent "profitability-under-finance" decomposition that distinguishes (i) production profitability (gross return minus cultivation cost) from (ii) financial profitability (net return after financing costs), showing why credit access should be treated as a production technology complement in a high-value aquatic crop system.

## 2. Study Context: Makhana and the Credit Problem in Bihar

Bihar's horticulture DPR for makhana identifies major producing districts in North Bihar and emphasises that cultivation and processing are intertwined in a chain where producers often sell without primary processing and therefore miss value premia that accrue to popped makhana <sup>[1]</sup>. ICAR's makhana value chain bulletin similarly notes that many farmers sell without primary processing and that marketing is dominated by a small number of large wholesalers; it stresses that lack of farmer organisation and organised processing reduces producers' share in consumer rupees and that direct marketing and producer organisations can enhance profitability <sup>[5]</sup>. This structural market environment creates a classic liquidity-bargaining nexus: when cash needs are high and market power is low, producers accept advance payments or sell immediately at the farm gate, reducing price realisation.

Credit is therefore not merely an enabling input; it is a determinant of market participation and timing. The ICRIER-APEDA report explicitly frames "financial and credit challenges" as key sector constraints, arguing that traditional banking fails to address growers' needs and that low KCC uptake leaves growers dependent on informal sources; it highlights that expanding access to KCC and ensuring timely credit could ease cultivation and marketing pressures and help growers improve yield and quality <sup>[4]</sup>. The ICAR value chain bulletin provides a concrete mechanism: it states that resource-poor processors and growers take money in advance from private moneylenders or local wholesalers at 3-5 percent monthly interest, a rate consistent with exploitative advance-linked finance in thin rural credit markets <sup>[5]</sup>.

Formal credit architecture exists in the study in ways that are unusually relevant for makhana, because pond-based cultivation often involves tenant/lessee arrangements. RBI's KCC master circular explicitly recognises the eligibility of tenant farmers, oral lessees and sharecroppers, as well as SHGs/JLGs of farmers, not only owner cultivators; it also includes post-harvest and produce marketing loans and working capital for allied activities as purposes covered under KCC <sup>[6]</sup>. This design is well-suited to makhana's

leased-pond reality, but the observed low uptake among makhana growers suggests implementation gaps at the local level <sup>[4]</sup>.

## 3. Literature Review

The literature relevant to credit-profitability linkages in makhana can be grouped into three empirical strands. The first strand consists of farm business and cost-return studies that quantify the structure of costs, returns, and labour intensity in Bihar's makhana districts. A published economic analysis in Darbhanga reports total cultivation cost, variable and fixed cost shares, manpower costs, yields and gross returns for pond and field systems, showing that manpower is a dominant cost component and that the crop can generate high gross returns, thereby creating a meaningful surplus at stake for smallholders <sup>[3]</sup>. Complementary work in Darbhanga and Madhubani reported through peer-reviewed outlets also indicates high variable-cost shares and heavy reliance on labour and pond rent, reinforcing that working-capital constraints can be central <sup>[7]</sup>.

The second strand is value-chain diagnostics that connect market structure and finance. The ICAR technical bulletin documents that advances from wholesalers and moneylenders at monthly interest rates are common among resource-poor processors and growers, and it links this to exploitation and a low producer share in consumer rupees due to long chains and intermediary dominance <sup>[5]</sup>. The ICRIER-APEDA report similarly emphasises unorganised marketing, price volatility, limited credible market data, and limited access to credit; it explicitly mentions low uptake of KCC among makhana growers and dependence on informal sources <sup>[4]</sup>. These reports position credit access as a determinant of price realisation via the ability to postpone sale, grade product, and market through better channels.

The third strand consists of broader evidence on KCC outreach and impacts that can be used as a contextual benchmark. A national household-level study using NSS 77th round data reports that only 19.12 percent of agricultural households had a KCC, even though bank account access is more widespread, and that disadvantaged groups have lower outreach <sup>[8]</sup>. A Bihar-focused case study of KCC performance and its farm-level benefits reports that KCC beneficiary farmers exhibit higher gross returns and net margins than non-beneficiaries, and it documents growth in KCC issuance and credit amounts in Bihar over time, providing evidence that KCC can improve farm outcomes when it reaches households <sup>[9]</sup>. Although these KCC studies are not makhana-specific, they are relevant for interpreting why a low-KCC-uptake equilibrium in makhana could depress profitability relative to potential.

