

Analyzing the Effect of Maize Production on Poverty Alleviation among Farmers: Empirical evidence from Pabna District, Bangladesh

Rajoana Haider Tithi

Pabna University of Science and Technology

Redwan Ahmed

Pabna University of Science and Technology

Jerin Fariha

Pabna University of Science and Technology

Md. Nayeem Hasan Pramanik

nayeem.econ@gmail.com

Pabna University of Science and Technology

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Abstract

Agricultural growth in developing countries is seen as key to reducing rural poverty, but the specific crop mechanisms at the household level are underexplored. This study aims to assess the contribution of maize (*Zea mays* L.) production to household income and quantify its effect on poverty alleviation among smallholder farming households in Pabna District, northwestern Bangladesh. Using a structured survey of 300 purposively and randomly selected maize-farming households, the study employs Foster-Greer-Thorbecke (FGT) decomposable poverty indices, a relative poverty line approach based on mean per capita income, independent-samples t-tests, and five-point Likert-scale analysis. The study reveals that maize cultivation yields a mean net income of Tk. 73,800 per household annually (benefit-cost ratio = 2.32), raising total mean household income from Tk. 189,300 to Tk. 263,100 — a statistically significant 39% increase ($t = 14.92$, $p < 0.001$). Inclusion of maize income reduces poverty incidence from 67% to 49% ($\Delta = 18$ pp, $p < 0.01$), poverty depth from 22% to 15% ($p < 0.01$), and poverty severity from 9% to 6% ($p < 0.05$). Likert-scale evidence further confirms significant perceived improvements in food security (mean = 4.38), household income (4.19), and children's educational expenditure (3.86). These findings underscore the need for policy interventions targeting input subsidy expansion for hybrid seeds and fertilizers, collateral-free agricultural microfinance, modernized extension services, and post-harvest market infrastructure — collectively essential to amplify maize cultivation's transformative potential as an instrument of poverty alleviation aligned with SDG Goal 1: No Poverty.

1. Introduction

Poverty remains one of the most persistent development challenges in the Global South, where agriculture underpins the livelihoods of the majority of rural households [1]. In low- and middle-income countries, agricultural growth has consistently outperformed industrial and service sector growth in reducing poverty owing to its direct employment and income linkages with rural communities [2]. Bangladesh exemplifies this dynamic: agriculture contributes approximately 11.02% to gross domestic product and engages nearly 45.4% of the national labor force [3], making it central to the country's socio-economic fabric. Despite notable macroeconomic progress, rural poverty remains entrenched, with over 20% of the rural population still living below the poverty line [4]. This persistent gap between aggregate growth and household-level welfare underscores the need to identify crop-specific pathways capable of translating productivity gains into tangible poverty reduction.

Maize (*Zea mays* L.) has emerged as one such pathway. Although maize ranks third in Asian cereal production after rice and wheat, it surpasses both in yield per unit area, offering considerable income advantages to smallholder cultivators [5, 6]. In Bangladesh, once confined to marginal cultivation in the Chittagong Hill Tracts, maize production has surged from 35.78 lakh metric tonnes in 2016–17 to 68.84 lakh metric tonnes in 2023–24 [7], driven by rising demand from the poultry, fisheries, and livestock sectors alongside its favorable benefit-cost profile and lower water requirements relative to rice. In northwestern districts such as Pabna, favorable agro-ecological conditions and expanding market

connectivity have accelerated this transition, positioning maize as a commercially viable alternative for smallholder farmers seeking to improve household income.

