

Factors Influencing Market Access by the Smallholder Farmers in the Central Coast of Bangladesh

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Abstract: Market access has been widely identified as a major constraint to climate smart agriculture adoption, yet the factors influencing it among coastal farmers in Bangladesh remain unexplored. This study aimed to identify the socioeconomic, institutional and infrastructural factors that influence access to markets of these farmers. The surveys were conducted in three coastal districts using multistage sampling procedure to select 390 smallholders in 29 villages. This research developed an overall Market Access Index (MAI), combining 18 normalized indicators across four categories of physical connectivity, market participation, information access, and bargaining power. Multiple linear regression with robust standard errors was used to estimate factors of market access. Farmers showed moderate access overall (MAI = 0.573 ± 0.089), and this was significantly higher among farmers with pucca to semi pucca roads ($B = 0.045$ to 0.051 , $p < 0.01$) and farmers who received credit from bank ($B = 0.048$, $p = 0.004$), but lower among those relying on cooperative credit ($B = -0.126$, $p = 0.026$) or maintained frequent extension contact ($B = -0.003$, $p = 0.014$). Interestingly, farmers who travel further to go to other markets scored higher on market access, indicating that the farmers get higher prices and buyer options at larger markets, rather than being discouraged by distance. The model explained 20.2% of the variance in the market access index. In addition to being close to markets, providing infrastructure, making credit more accessible, and redesigning extension services to be more market-oriented are crucial to improve smallholders market integration.

Keywords: Agricultural credit; Bargaining power; Coastal agriculture; Extension communication; Rural infrastructure

Introduction

Climate change is one of the most considerable global issues of the twenty-first century, with human activity being unequivocally estimated to have led to a global warming of approximately 1.1°C above pre-industrial levels in the period 2011–2020 (IPCC, 2023). At a national level, Bangladesh is perhaps the embodiment of this vulnerability despite contributing almost negligible to global warming emissions (Amin and Hasan, 2024). The sea level is rising at Char Changa as 7.6 mm/year, and at 14.5 mm/year in Cox's Bazar (Ashrafuzzaman et al., 2022). Across the coastal belt, this rise adds to prevailing salinization, with median increases of 39% in soil salinity above background at 41 monitoring stations by 2050 (Dasgupta et al., 2015), with the potential to threaten crop productivity and rural livelihoods. Environmental stresses like salinity intrusion, cyclones, tidal flooding and impact of climate change such as changing pattern in temperature and rainfall have a significant influence on coastal agriculture (Jamal et al., 2022). This has led to lower soil fertility, damage of crops and interruption in normal agricultural practices accompanied by changes in planting and harvesting time that resulting approximately 20% reduction in yield (Hasan and Kumar, 2020a). This extreme climate change events can reduce agricultural GDP of Bangladesh by one third according to the World Bank's Country Climate and Development Report, while a 9% reduction is predicted for total GDP through severe flooding (World Bank, 2022). The converging pressures from these different angles demonstrate the need to understand how smallholder farmers from these coastal zones of Bangladesh respond to climate change, as well as adapt to it.

To nullify the climatic stresses and safeguard their livelihood, coastal smallholder farmers in Bangladesh have adopted climate smart agriculture (CSA), although overall adoption remains relatively low (Majumder et al., 2024). CSA adoption is determined primarily by yield loss of crops, income from crops, and the access to extension and training services (Khan et al., 2022). Similarly, Hasan (2016) found that CSA adoption among smallholder coastal farmers was significantly low with an average adoption quotient of 13.91% only. Farmers are more willing to adopt practices that are less expensive and more compatible with their existing practices like plastic storage bags, urea deep placement, sorjan, variety change etc., rather than investing in costly infrastructure change (Islam and Farjana, 2024; Sarker et al., 2026).

Market access is defined as the ability of farming households to reach output markets, where they can sell their output, and to input markets where productive inputs, such as seeds, and fertilizers can be acquired at acceptable prices and low transaction costs (Ma et al., 2024; Marion et al., 2024). However, it is recognized as an important factor in agricultural productivity, commercialization, and the alleviation of rural poverty (Aggarwal et al., 2024). The availability of reliable connections with buyers enables farmers to boost marketed surplus, react to price signals, and reinvest farm income. Efficient input markets decide affordability of obtaining new technologies that enhance productivity and are climate-resilient (Aggarwal et al., 2024; Ma et al., 2024). A comprehensive systematic review of agricultural market interventions also identifies that investments in farm to market transport, market information, alternative marketing opportunities, contract farming and storage can lead to moderate gains in agricultural production and household welfare (Marion et al., 2024). Market access is not only determined by geographical proximity but also by the availability of infrastructure, information, financial capacity, organizational linkages and institutional support (Mwema et al., 2021; Perosa et al., 2024; Xie et al., 2024; Tabe-Ojong et al., 2024). Despite of high-income generating potential, smallholders' vegetable farmers in Bangladesh still have to struggle with various logistical challenges including high transaction costs, lack of bargaining power and fragmented supply chains (Choudhury et al., 2026). Coastal smallholders are already very vulnerable to salinity, tidal flooding, cyclones and other climate stresses. Their livelihood vulnerability is aggravated by weak market access, which can further negatively affect their capacity to sell their produce at profitable prices, access their input supply at affordable prices, cope with climate shocks, and invest in resilient production systems (Majumder et al., 2024; Tadesse and Ahmed, 2023).