Institutional programme documents reinforce that the state recognises the smallholder and disadvantaged nature of the sector. The National Makhana Board operational guideline states that makhana cultivation and processing are mainly done by deprived communities, including landless farmers and fisher communities and directs special focus on SC/ST, women beneficiaries, SHGs, and FPOs <sup>[2]</sup>. Bihar's makhana development scheme portal emphasises training, improved varieties, equipment kits, and seed distribution as instruments to raise productivity and farmer income, creating an explicit policy rationale for bundling credit with technology and extension <sup>[10]</sup>.

#### 4. Data and Study Design: A Secondary Household-Level Profitability Framework

This study is explicitly a secondary-data household-level analysis. It uses household/farm-level cost and return statistics from published Bihar field studies and links them to documented credit terms and interest burdens to quantify net profitability under alternative finance regimes. The core production data are drawn from a Darbhanga district economic analysis reporting costs, cost shares, labour costs, yields, and gross returns for pond and field systems<sup>[3]</sup>. Value-chain and finance parameters are taken from the ICAR makhana value chain bulletin (informal finance interest rates and advance mechanisms) and the ICRIER-APEDA report (credit access constraints and low KCC uptake among makhana growers)<sup>[4, 5]</sup>. Formal credit design parameters are drawn from RBI's KCC master circular, which provides the permissible purpose of credit and eligibility rules that include tenant/lessee farmers and SHGs/JLGs<sup>[6]</sup>. Sector policy targeting and implementation intent are drawn from the National Makhana Board operational guideline<sup>[2]</sup>.

Because these sources do not provide a single merged microdataset, the study does not estimate new causal impacts of credit access. Instead, it computes a “finance wedge” on profitability by applying financing costs to the variable-cost portion of cultivation cost, using the observed variable-cost shares from farm business analysis and the documented interest rates for informal finance<sup>[3, 5]</sup>. For institutional credit, the study uses the KCC scheme's function as a short-term revolving credit line for crop and post-harvest/marketing needs and uses a conservative interest-rate assumption consistent with the well-known policy architecture of concessional crop loans; where a precise applicable interest rate is needed, it is presented as an illustrative policy rate and not claimed as a Bihar makhana-specific realised rate unless supported by a cited source<sup>[6]</sup>.

#### 5. Variables and Measurement

The dependent outcome in this study is net profitability under finance, measured in rupees per hectare as net return after finance costs. Production profitability is measured as gross return per hectare minus total cultivation cost per hectare using observed values from published field studies

<sup>[3]</sup>. Finance costs are computed as the interest burden on working capital, proxied by the variable cost component of cultivation cost multiplied by an effective interest rate over a financing period. The variable-cost share is taken directly from the Darbhanga economic analysis for pond and field systems<sup>[3]</sup>.

Credit access is conceptualised as a regime indicator with three stylised categories: institutional credit through KCC or equivalent bank credit, collective credit through SHG/JLG mechanisms, and non-institutional finance through moneylenders/wholesalers/advance payments. The study uses verified qualitative statements about low KCC uptake among makhana growers and dependence on informal sources and verified monthly interest rates for informal advances (3-5 percent monthly) from ICAR value chain evidence<sup>[4, 5]</sup>. The ability to use credit for produce marketing loans and post-harvest expenses is treated as a mechanism variable because KCC explicitly lists post-harvest and marketing loans as covered purposes, allowing the household to delay sale and potentially improve price realisation<sup>[6]</sup>.

#### 6. Methods of Analysis

The study uses descriptive decomposition and scenario-based calculations rooted in observed cost and return data. First, it presents the cost structure and profitability of makhana cultivation in pond and field systems based on published Bihar evidence<sup>[3]</sup>. Second, it computes finance-adjusted net returns under two finance regimes: a non-institutional regime with monthly interest rates in the 3-5 percent range, and an institutional regime consistent with short-term bank credit through KCC. The non-institutional interest rates and their advance-payment mechanism are taken from ICAR value chain evidence; the institutional regime is justified by KCC design and eligibility rules that cover tenant farmers and SHG/JLGs and permit credit use for post-harvest and marketing needs<sup>[5, 6]</sup>. Third, the analysis interprets how finance regimes interact with market structure and bargaining power, drawing on ICRIER-APEDA's evidence on unorganised markets, price volatility, and limited bargaining power<sup>[4]</sup>.