The welfare implications of maize cultivation have been studied extensively in Sub-Saharan Africa. Employing Foster-Greer-Thorbecke (FGT) poverty indices in Edo State, Nigeria, [8] demonstrated that maize income significantly reduced poverty incidence, depth, and severity among smallholder farmers, with reported improvements in food security and income stability. In Ghana, [9] found average profit efficiency among maize farmers at only 45.9%, attributing inefficiencies to constrained credit access, poor infrastructure, and limited extension services, and concluded that institutional support—rather than farm size expansion alone—is essential for maximizing the poverty-reduction potential of maize. Conversely, [10] demonstrated through South Africa’s Massive Food Production Programme that high-yield hybrid technologies designed for large-scale systems proved counterproductive for resource-poor smallholders, warning against policy designs that ignore local socio-economic realities. At the market end, [11] showed that linking smallholders to high-value maize markets improved incomes only when supported by producer organizations, rural infrastructure, and transparent market information that reduced transaction costs. Within Bangladesh, [12] established that agricultural GDP growth was more poverty-reducing than industrial growth over 1991–2005, though structural inequalities limited its reach to the poorest households. More recently, [13] confirmed that maize cultivation in Chuadanga district yielded the highest net returns and benefit-cost ratios (1.72) among marginal farmers, while [14] underscored maize’s broader contributions to employment generation and nutritional security in rural Bangladesh.

Despite this growing body of evidence, empirical research that directly quantifies the effect of maize income on multidimensional poverty outcomes—using decomposable poverty indices at the household level—remains absent in the Bangladeshi literature. No study has yet measured how maize income shifts the incidence, depth, and severity of poverty among farming households in Bangladesh, leaving a critical gap in the evidence base needed to guide agricultural and social protection policy. Addressing this gap, the present study investigates the effect of maize production on poverty alleviation among farmers in Pabna district, where cultivated maize area rose from 1,783 acres to 1,863 acres and production from 4,983 to 7,246 metric tonnes between 2021–22 and 2022–23 [7]. Specifically, the study aims to: (i) assess the contribution of maize production to total household income; (ii) estimate the relative poverty line and classify farmers by poverty status with and without maize income using the FGT framework; and (iii) examine the perceived socio-economic benefits associated with maize cultivation. The findings are intended to furnish policymakers, development agencies, and rural stakeholders with actionable evidence for promoting maize as a strategic instrument for poverty alleviation, consistent with Bangladesh’s national development priorities and Sustainable Development Goal 1: No Poverty.

2. Materials and Methods

2.1 Study Area

The study was conducted in Pabna Sadar Upazila of Pabna District, Rajshahi Division, northwestern Bangladesh (23°48'–24°21' N; 89°00'–89°44' E). The district spans 2,376.13 km² and recorded a population of 2,909,624 in the 2022 national census [15], of whom approximately 34% are primarily engaged in agriculture. Among the district’s nine upazilas, Pabna Sadar was selected purposively for its high agricultural productivity, rapid expansion in maize cultivation, and socio-economic diversity (see Fig. 1).

Maize has emerged as a commercially prominent cash crop in the area owing to rising demand from the poultry, fisheries, and livestock sectors, competitive input costs, and a favorable agro-ecological environment—with loam and sandy-loam soils, optimal growing temperatures of 28–34°C, and reliable irrigation access supporting cultivation during both the Rabi (Oct–Nov sowing) and Kharif (Feb–Mar sowing) seasons [16]. Most farmers cultivate hybrid varieties, which deliver higher yields and shorter growing cycles than traditional types.

2.2 Sampling Design and Sample Size Determination

A four-stage multi-stage sampling procedure was employed (see Table 1). At the first two stages, Pabna District and Pabna Sadar Upazila were selected purposively based on documented maize production growth and farm-size diversity. Within the upazila, one union was purposively identified for its concentration of active maize cultivators, and three villages were subsequently selected by simple random sampling. In the final stage, the requisite number of farming households was drawn systematically from village registers.

Table 1
Multi-stage sampling design

Stage	Unit of Selection	Method	Sample	Rationale
I	Region → District	Purposive	Pabna District	High maize output; growing market linkages
II	Upazila → Union	Purposive	Pabna Sadar Upazila; one union	High agri. productivity; diverse farm-size profile
III	Villages	Simple random	3 villages	Geographic representativeness within upazila
IV	Farming households	Systematic random (Yamane, 1967)	300 households	Statistically representative of maize-farming population

Note: Stage IV sample determined using Yamane’s (1967) formula.

2.2.1 Sample Size Determination

The sample size for Stage IV was calculated using [17] simplified formula for finite populations at a 95% confidence level and a 5% margin of error:

$$n = \frac{N}{1 + Ne^2}$$

1

Where,

n = required sample size;

N = total population of maize-farming households in the selected union = 1,200;

e = acceptable margin of error = 0.05 (5%).