Determinants of market access have been studied globally in various agricultural context. The physical infrastructure is one of the strongest factors as physical characteristics of rural roads, transport availability, market distance, and costs of transportation directly affect the price farmers receive and pay for their inputs (Agholor et al., 2023; Marion et al., 2024). For instance, evidence in northern Tanzania suggests that remoteness of the villages is significantly correlated with reduced adoption of fertilizers and travel costs that can have a significant positive impact on farmers' adoption of agricultural inputs (Aggarwal et al., 2024). Reliable price information and diversified buyers' networks are also essential, as they reduce information asymmetries and the reliance of farmers on individual buyers (Ma et al., 2024; Marion et al., 2024). Farmer associations facilitate farmers to boost their production, share transportation expenses, disseminate market information and improve their bargaining power with traders (Aku et al., 2018; Mwema et al., 2021). Farmers education, farm size, income, possession of farm resources, plot characteristics, and climatic risk exposure also influence farmers' ability to engage in market and climate-smart practices (Aryal et al., 2018; Tadesse and Ahmed, 2023). Market experience also can affect participation by decreasing risk aversion and boosting farmers' confidence in market-oriented production choices (Melesse and Cecchi, 2017). Access to institutional credit, agricultural extension support and farmer organizations, determines farmer's capacity to convert the physical proximity of the market into sustained market participation (Xie et al., 2024; Kipkoge et al.,

2025; Olabanji and Chitakira, 2025). Digital platforms can also serve as a link between farmers and market information, input suppliers, and geographically fragmented buyers (Tabe-Ojong et al., 2024; Li et al., 2025). The results of these studies jointly suggest that market access is a combination of infrastructural, informational, financial, and institutional conditions, not just being close to the market.

A review of the recent existing literature on CSA adoption in coastal Bangladesh reveals that among several variables market access has consistently been treated as one variable rather than as a primary object of study. For instance, Saha et al. (2019) discussed the impact of several household and institutional factors on the adoption of individual climate smart practices and Majumder et al. (2024) explored the factors influencing climate smart agriculture adoption and their significance for food security of households. Other more recent works have also focused on the scale and incentives for the adoption of climate-smart farming by coastal farmers, instead of on the drivers of farmers' ability to effectively access input or output markets (Mia and Roy, 2025). While the study of Choudhury et al. (2026) explored farm and market level determinants among vegetable farmers in Jashore, existing studies in coastal Bangladesh have mainly focused on climate-smart agriculture adoption, livelihood vulnerability rather than examining market access as a multidimensional outcome. Outside of Bangladesh, the broader literature on determinants of market access in other developing countries has tended to focus on one dimension of access at a time, such as road infrastructure and transport cost (Agholor et al., 2023; Marion et al., 2024), price information and buyer networks (Ma et al., 2024), credit access and farmer organizations (Xie et al., 2024; Kipkoge et al., 2025; Olabanji and Chitakira, 2025). These studies were mostly conducted for farming systems not exposed to the combination of salinity intrusion, tidal flooding and cyclone exposure found in the central coast of Bangladesh. Available evidence remains limited regarding how physical, informational, financial and institutional aspects collectively influence market access among climate-vulnerable smallholder farmers. This paper offers an integrated assessment of market access which differs from previous market-access research studies by constructing a composite Market Access Index among smallholder farmers. Therefore, the objective of this study is to explore the market access by the smallholder farmers and its determinants in the central coast of Bangladesh.

The results of this study should be significant for policy, research and rural development in coastal Bangladesh. The study can help to identify the extent of market access among smallholder farmers and thus, the extent of constraint and support needs. The causal analysis can also inform policy-makers of better interventions to be implemented, such as investments in rural roads, market information systems, farmer cooperative networks, and on-going input subsidies and training programs. Broadly, the findings can be used to enhance extension and capacity-building activities by aligning them with the actual market conditions, and making them more effective in enhancing agricultural resilience in the coastal areas.

Materials and Methods

Three coastal districts of Bangladesh namely Barguna, Bhola and Patuakhali were purposively selected, as they are situated at the front line of the Bay of Bengal and formally belonged to the coastal zone of Bangladesh. According to BBS (2022), almost 35 million people (28% of the total population) residing in 19 districts living in the coastal area who depend on its livelihoods for their existence, covering about 47,201 km². Coastal areas typically feature tidal floodplains, deltas, complex and complicated river systems, and an increased salinity intrusion with sea-level rise and diminished freshwater flow from the upstream source. Hence, the region is one of the most climate sensitive agriculture landscapes worldwide, and the climatically induced losses and livelihood insecurity of smallholder farming households are disproportionate (Aryal et al., 2020; Hasan and Kumar, 2020a). The study was conducted with smallholder farmers as they are the most policy relevant group to study agricultural

adaptation and market access responses in coastal Bangladesh where coastal agriculture is primarily dominated by resource constrained farm households that face salinity stress, water insecurity, climate hazards, and poor market access (Islam and Kabir,2025).

A multi-stage sampling approach was used by following the administrative hierarchy of Bangladesh which include division, district, upazila, union, village and household. The three districts were selected purposively at the first stage according to their direct exposure to the hazards of the Bay of Bengal, the predominance of smallholder rice-based farming systems and the variation in market access, infrastructure and geographic isolation. In the second stage, 6 sub-districts (two from the each of the selected district) were chosen purposively to cover the different types of coastal exposure. Selection was done in consultation with the agricultural extension officers to ensure that the selection is close to the coast and farming communities exist. In the third stage, a selection of at least two unions was made purposively from each sub-district considering their closeness to the sea and geographical diversity to make a total of 13 unions. One or more coastal villages were selected purposively from the union depending on the household numbers of the villages. The household registers of Union Parishad were collected to know the households which were engaged in active farming with farm size ≤ 2 ha. Sampling population was 4,414 households while the number of samples was estimated by using Formula (Hasan and Kumar (2024))

$$n = \frac{Nt^2\rho^2}{N + t^2\rho^2}$$

where n is the sample size, N is the population (4,414 households), t is the t -value (1.9605) at a desired level of probability with $df = 4,413$ and ρ is the sample control ratio to be estimated by $\frac{\sqrt{p(1-p)}}{\varepsilon}$ for categorical variables where ε (0.05) is the proportion of acceptable error and p (0.5) is the proportion of presence of an attribute in the population. Therefore, ρ is 10, and the sample size becomes 354. Considering the possibility of 10% non-completion, refusal and unusable responses, the target sample size was inflated. The field implementation resulted in creation of 390 completed and fully usable interview schedules which were handed out in 13 unions of six sub-districts and three coastal districts and were retained for final analysis (Table 1).

Table 1. Visited union with the number of smallholder farmers and sampled farmers.