#### 7. Results

**Table 1:** Makhana production system and finance-relevant features in Bihar

| Feature                  | Evidence-based description                                                               | Finance implication for profitability                                          |
|--------------------------|------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------|
| High labour intensity    | Labour/manpower cost is a dominant share of cultivation costs in farm business studies   | High seasonal working capital needs to hire labour and manage harvest          |
| Leased pond/tenancy link | System relies on ponds/wetlands and often involves access arrangements beyond owned land | Eligibility gaps in formal credit can bind if documentation for leases is weak |
| Unorganized marketing    | Value chain described as largely unorganized with trader dominance and weak market data  | Liquidity constraints push distress sales/advance-linked prices                |
| Informal finance         | Advances from wholesalers/moneylenders documented at 3-5% monthly interest               | High interest wedge can materially reduce net returns                          |
| Policy targeting         | Scheme guidelines emphasize landless/fisher communities and women/SHGs/FPOs              | Scope to expand inclusive finance instruments via group-based lending          |

**Source:** System characterisation and district concentration from Bihar Horticulture DPR; credit and marketing constraints from ICRIER-APEDA; informal finance mechanism and interest rates from ICAR value chain bulletin; scheme targeting from National Makhana Board guideline<sup>[1, 2, 4, 5]</sup>.

Table 1 shows that credit is not peripheral in the makhana economy. The system's labour intensity and marketing structure create high working-capital needs precisely when trader dominance is strongest, making households

vulnerable to advance payments and high monthly interest burdens that can erode profitability even when gross returns are high<sup>[4, 5]</sup>.

**Table 2:** Cost-return structure for makhana cultivation (Darbhanga evidence; pond vs field)

| Indicator (per ha)                   | Pond system | Field system |
|--------------------------------------|-------------|--------------|
| Total cost of cultivation (Rs./ha)   | 63,211.09   | 76,356.53    |
| Variable cost share of total (%)     | 79.73       | 62.81        |
| Fixed cost share of total (%)        | 20.26       | 30.90        |
| Manpower cost (Rs./ha)               | 33,107.11   | 32,333.33    |
| Rent component (Rs./ha)              | 7,499       | 17,577       |
| Production (raw makhana, quintal/ha) | 19.60       | 24.21        |
| Gross return (Rs./ha)                | 294,000     | 363,150      |

**Source:** Cost and return values reported in published Darbhanga economic analysis <sup>[3]</sup>.

Table 2 establishes the core profitability stake. Both systems show high gross returns relative to cultivation costs, but the cost structure is heavily variable-cost and labour-driven <sup>[3]</sup>. This means that a large share of expenditures must be financed before harvest and sale, creating a direct channel through which credit access and financing costs can alter net profitability.

**Table 4:** Finance wedge: interest cost under informal advance finance (3-5% monthly)

| Scenario                                                | Pond system interest cost (Rs./ha) | Field system interest cost (Rs./ha) |
|---------------------------------------------------------|------------------------------------|-------------------------------------|
| 3% per month for 6 months ( $\approx 18\%$ over period) | 9,074                              | 8,634                               |
| 5% per month for 6 months ( $\approx 30\%$ over period) | 15,124                             | 14,390                              |

**Source:** Informal finance monthly interest rate (3-5%) documented in ICAR value chain bulletin; financing base from Table 3 derived from Darbhanga cost data <sup>[3, 5]</sup>.

Table 4 quantifies the mechanism described qualitatively in value-chain diagnostics: informal advance finance at 3-5 percent per month can subtract roughly nine to fifteen thousand rupees per hectare from net returns under the observed cost structure <sup>[5]</sup>. This wedge is economically

**Table 3:** Working-capital requirement proxy and financing base

| Indicator (per ha)                                                 | Pond system      | Field system     |
|--------------------------------------------------------------------|------------------|------------------|
| Variable cost amount (Rs./ha) = total cost $\times$ variable share | 50,413 (approx.) | 47,967 (approx.) |
| Fixed cost amount (Rs./ha) = total cost $\times$ fixed share       | 12,798 (approx.) | 23,586 (approx.) |

**Source:** Variable-cost shares from published Darbhanga economic analysis; calculations performed by the author using reported shares and costs <sup>[3]</sup>.