Accordingly, a final sample of 300 maize-farming households was interviewed. The population figure (N = 1,200) was derived from village registers and confirmed through local agricultural extension office records. To account for potential non-response, an additional 5% buffer was built into the fieldwork schedule, resulting in an initial target of 315 households approached; 300 fully completed questionnaires were ultimately retained for analysis.

2.2.2 Data Collection

Primary data were collected through structured face-to-face interviews conducted in the last quarter of 2025 using a pre-tested questionnaire organized into five sections: (i) demographic and socio-economic characteristics; (ii) maize production and input use; (iii) household income from maize and non-maize sources; (iv) access to institutional services (credit, training, extension); and (v) perceived socio-economic benefits. The schedule-based interview method facilitated direct researcher–respondent interaction and enabled the inclusion of illiterate participants, improving data completeness and accuracy. Secondary data were sourced from the Bangladesh Bureau of Statistics (BBS), the Bangladesh Economic Review (BER), the Agricultural Information Service (AIS), and peer-reviewed literature to support contextual analysis and cross-validation.

2.3 Methods of Data Analysis

The core analytical assumption is that changes in household welfare indicators between the two counterfactual income scenarios—excluding and including maize income—are attributable to maize cultivation. Five complementary methods were applied (see Table 2).

Table 2
Analytical framework

Method	Objective Addressed	Output Metric	Reference
Descriptive statistics	Characterize socio-economic & production attributes of respondents	Mean, SD, frequency, %	Field survey, 2025
Relative poverty line (MPCI)	Establish context-specific poverty threshold; classify farmers as poor / non-poor	Poverty line (Tk.)	Coudouel et al., [18]
FGT indices ($\alpha = 0, 1, 2$)	Quantify incidence, depth & severity of poverty with/without maize income	HCI, PGI, PSI	Foster et al., [19]
Independent-samples t-test	Test statistical significance of welfare differences across income scenarios	t-ratio (df = 298)	Olayemi, [20]
Likert scale (5-point)	Measure perceived socio-economic benefits of maize cultivation	Mean score (≥ 3.00 = significant)	Field survey, 2025
<i>Note: FGT = Foster-Greer-Thorbecke; HCI = Headcount Index; PGI = Poverty Gap Index; PSI = Poverty Severity Index; MPCI = Mean Per Capita Income; SD = standard deviation.</i>			

2.3.1 Relative Poverty Line

A relative poverty line was defined as the mean per capita income (MPCI) of all respondents in each income scenario, following [21]. Respondents with annual per capita income below the MPCI were classified as poor; those at or above were classified as non-poor. Two separate thresholds were computed—one excluding maize revenue and one inclusive of it—enabling a direct before-and-after assessment of maize cultivation's effect on poverty classification.

2.3.2 Foster-Greer-Thorbecke (FGT) Poverty Indices

Poverty was quantified across three dimensions using the FGT class of decomposable indices [19]:

$$P_{\alpha} = \left(\frac{1}{N} \right) \sum \frac{(z - g_i)}{z} \alpha$$

2

Where,

z = poverty line; g_i = per capita income of the i^{th} respondent;

q = number of respondents below the poverty line; N = total sample size;

α = sensitivity parameter (0 = incidence; 1 = depth; 2 = severity).

When $\alpha = 0$, the Headcount Index (HCI) measures the proportion of the sample living below the poverty line. When $\alpha = 1$, the Poverty Gap Index (PGI) captures average income shortfall relative to the poverty line, indicating the resources needed to eliminate poverty. When $\alpha = 2$, the Poverty Severity Index (PSI) weights squared income gaps, giving greater emphasis to the poorest households and capturing inequality within the poor population.

2.3.3 Independent-Samples t-Test

Statistical significance of observed welfare differences between the two income scenarios was assessed using the independent-samples t-test formulation:

$$t = (X_{j2} - X_{j1}) / \sqrt{[(S_{j2}^2 + S_{j1}^2) / N]} \quad (3)$$

where $j = 1-5$ denotes the five welfare variables (mean annual household income, mean per capita income, poverty incidence, poverty depth, and poverty severity); X_{j2} and X_{j1} = means with and without maize income; S_{j2} and S_{j1} = corresponding standard deviations; $N = 300$.