Union (districts)	Village	Total number of smallholder farmers in the villages	Number of selected smallholder farmers	Percentage of smallholder farmers selected
Chawra (Barguna)	Chandra, Ghotkhali	130	17	13.1
Haldia (Barguna)	Amragachia, Haldia, Morichdanga, Tepura	425	35	8.2
Burir Char (Barguna)	Hazarbigha, Manikkhali, Sunatola	375	30	8.0
Fuljhuri (Barguna)	Choto Gourichalna, Golachipa	365	24	6.6
Aminabad (Bhola)	Jinnatpur, Narayanpur	430	35	8.1

Char Madraj (Bhola)	Char Madraj	328	22	6.7
North Joynagar (Bhola)	Char Ghumani, Moddho Joynagar	331	24	7.3
Saidpur (Bhola)	Char Khalifa, Saidpur	344	38	11.0
Alipur (Patuakhali)	Purbo Alipur	259	35	13.5
Bashbaria (Patuakhali)	Gojhani, Moddho Bashbaria	295	22	7.5
Betagi Sankipur (Patuakhali)	Boro Gopaldi, Masuakhali	456	39	8.6
Lota Chapli (Patuakhali)	Kuakata	130	27	20.8
Nilgonj (Patuakhali)	Kumirmara, Pakhimara	546	42	7.7
Total	29	4414	390	8.84

The face-to-face household interview was conducted with primary data collection using a pre-tested semi-structured interview schedule. Data of the monsoon (Aman) season, and the dry (Boro) season were collected for the periods August 2025 – April 2026. The data was collected during a long time-frame spanning across the two major cropping seasons of Bangladesh, which enables capture of the temporal heterogeneity of farmer market participation and technology adoption throughout the year. After that, survey data was coded, cleaned and quality checked in Microsoft Excel. Then, the cleaned dataset was then imported into R version 4.3.2 for advanced statistical analysis.

The study examined a comprehensive set of socio-demographic, economic, institutional, and behavioral variables relevant to research objectives. We compared their responses with observed trends which were based on previous findings on coastal belt. To explain the physical and economic access to market, sixteen independent variables were explored and to explore farmers market information access, eight independent variables were explored which included farmers' demographic, social, psychological and economic characteristics. These variables were selected based on the existing literature (e.g. Perosa et al.,2024; Kabir et al., 2021; Hasan and Kumar,2020a) and their measurement techniques are summarized in Table 2a and 2b.

Table 2a. Measurement of explanatory variables

Variables	Unit	Reference
Age	Years	(Cuaresma and Lutz, 2015; Nnadi et al., 2019)
Sex	Dummy variable: 0 (female) to 1 (male)	(Aryal et al., 2020).
Education level	Years of formal schooling	(Khan et al., 2022)
Family size	Total number of family members	(Abdel Sattar et al., 2025)
Farm size	Hectares	(BBS, 2019)
Farming experience	Years of engaged in agriculture	(Aryal et al., 2020).

Annual household income	USD	(Belcore et al., 2020)
Non-farm income	USD	(Hasan and Kumar, 2020a).
Training facilities	Dummy variable: 0 (No), 1 (Yes)	(Khan et al., 2022)
Distance to primary market	Closest market distance in km from home	(Hasan and Kumar, 2020b).
Alternate market distance	Alternative market distance in km from home	(Kabir et al., 2021)
Travel time to primary market	Minute required to reach nearest market	(Kabir et al., 2021)
Extension communication	Composite score based on the extension communication channels used by the farmer	(Kabir et al., 2021)
Access to credit	Self-coded; 0 (no credit access), 1 (relatives), 2 (cooperatives), 3 (NGOs), 4 (bank)	(Midamba et al., 2022)
Road condition	Self-coded; 1 (Kutch), 2 (semi-pucca), 3 (pucca)	(Shrestha, 2020)
Main transport mode	Self-coded; 1 (Walking), 2 (Van/Rickshaw), 3 (Bicycle/Motorcycle), 4 (Boat), 5 (Truck/Pickup)	(Perosa et al., 2024)
Sold produce earlier due to urgency	Dummy variable: 0 (No), 1 (Yes)	(Perosa et al., 2024)

Note: 1 USD= 120 BDT.

A composite Market Access Index (MAI) was created to measure the general access levels of the households to the agricultural market. The 18 indicators that are part of the Market Access Index (MAI) were chosen from the existing literature and empirical studies, and were pre-tested by the survey instrument. The indicators have been studied separately in the context of various aspects of agricultural marketing. In the pre-testing process, the relevance, clarity and applicability of each indicator was tested in the context of coastal smallholder farming systems in Bangladesh. Using this process, indicators were retained that were important and measurable aspects of farmers' involvement in agricultural markets. These indicators further grouped into four major dimensions of market access: physical connectivity (own transport access, transport cost), market participation and linkage (contact with traders, trader visits, contract farming participation, buyer support, payment method, profit from marketing), information access (receipt of price information, source of market information, frequency of market information, timeliness of market information), and bargaining power (price-setting power, negotiation ability, middlemen independence, ability to sell directly, market price outcome, price received compared with large farmers). The indicators selected were measured on binary and ordinal scales as well as continuous scales. So, it was not possible to aggregate their original values directly due to varying units of measurement and scales of scores. According to Sullivan et al. (2002), each component was scaled to a dimensionless score using the min–max normalization procedure.

The normalized score was computed as for positively oriented indicators (where a larger observed factor meant a better market access). The normalized score was calculated as:

$$NI_{ij} = \frac{X_{ij} - X_j^{min}}{X_j^{max} - X_j^{min}}$$

where NI_{ij} denotes the normalized score of households i for market-access component j ; X_{ij} represents the observed value of households i for component j ; and X_j^{min} and X_j^{max} indicate the minimum and maximum observed values of component j , respectively.

For negatively oriented indicators, where a higher observed value indicated poorer market access, the scoring direction was reversed before aggregation. The normalized score was estimated as:

$$NI_{ij} = \frac{X_j^{max} - X_{ij}}{X_j^{max} - X_j^{min}}$$

which is equivalent to:

$$NI_{ij} = 1 - \left(\frac{X_{ij} - X_j^{min}}{X_j^{max} - X_j^{min}} \right)$$

For adverse indicators, e.g., (the percentage of sales value devoted to transporting products) the reverse normalization was applied so that higher normalized values always indicated more favorable market-access conditions. The normalization procedure standardized each component to a common scale ranging from 0 to 1, with scores closer to 0 being relatively poor access and closer to 1 being relatively good access. The analytical procedure also reversed the transport cost and then added the components together.