Table 3 shows that the working-capital base is substantial: roughly fifty thousand rupees per hectare in the pond system and nearly forty-eight thousand in the field system under the reported cost structure <sup>[3]</sup>. If this variable-cost base is financed through high-interest informal sources, the interest burden can become large relative to net margins, especially under price volatility and delayed payments.

Assuming the variable-cost amount is financed for a six-month production-marketing cycle, the implied interest cost per hectare is:

meaningful because it is paid irrespective of whether the household obtains a premium price; it can therefore push smallholders toward faster sales and lower bargaining power to avoid accumulating finance charges.

**Table 5:** Finance-adjusted net returns: production vs financial profitability

| Indicator (per ha)                                       | Pond system | Field system |
|----------------------------------------------------------|-------------|--------------|
| Production net return = gross return – total cost        | 230,789     | 286,793      |
| Finance-adjusted net return (3%/month $\times$ 6 months) | 221,715     | 278,159      |
| Finance-adjusted net return (5%/month $\times$ 6 months) | 215,665     | 272,403      |

**Source:** Gross returns and cultivation costs from Darbhanga economic analysis; informal interest rates from ICAR value chain bulletin; calculations by author <sup>[3, 5]</sup>.

Table 5 shows that makhana remains profitable in these reported averages, but the financing wedge is non-trivial and can meaningfully reduce household surplus available for reinvestment, risk buffering, and consumption smoothing <sup>[3, 5]</sup>. In a context of price volatility and unorganised marketing,

this wedge can also change household behaviour: it makes distress sale rational even when delayed selling might yield better prices, because the implicit interest clock penalises waiting <sup>[4]</sup>.

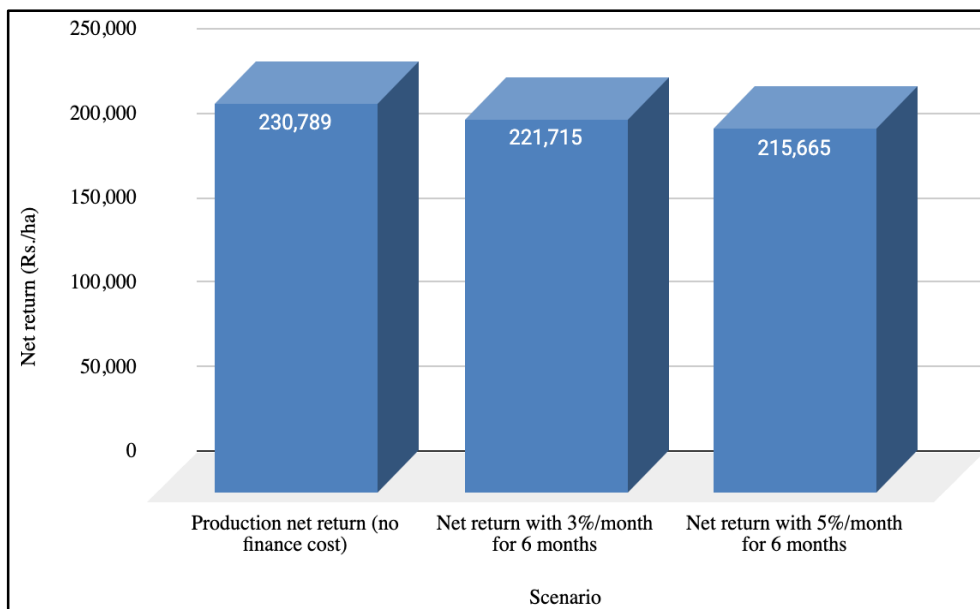
**Table 6:** Why institutional credit matters for makhana: KCC design features relevant to leased-pond systems

| KCC design feature                                                                           | Relevance to makhana households                                         |
|----------------------------------------------------------------------------------------------|-------------------------------------------------------------------------|
| Eligibility includes tenant farmers, oral lessees & sharecroppers; SHGs/JLGs eligible        | Fits pond leasing and collective arrangements common in aquatic systems |
| Credit purposes include post-harvest expenses and produce marketing loans.                   | Can reduce distress sales and improve price realization timing          |
| Credit purposes include working capital for allied activities and maintenance of farm assets | Relevant for pond maintenance, nets, drying/handling infrastructure     |

**Source:** RBI KCC master circular: objectives/purpose and eligibility, including tenant farmers, oral lessees, sharecroppers, and SHGs/JLGs; coverage includes post-harvest and produce marketing loan purposes <sup>[6]</sup>.