Two null hypotheses were tested at the 5% level of significance ($t_{0.05, df = 298}$): (H_{10}) no significant difference in household income with and without maize production; and (H_{20}) no significant difference in poverty incidence, depth, or severity across the two scenarios.

2.3.4 Likert Scale Analysis

Respondents' perceived socio-economic benefits from maize cultivation were measured on a five-point Likert scale (1 = strongly disagree to 5 = strongly agree) across ten benefit statements. Mean scores were computed for each item; a threshold of ≥ 3.00 was applied to identify benefits perceived as significant. This approach quantifies subjective welfare dimensions—food security, housing, healthcare, asset ownership, and educational expenditure—that complement the income-based poverty measures and provide a more holistic account of maize cultivation's contribution to rural livelihoods.

3. Results and Discussion

The following sections present the empirical findings for the 300 surveyed maize-farming households in Pabna Sadar Upazila, structured across four thematic areas: respondent profile; household income composition and the contribution of maize; poverty status assessed through FGT indices; and farmers' perceived welfare benefits. All monetary values are in Bangladeshi Taka (Tk.); tests of significance are at the 5% level (critical $t \approx 1.968$, $df = 299$), unless stated otherwise.

3.1 Socio-economic and Farm Profile of Respondents

The respondent profile (see Table 3) reveals a farming community concentrated in its economically active prime: 61% of respondents fall within the 35–50-year age bracket and a further 19% are aged 51–65, confirming that maize cultivation in the study area is anchored by experienced, mid-career smallholders rather than younger agricultural entrants. With a mean farming experience of 12.4 years,

respondents possess adequate field-level knowledge of hybrid maize agronomy, yet educational attainment remains a binding structural constraint: 38% are illiterate and 32% hold only primary schooling, meaning that seven in ten farmers have never progressed beyond basic literacy. This limits their capacity to interpret agronomic advisories, navigate credit applications, and engage with digital market-price platforms—consequences that surface later in the institutional access data.

The mean household size of 4.8 persons with 1.6 earning members imposes a dependency ratio of roughly 3:1, placing considerable pressure on each earner to generate income sufficient for basic subsistence. Farm structure reflects the classic smallholder profile of northwestern Bangladesh: the mean total holding is 3.24 bigha (approximately 1.07 acres), almost exactly divided between own land (1.62 bigha) and leased or sharecropped land (1.62 bigha). Of this, a mean 1.81 bigha—equivalent to 56% of total cultivable area—is allocated to maize, with 46% of respondents cultivating more than 2 bigha under the crop. The heavy reliance on tenanted land exposes a substantial portion of the farming community to tenure insecurity, which depresses incentives for long-term soil investment and can limit access to institutional credit that requires collateralized land titles.

Regarding institutional access, only 36% of respondents reported receiving credit from any formal or semi-formal source, and 38% had attended at least one agricultural training session—though most training was linked to NGO-run programmes rather than the public extension system. Government or departmental assistance was reported by fewer than 4% of respondents, and 54% received agronomic advice—primarily from input dealers (31%) and fellow farmers (62%) rather than trained extension officers. These figures collectively indicate a shallow institutional footprint in the study area, where the majority of farmers make production decisions based on informal peer knowledge rather than evidence-based technical guidance.

Table 3

Socio-economic and farm profile of surveyed maize farmers (n = 300) *Source: Field Survey, 2025*

Variable / Category	n	%
A. Age Group (years)		
< 35 (young)	42	14.0
35–50 (core working age)	183	61.0
51–65 (senior)	57	19.0
> 65 (elderly)	18	6.0
B. Educational Attainment		
Illiterate	114	38.0
Primary (Class I–V)	96	32.0
Secondary (Class VI–X)	60	20.0
Higher secondary (HSC)	21	7.0
Graduate and above	9	3.0
C. Household Characteristics		
Mean household size (persons)	4.8	—
Mean earning members	1.6	—
Mean farming experience (years)	12.4	—
D. Land and Farm Structure		
Mean total farm area (bigha)	3.24	—
Mean own land (bigha)	1.62	—
Mean leased / sharecropped land (bigha)	1.62	—
Mean maize-cultivated area (bigha)	1.81	~ 56% of farm
Respondents cultivating > 2 bigha maize	138	46.0
<i>Note: — = not applicable (mean value reported). Land measured in bigha (1 bigha ≈ 0.33 acres).</i>		