After normalization and directional adjustment, the household-level MAI was calculated as the arithmetic mean of the 18 component scores:

$$MAI_i = \frac{1}{18} \sum_{j=1}^{18} NI_{ij}$$

where MAI_i represents the Market Access Index for household i , NI_{ij} is the normalized value of component j for household i , and 18 is the total number of components included in the index. The arithmetic-mean approach assigns equal weight to each component, implying that every indicator contributes equally to the household's overall market-access score.

Thus, the MAI is a continuous variable with a range from 0 to 1. Higher MAI values mean improved overall situation of agricultural market access: better transportation situation, stronger bargaining and price-setting capacity, better buyer relationship, better marketing arrangements and better access to up-to-date market information. A lower value, on the other hand, indicates higher physical, institutional, informational and transaction costs for market access. The index was created as the arithmetic mean of the 18 component scores (normalized) of the empirical analysis.

Table 2b. Measurement of variables used to construct the Market Access Index

Variables	Unit	Reference
Own transport	Dummy variable: 0 (does not have own transport), 1 (have own transport access)	(Raitzer et al., 2019; Shrestha, 2020)
Transport cost	Percentage of the total sales value spent on transportation (score); reverse-normalized so that lower transport cost generates a higher index score	(Barrett, 2008; Aggarwal et al., 2024)
Price-setting power	Farmer's level of control over the selling price; Self-coded: 1 (price determined by trader), 2 (price negotiated jointly), 3 (price determined by farmer)	(Barrett, 2008)
Negotiation ability	Measuring the farmer's ability to negotiate with buyers; Self-coded: 0 (not at all), 1 (poor), 2 (moderate), 3 (good)	(Authors calculation; Ma et al., 2024)
Middlemen independence	Dummy variable: 0 (sells through middlemen), 1 (sells directly without middlemen)	(Barrett, 2008; Rana and Maharjan, 2022)
Market price outcome	Measuring the favorability of the price received; Self-coded: 1 (lower), 2 (same), 3 (higher)	(Ma et al., 2024)
Payment method	Self-coded: 1 (delayed cash payment), 2 (advance payment), 3 (immediate cash payment)	(Barrett, 2008)
Ability to sell directly	Dummy variable: 0 (unable to sell directly), 1 (able to sell directly)	(Barrett, 2008; Marion et al., 2024)
Price compared with large farmers	Comparing the price received by the respondent with the price received by large farmers; Self-coded: 1 (worse), 2 (same), 3 (better)	(Authors calculation; Rana and Maharjan, 2022)
Profit from marketing	Measuring whether the farmer obtains a satisfactory profit from marketing; Self-coded: 0 (no profit), 1 (less than expected), 2 (as much as expected), 3 (greater than expected)	(Authors calculation; Ma et al., 2024)
Contact with traders	Dummy variable: 0 (no contact with traders), 1 (has contact with traders)	(Mottaleb et al., 2019; Mwema et al., 2021)
Trader visits	Dummy variable: 0 (traders do not visit), 1 (traders visit the farmer or locality)	(Mwema et al., 2021)
Contract farming	Dummy variable: 0 (does not participate in contract farming), 1 (participates in contract farming)	(Marion et al., 2024)
Buyer support	Dummy variable: 0 (does not receive buyer support), 1 (receives production or marketing support from buyers)	(Xie et al., 2024)
Receipt of price information	Dummy variable: 0 (does not receive price information), 1 (receives price information from other sources)	(Tabe-Ojong et al., 2024)
Source of market information	Self-coded: 1 (others), 2 (farmers), 3 (NGO), 4 (extension service), 5 (trader), 6 (online source)	(Tabe-Ojong et al., 2024)
Frequency of market information	Measuring how frequently market information is received; Self-coded: 0 (not at all), 1 (monthly), 2 (fortnightly), 3 (weekly), 4 (daily)	(Authors calculation; Tabe-Ojong et al., 2024)
Timeliness of market information	Dummy variable: 0 (information not received on time), 1 (information received on time)	(Fabregas et al., 2019; Tabe-Ojong et al., 2024)

Market Access Index	Ranging from 0 to 1; Higher scores indicate better market access	(Sullivan et al., 2002)
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Results

Socio-demographic and Farm-related Characteristics of the Respondents

The socio-demographic and farm related characteristics of the sampled farmers is summarized in Table 3, with information gathered from the survey respondents. The average age of the respondents was 46.3 years (SD = 13.0; range: 22–92 years), suggesting that farming activities were dominated by middle aged and experienced farmers. Farmers had an average farming experience of 23.1 years (SD = 12.5) indicating a significant level of farming experience. The majority of the respondents were males (81.5%). Respondents' education levels averaged 6.32 years (SD = 4.34, range 0-16) and the average family size was 5.25 members (SD = 1.75). The average landholding of the surveyed households was 0.682 ha with a standard deviation of 0.425 ha, ranging from 0.081–3.24 ha, which also reflected that the surveyed households mainly belonged to the smallholder farmers.