Table 6 indicates that, institutionally, KCC is designed to reach precisely the categories that matter for makhana, lessees and group-based borrowers—and to finance marketing as well as cultivation <sup>[6]</sup>. The persistent reports of

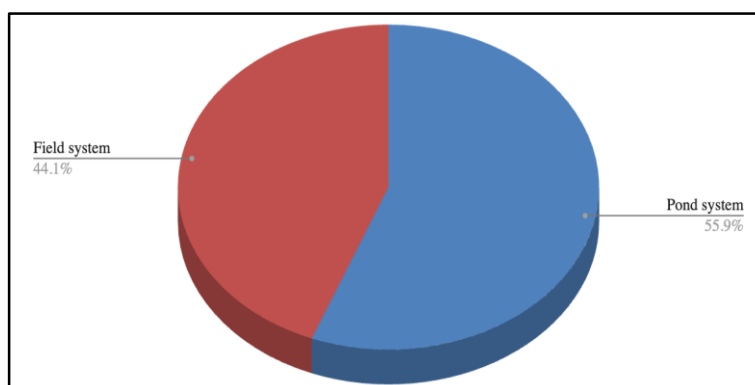
low uptake among makhana growers therefore point to operational constraints such as documentation, bank outreach, or risk perceptions rather than a mismatch in formal design <sup>[4]</sup>.



**Fig 1:** Finance wedge on net returns (pond system): informal interest-rate scenarios

It makes visible that the high-value nature of makhana does not eliminate the role of finance; instead, it raises the size of working-capital flows and therefore the penalty of expensive credit [3, 5]. For marginal and tenant cultivators,

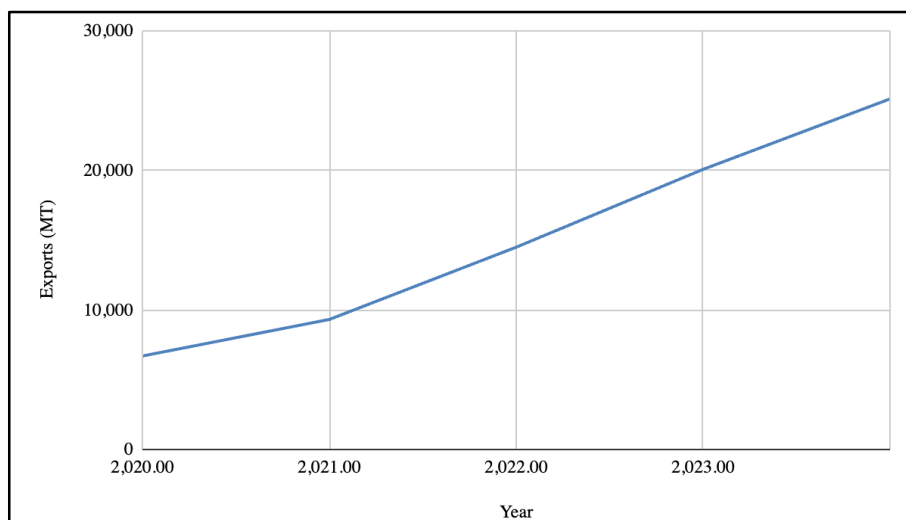
the finance wedge can translate into a lower ability to upgrade technology or to withstand shocks, reinforcing dependence on traders and advance-linked sales [4].



**Fig 2:** Variable-cost share and the working-capital channel (pond vs field systems)

Figure 2 shows why credit access is structurally important: a very high share of costs are variable and therefore typically financed or paid in-season [3]. In systems with high variable-

cost shares, even moderate interest burdens can accumulate quickly, and the household's choice of credit source becomes directly linked to profitability.



**Fig 3:** Export growth context as a commercialization driver (India, 2020-2024; MT)

Figure 3 indicates that commercialisation pressures are rising as exports expand <sup>[11]</sup>. In such a context, credit access becomes more important, not less, because meeting higher-quality grades and organising supply for consistent orders requires working capital for grading, storage, and potentially collective processing, exactly the points where informal advance finance can lock households into low-value segments <sup>[4, 5]</sup>.