3.2 Household Income Structure and Contribution of Maize

Following Table 4 represents the annual household income composition for the study sample. In the absence of maize income, the mean household income is Tk. 189,300, derived from seven non-maize sources. Other crop cultivation constitutes the dominant share (35.9%, Tk. 78,640), followed by livestock and poultry rearing (19.3%, Tk. 42,320) and off-farm service or employment (12.1%, Tk. 26,500). Small

business, day labour, remittances, and aquaculture account for the remaining 19.1%, reflecting the diversified but fragile livelihood portfolios typical of smallholder households in this region.

Table 4

Annual household income composition with and without maize production (n = 300) *Source: Field Survey, 2025*

Income Source	Mean Annual Income (Tk.)	Share (%)
<i>Non-maize income sources</i>		
Cultivation of other crops	78,640	35.9
Livestock and poultry	42,320	19.3
Off-farm service / employment	26,500	12.1
Small business / trade	18,240	8.3
Day labour	11,760	5.4
Remittance income	9,800	4.5
Fishing and aquaculture	2,040	0.9
Sub-total: non-maize income	189,300	86.4
Maize production income		
Gross revenue from maize	129,600	—
Less: total production cost	(55,800)	—
Net maize income	73,800	13.6
Total household income (with maize)	263,100	100.0
Total household income (without maize)	189,300	—
<i>Note: *** $p < 0.001$; production cost includes seeds, fertilizers, pesticides, irrigation, and hired labour. Totals may vary marginally due to rounding.</i>		

Maize cultivation generates a mean gross revenue of Tk. 129,600 per household, against a mean total production cost of Tk. 55,800, yielding a mean net income of Tk. 73,800—equivalent to a benefit-cost ratio of 2.32. This net income raises total mean household income to Tk. 263,100, a gain of 39% over the non-maize baseline. The corresponding mean per capita income rises from Tk. 39,438 (without maize) to Tk. 54,813 (with maize)—an increase of Tk. 15,375 per person, or 39%. These two per-capita figures simultaneously constitute the relative poverty lines applied in the FGT analysis below. The income difference is confirmed as highly significant ($t = 14.92$, $p < 0.001$), providing strong grounds to reject the first null hypothesis and affirming that maize cultivation is a material driver of household income in the study area. The benefit-cost ratio of 2.32 is broadly consistent with [22] who reported ratios of 1.72–2.08

in comparable Bangladeshi districts, and suggests that maize profitability in Pabna is somewhat higher, possibly reflecting better hybrid variety adoption and closer market proximity.

3.3 Poverty Status: FGT Poverty Index Analysis

Following Table 5 reports the three FGT poverty indices computed for both income scenarios. The results demonstrate a consistent, statistically significant reduction in poverty across all three dimensions—incidence, depth, and severity—when maize income is included in household earnings.

Table 5
FGT poverty indices with and without maize income (n = 300) *Source: Authors' Computation*

Poverty Measure	Without Maize (A)	With Maize (B)	Δ (A – B)	t-ratio
Poverty line (mean per capita income, Tk./year)				
MPCI (poverty line)	Tk. 39,438	Tk. 54,813	Tk. 15,375	14.92***
FGT indices				
Headcount Index ($\alpha = 0$) – poverty incidence	0.67 (67%)	0.49 (49%)	0.18	3.14**
Poverty Gap Index ($\alpha = 1$) – poverty depth	0.22 (22%)	0.15 (15%)	0.07	2.68**
Poverty Severity Index ($\alpha = 2$) – poverty severity	0.09 (9%)	0.06 (6%)	0.03	2.41*
<i>Note: *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$. Poverty line = mean per capita income (MPCI) in each scenario. Critical $t \approx 1.968$ ($df = 299$, two-tailed). HCI = Headcount Index; PGI = Poverty Gap Index; PSI = Poverty Severity Index.</i>				