Table 3. Descriptive Statistics of Socioeconomic and Institutional Factors (n = 390)

Variables	Minimum	Maximum	Mean	SD
Age (years)	22	92	46.3	13.0
Education (years of schooling)	0	16	6.32	4.34
Family size (persons)	2	14	5.25	1.75
Land holding (ha)	0.081	3.24	0.682	0.425
Farming experience (years)	5	65	23.1	12.5
Non-farm income	0	324	63.1	81.9
Training duration (days)	0	120	7.42	10.9
Distance to primary market (km)	0.2	15	3.14	2.12
Distance to alternate market (km)	0	25	5.44	4.69
Time to market (minutes)	1	80	18.2	12.2
Share of sale value spent on transport (%)	1	30	7.93	6.10
Extension communication score	15	44	32.0	4.20

Financial credit was reported for 44.9% of the respondents (Table 4). In the case of those who borrowed, NGOs were the largest source (37.7%), followed by banks (3.85%), co-operative societies (2.05%) and informal borrowing from friends and relatives (1.28%). The figure suggests that the role of NGO-led financial services for agricultural smallholders is still significant. Exposure to training was also relatively common, 73.3% of the respondents had received some training in agriculture with an average duration of 7.42 days (SD = 10.9, range 0-120 days). On the market infrastructure side, respondents spent an average of 18.2 minutes (SD = 12.2) travelling to their main market with an average distance of 3.14 km (SD = 2.12) and 5.44 km (SD = 4.69) to the alternative market. Non-motorized or shared local transport (e.g., vans, rickshaws) was the most commonly used mode (75.9%), followed by walking (19.0%) and motorized transport (5.13%). The data on road connectivity reveals that 63.3% of the respondents said the road leading to their market was pucca (paved), 27.7% semi-pucca (semi-paved) and 8.97% was kutcha (unpaved).

Table 4. Frequency Distribution of Farmers' Socioeconomic, Institutional, and Market Accessibility Characteristics (n = 390)

Variables	Category	Number	Percentage
Sex	Male	318	81.5
	Female	72	18.5
Loan access	No	215	55.1
	Yes	175	44.9
Credit source	None	215	55.1
	Friends/relatives	5	1.28
	Cooperatives	8	2.05
	NGOs	147	37.7
	Bank	15	3.85
Training received	No	104	26.7
	Yes	286	73.3
Mode of transport	Walking	74	19.0
	Non-motorized/shared local transport	296	75.9
	Motorized transport	20	5.13
Road condition	Kutcha (unpaved)	35	8.97
	Semi-pucca	108	27.7
	Pucca (paved)	247	63.3
Sold produce earlier due to urgency	No	137	35.1
	Yes	253	64.9
Affordable input prices	No	85	21.8
	Yes	305	78.2

The average percentage devoted to transportation costs was 7.93% (SD = 6.10) of the sales revenue of the farmers. Even with the market connectivity, 64.9% of respondents said that they sold the produce before their planned time, meaning that the liquidity constraint in the marketing sector still remains. Regarding input affordability, 78.2% of the farmers found input prices to be affordable while 21.8% found them to be unaffordable. The overall mean extension communication score was 32.0 (SD=4.20; range 15–44), indicating moderate involvement with agricultural information services.

Farmers' Communication Media Preferences

Extension communication was measured as a composite score of the media used to disseminate agricultural information and was a significant negative predictor of the Market Access Index (Table 5). The composition of this score is therefore described in detail in this section, because the composition of these component media is needed to interpret that association. The average usage scores for different communication media used by sample farmers to receive agricultural information is shown in Figure 1 on a score range of 0-10. The results indicate significant variations in farmers' preference for the sources of information, with farmers who received information from seed dealers having the highest usage score followed by NGO workers and posters. The higher dependency on seed dealer indicates that heavy reliance on locally commercial actors for information on production, especially about seed choice, supply and production practices. Obtaining information from NGO workers and poster is relatively high, indicating that community-based extension as well as simple and user-friendly tools continues to be important in enhancing farmers' access to agricultural knowledge.

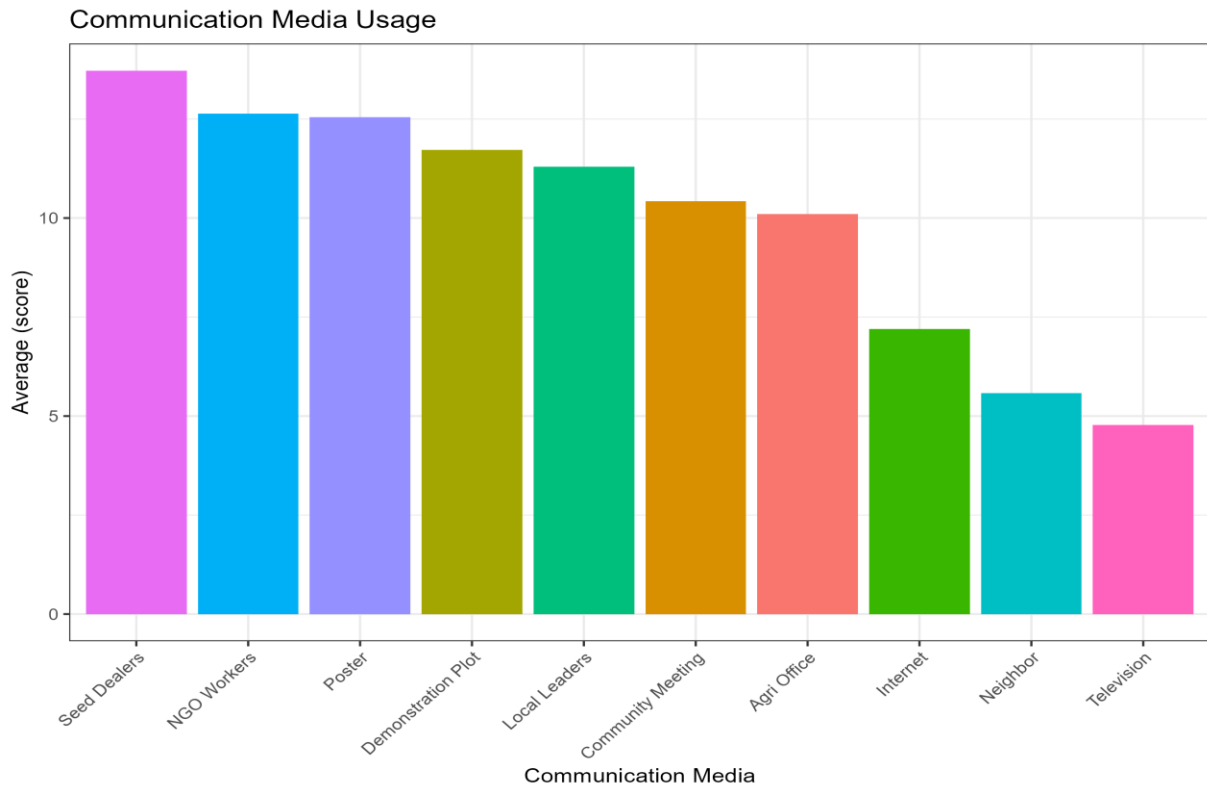


Figure 1. Average usage score of communication media among sampled farmers

Moderate usage scores were found for demonstration plots, local leaders, community meetings, and agricultural offices, suggesting that experiential learning and institutional extension mechanisms are both important for the decision-making process of farmers. In contrast, internet, neighbors and television use had relatively low scores reflecting low adoption of internet and mass media sources of information access on agriculture. The seven channels of interpersonal and community-based communication combined make up 82.5% of the farmers' total communication contact, which means that the extension communication score is mainly production-oriented. These patterns indicate that farmers primarily depend on trusted, local and interactive communication channels, instead of using technology-mediated channels.