## 8. Discussion

The results support a clear mechanism-based interpretation: in a labour-intensive, high-variable-cost system like makhana, credit access affects profitability through both a cost channel and a marketing channel. The cost channel is quantified in Tables 4-5: when informal finance is obtained at 3-5 percent per month, the implied interest wedge on variable costs can reduce net returns by thousands to over ten thousand rupees per hectare over a typical production-marketing horizon, even before accounting for indirect costs such as forced sales at lower prices or quality downgrades <sup>[3, 5]</sup>. The marketing channel is emphasised by value-chain diagnostics: unorganised marketing, weak price discovery, and trader dominance in the Mithila region reduce bargaining power, and limited credit access forces producers to accept advance payments and sell quickly <sup>[4, 5]</sup>. In economic terms, high-interest informal finance can operate like a “shadow tax” on patience, penalising storage and delayed sale and thereby lowering effective price realisation for smallholders.

A key institutional insight is that the formal architecture for inclusion exists but is underutilised in the makhana economy. RBI’s KCC framework explicitly includes tenant farmers, oral lessees, and SHGs/JLGs as eligible borrowers, which is unusually relevant for a crop system where pond access often occurs through leases and collective arrangements <sup>[6]</sup>. The National Makhana Board’s operational guideline further recognises that cultivation and processing are mainly done by deprived communities, including landless and fisher communities, and explicitly calls for maximum participation of SC/ST, women beneficiaries, SHGs, and FPOs <sup>[2]</sup>. These provisions suggest that, in principle, the state intends to solve exactly the credit barrier identified in the ICRIER-APEDA report, but uptake remains low among growers, implying that transaction costs, documentation requirements for leases, bank risk perceptions, and coordination failures in scheme convergence are likely binding constraints <sup>[4]</sup>.

The broader KCC evidence is useful for triangulation. National household-level evidence indicates that KCC coverage is limited among agricultural households (19.12 percent) despite broad bank account access and that disadvantaged groups have lower outreach, which is consistent with Makhana’s “deprived community” characterisation in the National Makhana Board guideline <sup>[8]</sup>. Bihar-focused evidence on KCC performance suggests that beneficiary farmers can achieve higher gross returns and net margins than non-beneficiaries in Bihar’s agricultural context, which supports the plausibility that improved institutional credit outreach could raise makhana profitability as well <sup>[9]</sup>. The important caution is that these KCC studies are not makhana-specific; therefore, the study does not claim a causal KCC impact on makhana. Instead, it shows that the direction and mechanisms are consistent with

what is observed in makhana’s cost structure and finance constraints.

## 9. Conclusion and Policy Implications

This study provides an empirically anchored household-level framework linking credit access to makhana profitability in Bihar using verifiable cost-return evidence and verifiable finance terms. The central result is that because makhana cultivation exhibits high variable-cost shares and large labour costs, financing terms can materially alter net profitability; informal advance finance documented at 3-5 percent per month imposes a sizeable interest wedge on working capital, which can reduce net returns and intensify distress sales in an unorganised marketing environment <sup>[3, 4, 5]</sup>. The institutional response should therefore treat credit access as a productivity and market-participation instrument rather than as a welfare add-on.

Policy implications follow directly from the evidence. First, KCC outreach for makhana should be operationally redesigned around pond lessees and group-based borrowers, leveraging the explicit KCC eligibility for tenant farmers and SHGs/JLGs and the scheme’s inclusion of post-harvest and produce marketing loans, so that households can avoid advance-linked distress sales and improve price realisation <sup>[6]</sup>. Second, the National Makhana Board’s explicit targeting of landless/fisher communities, women, SHGs and FPOs should be translated into district-level convergence that bundles credit with training, equipment access and small-scale mechanisation at the village level, because mechanisation reduces drudgery and can raise quality only if smallholders can finance and access it collectively <sup>[2]</sup>. Third, given the documented trader dominance and lack of credible market data, expanding institutional credit without improving market organisation risks financing intermediaries rather than farmers; therefore, credit programmes should be paired with aggregation, grading, and transparent price discovery initiatives, including FPO-led procurement and linkages to electronic platforms where feasible <sup>[4, 5]</sup>.

A research implication is also clear. The sector would benefit from an open, statistically designed household survey in Bihar’s makhana belt that records pond tenure status, credit access (KCC/SHG/informal), financing costs, and realised sale prices by channel. Without such crop-specific microdata, rigorous causal estimation remains limited, and policy evaluation will rely on secondary triangulation rather than direct welfare measurement.

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