The Headcount Index ($\alpha = 0$) falls from 0.67 to 0.49—an 18 percentage-point reduction in poverty incidence—implying that maize income enables approximately 54 out of every 300 farming households to cross the poverty threshold. Put differently, the poverty headcount declines from 201 to 147 households within the sample, a shift that is both economically material and statistically robust ($t = 3.14$, $p < 0.01$). The Poverty Gap Index ($\alpha = 1$) narrows from 0.22 to 0.15, indicating that the average income shortfall of poor households relative to the poverty line—the ‘depth’ of poverty—contracts by 7 percentage points. In absolute terms, this translates to a reduction in the per-household poverty gap of approximately Tk. 3,900 per year, meaning that poor households who remain below the poverty line after maize income are, on average, considerably closer to the threshold than before. The Poverty Severity Index ($\alpha = 2$), which squares the normalized income gaps and is therefore sensitive to conditions at the very bottom of the distribution, declines from 0.09 to 0.06 ($t = 2.41$, $p < 0.05$). This finding is particularly informative: it demonstrates that maize income does not merely raise average household welfare but disproportionately benefits those in deepest poverty, compressing intra-poor income inequality.

Collectively, the significant improvement across all three FGT dimensions leads unambiguously to the rejection of the second null hypothesis: maize cultivation materially reduces the incidence, depth, and severity of poverty among farming households in the study area. These findings align with [23], who reported analogous three-dimensional poverty reductions among maize-farming households in Nigeria, and corroborate the broader evidence from [24] that agricultural income growth in Bangladesh can be a powerful lever for poverty alleviation—provided structural constraints on land tenure, credit access, and extension are concurrently addressed.

3.4 Perceived Socio-economic Benefits of Maize Cultivation

The Likert-scale analysis (see Table 6) complements the income and poverty metrics with respondents’ subjective assessments of welfare change. Eight of the ten benefit statements attained mean scores at or above the significance threshold of 3.00, indicating a broadly positive perception of maize cultivation’s welfare effects across the sample.

Table 6 Perceived socio-economic benefits of maize cultivation (n = 300) <i>Source: Authors’ Computation</i>		
Benefit Statement	Mean Score	Significance
Food and nutritional security improved markedly	4.38	Significant
Household income has increased noticeably	4.19	Significant
Children’s education expenses met with less difficulty	3.86	Significant
Better access to primary healthcare	3.74	Significant
Ownership of household durables has increased	3.61	Significant
Housing condition has improved	3.42	Significant
Savings and investment capacity improved	3.18	Significant
Able to lease or purchase additional farmland	3.07	Significant
Access to farm machinery has improved	2.94	Not significant
Able to purchase motorized vehicles	2.58	Not significant
<i>Note: Scored on a 5-point Likert scale (1 = strongly disagree; 5 = strongly agree). Threshold for significance: mean ≥ 3.00. Items listed in descending order of mean score.</i>		

Improved food and nutritional security attracts the highest mean score (4.38), reflecting near-universal agreement that maize income has stabilized household food access—a finding consistent with the crop’s dual role as a marketable commodity and an on-farm nutritional resource. A perceptible increase in household income ranks second (4.19), confirming that the income gains quantified in Table 4 are also experienced as tangible improvements in daily living standards rather than as statistical artifacts.

Notably, improvements in children's educational expenditure (3.86) rank third, suggesting that maize income is being actively channelled into human-capital investment, with implications for intergenerational poverty mobility that extend well beyond the current survey period. Better access to healthcare (3.74), increased ownership of household durables (3.61), and improved housing conditions (3.42) round out a cohesive picture of welfare improvement that spans health, physical assets, and shelter—the core dimensions of the multidimensional poverty framework [25].

The two items that fell below the significance threshold—access to farm machinery (2.94) and purchase of motorized vehicles (2.58)—reflect the capital-intensive nature of mechanization and transport assets, whose costs remain beyond the reach of most smallholder households even with maize income supplementation. The boundary between the significant and non-significant items is instructive: it delineates the current welfare ceiling of maize cultivation in Pabna and implicitly signals the next frontier for policy support. Subsidized machinery rental programmes, farmer equipment cooperatives, and rural transport infrastructure investments could lower the cost barriers that currently prevent maize income gains from translating into deeper productive-asset accumulation.