Distribution of the Composite Market Access Index

A Market Access Index (MAI) was developed using eighteen indicators across physical connectivity, market participation, information access and bargaining power. The individual components contributions to the overall MAI are shown in Figure 2. There was substantial variation in the various aspects of market access. Farmers' average scores were relatively higher for indicators on contact with traders, information sources, information frequency, information timeliness and payment arrangement, indicating a comparatively better access to market-related information networks and linkages among farmers. Lower scores, however, were found for indicators reflecting transport access, support services, direct market access, and reliance on middlemen, which suggests that physical access and farmers' bargaining power remain constrained. The results highlight that market access is a multidimensional concept.

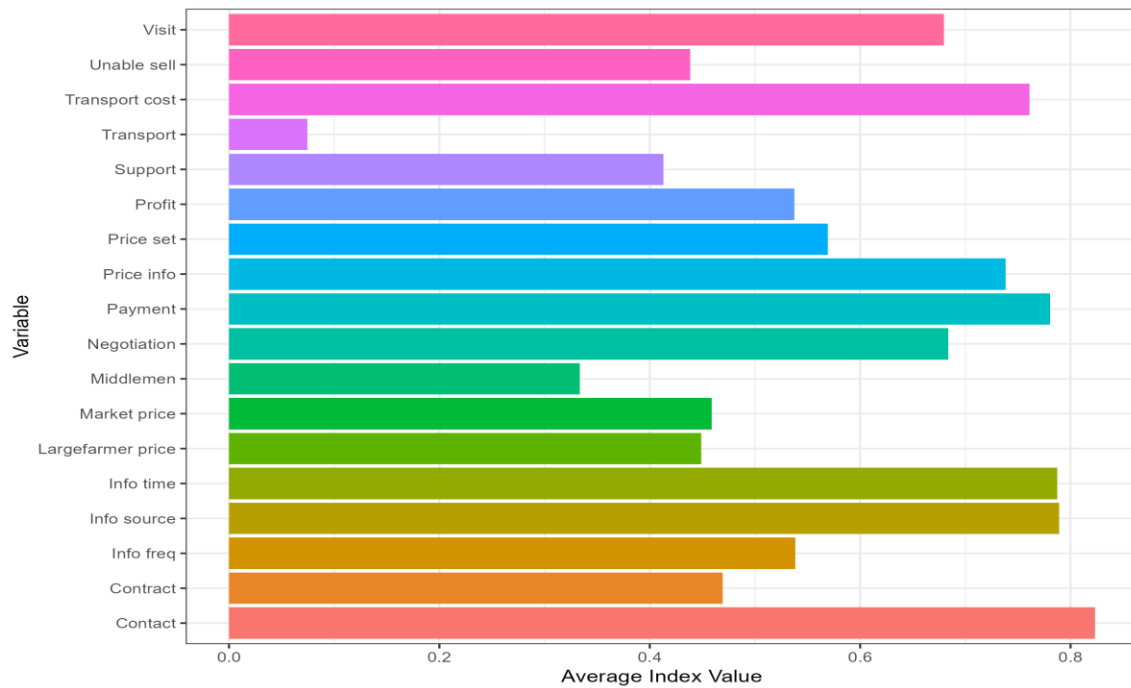


Figure 2. Mean values of the eighteen normalized components used to construct the Market Access Index

The distribution of the composite MAI is shown in Figure 3. The index values were between 0.265 and 0.842 with an average score of 0.573 (SD = 0.089) showing that overall, the sampled farmers had moderate market accessibility. The distribution is approximately symmetric and continuous, with the possibility of somewhat extreme clustering and sufficient variability for further empirical analysis. Based on the midpoint classification of 0.50 for descriptive classification, 63 farmers (16.2%) had low market access while 327 farmers (83.8%) had high market access. While the majority of the farmers showed relatively good access, the observed differences suggest that a significant portion of farmers are still constrained when it comes to market integration, especially in terms of transport or negotiating with markets, and direct market participation. The high share of farmers with scores above the median indicates that overall market access is moderate to good, and the low scores of farmers in this sample, in small numbers, could be considered a target group for policy interventions to enhance market linkages, which is an identifiable group.

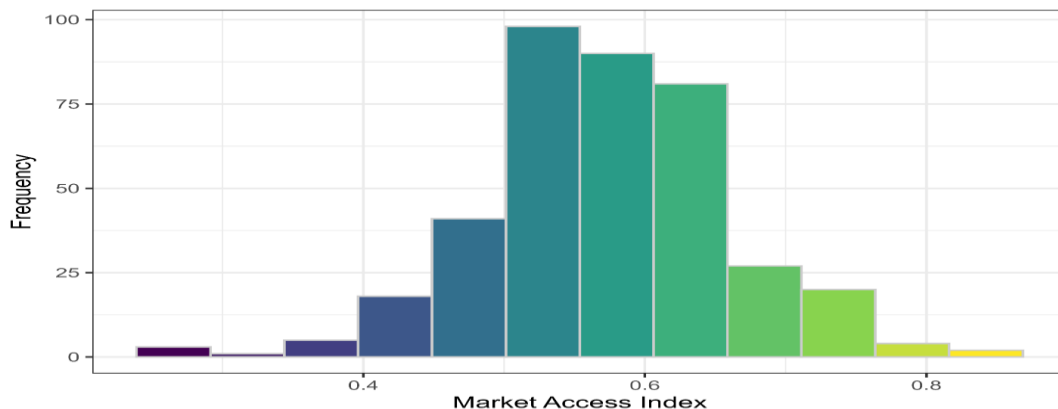


Figure 3. Distribution of the composite Market Access Index (MAI)