4. Conclusion and Policy Implications

This study examined the effect of maize production on poverty alleviation among 300 farming households in Pabna Sadar Upazila, Bangladesh, using FGT decomposable poverty indices [19], a relative poverty line constructed from mean per capita income [21], independent-samples t-tests [20], and five-point Likert-scale analysis. Maize cultivation generates a mean net household income of Tk. 73,800 per annum — equivalent to 28% of total household earnings — raising the mean total income from Tk. 189,300 to Tk. 263,100 (a 39% increase; $t = 14.92$, $p < 0.001$). This income supplement shifts the relative poverty line from Tk. 39,438 to Tk. 54,813 per capita and produces statistically significant improvements across all three FGT dimensions: poverty incidence (Headcount Index) falls from 67% to 49% ($\Delta = 18$ pp, $t = 3.14$, $p < 0.01$); poverty depth (Poverty Gap Index) declines from 22% to 15% ($\Delta = 7$ pp, $t = 2.68$, $p < 0.01$); and poverty severity (Poverty Severity Index) decreases from 9% to 6% ($\Delta = 3$ pp, $t = 2.41$, $p < 0.05$). The Likert-scale evidence reinforces these objective measures: eight of ten perceived benefit indicators — including food security (mean = 4.38), household income (4.19), children's education (3.86), and healthcare access (3.74) — attained scores at or above the significance threshold of 3.00, consistent with welfare improvement findings reported for maize farmers in analogous smallholder settings [23, 26]. Together, these findings establish maize as a statistically confirmed and perceptually validated instrument of poverty alleviation in the study area, corroborating broader evidence that agricultural income growth in Bangladesh can serve as a powerful lever for rural poverty reduction [4, 12].

The empirical evidence points to four targeted policy priorities. First, the high benefit-cost ratio of maize production (2.32) — consistent with profitability estimates reported by [13] for comparable Bangladeshi districts — justifies expansion of input subsidy programmes, particularly for hybrid seeds and fertilizers, which respondents identified as the primary cost constraints. Second, given that only 36% of

respondents accessed formal credit despite the documented profitability of maize, there is an urgent need to extend collateral-free agricultural microfinance through rural cooperatives and programmes aligned with Bangladesh Bank's Agricultural Credit Policy. Third, with 70% of farmers holding at most primary education and the majority relying on informal peer knowledge for agronomic guidance, structured extension services — including mobile-based digital advisory platforms — are essential to improve input-use efficiency and reduce avoidable yield losses. Fourth, the non-significant Likert scores for farm mechanization (mean = 2.94) and vehicle ownership (2.58) identify post-harvest handling and market access as the next welfare frontier; investment in shared machinery service centres, rural road connectivity, and market information systems would enable smallholder farmers to capture a greater share of the maize value chain, translating income gains into durable productive-asset accumulation. These measures, implemented within Bangladesh's National Agricultural Extension Policy and SDG Goal 1: No Poverty framework, would amplify the poverty-reducing effects of maize cultivation documented here.

Despite its contributions, this study has limitations affecting interpretation and future research. Its cross-sectional, single-district design limits causal inference and generalizability; longitudinal studies across seasons and surveys in other districts would better reveal how maize income influences poverty over time. Additionally, the all-male respondent profile, due to land-ownership norms, prevents analysis of gender-specific welfare outcomes; future research should include gender-disaggregated data to explore intra-household dynamics and barriers to participation that current structures may hide [25].

Declarations

Ethics Approval Statement: Ethical approval to conduct this study was obtained from the Research Ethics Committee of the Department of Economics, Pabna University of Science and Technology, Rajapur, Pabna-6600, Bangladesh (Approval No. PUST/ECON/REC/139). All methods were carried out in accordance with the ethical guidelines for social science research at Pabna University of Science and Technology.

Statement on Participant Consent: Informed consent was obtained from all individual participants involved in the study prior to data collection.