Determinants of the Market Access

A multiple linear regression model was estimated to determine the socioeconomic, institutional and infrastructural factors associated with the variations in the farmers' Market Access Index (MAI). Several socioeconomic, institutional and infrastructural variables were initially proposed as potential explanatory variables, based on previous literature. Variables examined were: age, education, family size, farm size, farming experience, household income, non-farm income, credit access, training facilities, extension communication, road condition, transport related factors and market related characteristics. The final model, however, kept predictors that made a significant contribution to the explanation of the variation of market access. The stepwise variable selection procedure was used to select the predictors which gave the best empirical contribution to the explanation of variation in market access without adding unnecessary complexity to the model. Due to the drawbacks of the stepwise procedures such as sensitivity to sample change and possible instability of the predictor's, selected variables were interpreted based on their theoretical relevance and past empirical evidence in addition to their statistical significance.

Diagnostic tests were used to test the reliability of the estimated model. Heteroskedasticity was detected with the Breusch–Pagan test ($BP = 25.0$, $df = 12$, $p = 0.010$); hence, the robust standard errors were used. There was no multicollinearity problem as all the adjusted generalized variance inflation factor values were in the acceptable range (1.03–1.14). The final model was statistically significant ($F(12, 377) = 9.20$, $p < 0.001$) and accounted for 22.7% of the variance in MAI (adjusted $R^2 = 0.202$), suggesting that the socioeconomic, institutional and infrastructural variables included in the model captured some but not all factors affecting farmers' market access.

Table 5. Regression results for determinants of the Market Access Index

Predictors	B	95% CI	t	p
Intercept	0.554***	0.475, 0.633	13.75	< 0.001
Education	0.001	-0.000, 0.003	1.55	0.122
Credit: Friends/relatives	0.001	-0.030, 0.032	0.06	0.950
Credit: Cooperatives	-0.126*	-0.237, -0.015	-2.23	0.026
Credit: NGOs	0.012	-0.005, 0.029	1.43	0.152
Credit: Bank	0.048**	0.016, 0.081	2.91	0.004
Market distance (km)	0.003	-0.001, 0.006	1.59	0.113
Alternate market distance (km)	0.003**	0.001, 0.005	3.40	0.001
Market distance (minutes)	0.002***	0.001, 0.003	4.92	< 0.001
Road condition: Semi-pucca	0.051**	0.019, 0.084	3.11	0.002
Road condition: Pucca	0.045**	0.015, 0.075	2.94	0.003
Sold earlier due to urgency	-0.017	-0.037, 0.003	-1.69	0.101
Extension communication	-0.003*	-0.005, -0.001	-2.47	0.014

Note: *, ** and *** denote significance at the 5%, 1% and 0.1% level of probability, respectively.

Market access was correlated with infrastructure-related factors, which were found to be important predictors (Table 5; Figure 4). Farmers enjoying access to semi-pucca roads had significantly higher MAI scores than those with access to unpaved (kutchra) roads ($B = 0.051$, $p = 0.002$) and access to pucca roads was also positively associated with market access ($B = 0.045$, $p = 0.003$). The results confirm the importance of rural transport infrastructure in enhancing farmers' access to agricultural markets. There

were differential effects for credit accessibility depending on the source of financing. The farmers who borrowed credit from banks showed much higher market access ($B = 0.048$, $p = 0.004$) which implies that formal financial services might help farmers to gain access to markets by providing greater liquidity and trading capacity. Cooperatives were the only source of credit that exhibited a negative association with MAI ($B = -0.126$, $p = 0.026$), which had the highest absolute value among the model's credit parameters. No statistically significant relationship was found with market access for credit from NGOs and informal sources like friends or family.

Market-related spatial variables showed an unexpected but consistent pattern. Farmers who had to travel further to market or longer to get there had higher market access scores, with both travel time to market ($B = 0.002$, $p < 0.001$) and distance to alternate markets ($B = 0.003$, $p = 0.001$) being positively related to MAI. This could be an indication of higher market participation of farmers with commercial orientation who are prepared to go extra-mile to access better market opportunities. Similar positive tendencies were observed with distance to the primary market ($B = 0.003$, $p = 0.113$), but this was not statistically significant.