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Conflict of Interest

The authors declare no competing interests.

Ethics approval

Not Applicable.

Consent to participate/publish

Not Applicable.

Data availability statement

Data will be made available on request.

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Figures

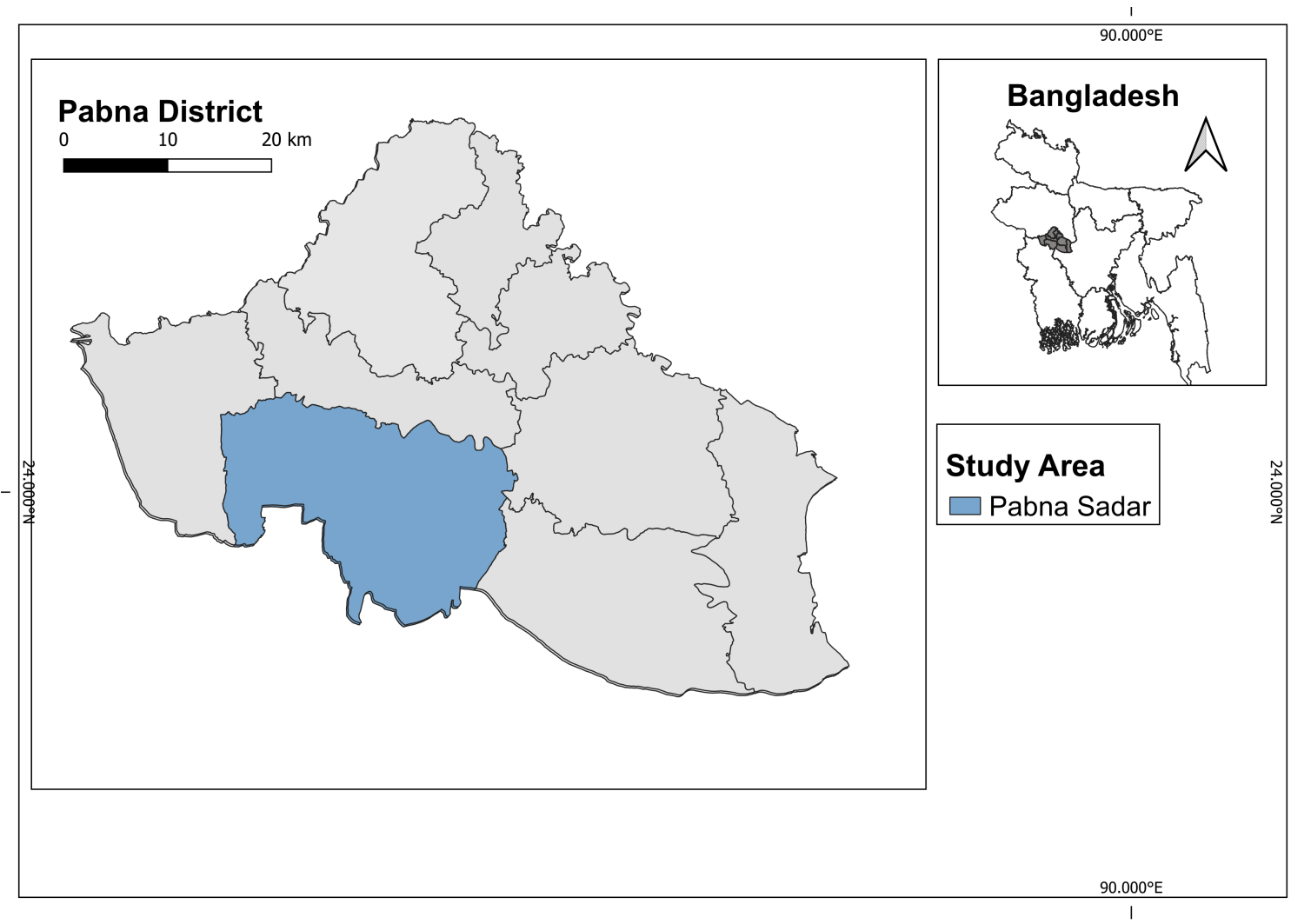


Figure 1

Study area map (Pabna Sadar)