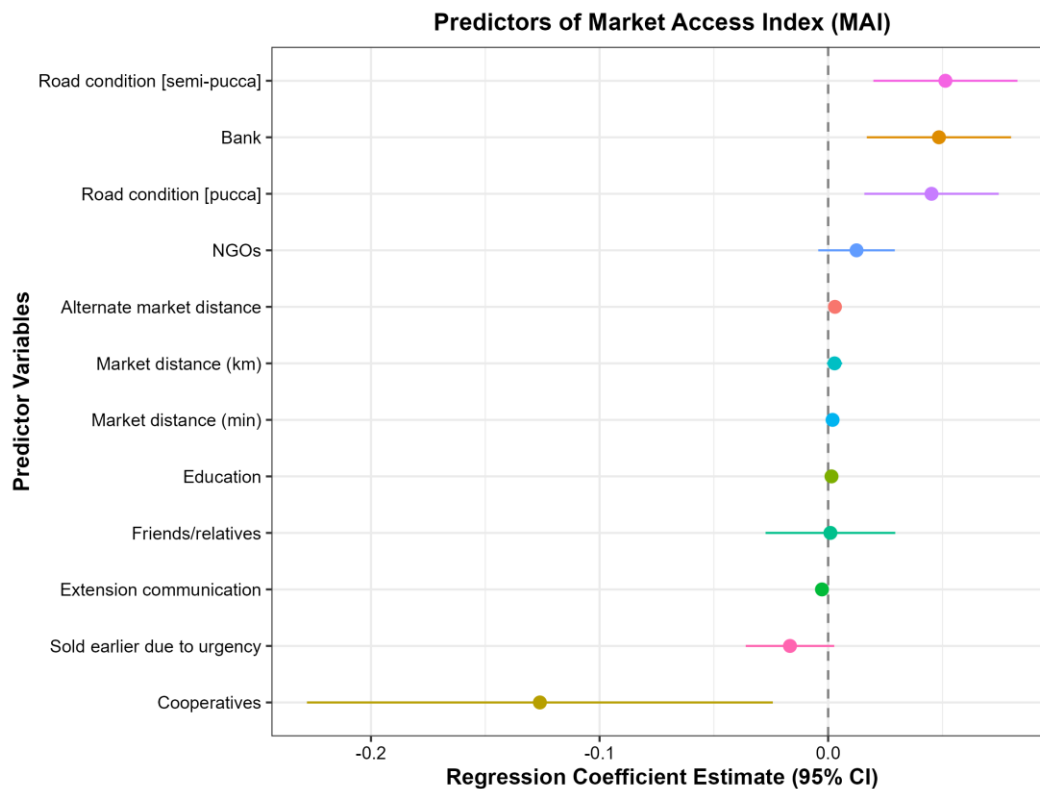


Figure 4. Regression coefficients with 95% confidence intervals for predictors of the Market Access Index

Among extension contacts, there was a tiny negative association with MAI ($B = -0.003$, $p = 0.014$), implying that extension contacts might be more likely to occur among farmers with higher market constraints (Hlatshwayo et al., 2021). The theoretically expected directions were for education and distress selling due to urgent financial needs, but these were not found statistically significant. The findings suggest that physical infrastructure, formal financial access, and market connectivity are key factors shaping farmers' market access, highlighting the importance of multifaceted interventions that

address rural market access problems, including access to physical infrastructure, formal financial access, and market connectivity.

Discussion

Household and Farm-level Context

Socio-economic and farm characteristics of the sampled farmers give important insight into the structural conditions that affect the participation of smallholder farmers in the markets. The majority of the respondents were middle aged with an average farming experience of more than 20 years showing that market related decisions in this sample are made by people with a lot of practical experience. This is in line with the earlier findings which stated that the medium farmers are more likely to use modern farming techniques and more market oriented (Tilahun et al., 2023; Waaswa et al., 2024).

Although women are generally an important source of labor on the farm, the prevalence of men in the sample (81.5%) is similar to that seen in rural Bangladeshi households, where men are generally recorded as the head of the household and are the primary point of contact for decisions regarding the market. Over the past decades, community-marketing interventions have been implemented in other parts of rural Bangladesh, indicating that the gender disparity in marketing activity observed here is due to social norms (Lee et al., 2022).

Farmers' relatively moderate level of formal education could also affect their market information processing capabilities, negotiation skills with the buyers, and their willingness to take up new marketing strategies. Past research has shown that education enhances farmers' ability to access and process information, to engage in commercial markets and to improve their agricultural practices (Hasan et al., 2025; Negera et al., 2022; Tilahun et al., 2023). The lack of a strong education and MAI relationship found in this study, however, implies that education alone might not be enough to improve market integration unless education is supported by effective extension, financial services, and market-oriented training.

The predominance of the small-scale farmers, reveals the nature of a smallholder farming system where the resources available to the farmers are restricted, which limits their bargaining power and commercialization. In developing countries, it can be seen that farmers have limited ability to participate in higher value markets, due to fragmented land ownership, low income and small holdings and household resource constraints (Barrett, 2008; Waaswa et al., 2024).

The high dependence on NGO credit (37.7%) in the sample farmers as compared with formal banking (3.85%) reflects the overall microfinance situation of rural Bangladesh (Mahmud and Tulla, 2024) and will have implications for the number, availability and flexibility of the credit facilities to smallholders that are applying for credit for both farm inputs and market transactions. On the other hand, agricultural training has achieved significant penetration (73.3%), it tends to be shallow, with a modest average duration (7.4 days) and exposing many farmers to only short-term training opportunities that are not necessarily enough to significantly boost their skills and livelihoods (Negera et al., 2022; Tilahun et al., 2023).

The significant percentage of farmers reporting distress selling, as a result of a need for immediate cash, suggests that there remains a liquidity constraint in smallholder systems. This early selling behavior may reduce farmers' capacity to wait for better prices to be available, and limit their bargaining power with traders (Chimi et al., 2023; Malatji, 2021; Shrestha, 2020). Thus, better market access needs to go hand in hand with the improvement of physical connectivity and interventions which tackle farmers' financial vulnerability and build farmers' market skills.

Communication Media Preferences and Agricultural Information Systems

In this study the communication pattern observed showed that the sources of agricultural information are still mostly locally embedded, and interpersonal, which means that interpersonal communication is still the favored farmer tool for obtaining agricultural information. Seed dealers, NGO workers, and community-based channels were the most common communication media to be used, as their trust, access, and relevance were found to be important when it comes to the adoption of information. Similar findings have been reported, in which farmers tend to value information sources that offer timely, locally relevant, and action-oriented information (Mottaleb et al., 2019). The overall results highlight the need to invest in farmer networks, input-dealer networks, and extension worker networks as an effective way of designing interventions to encourage adoption of climate-smart agricultural practices, in addition to mass media campaigns.

Relatively lower use of internet and television suggested that the penetration of digital and mass media based agricultural information system into farming communities studied is fully penetrated. Digital agriculture represents a great opportunity to enhance market information but digital literacy, connectivity, affordability and user trust are key factors that will drive the adoption (Fabregas et al., 2019). So, digital extension methods ought to be a supplement to the existing community-based communication systems. Using a combination of digital platforms and local intermediaries can offer a better way to enhance farmers' access to timely market information.

The Market Access Index as a Multidimensional Measure

The Market Access Index includes physical, economic, informational and institutional dimensions and, therefore, offers a more comprehensive conceptualization of market accessibility. Geographical proximity or transport costs have been used as indicators of market access, but these may not reflect farmers' capacity to effectively engage in markets (Barrett, 2008). Physical proximity is no longer the only determinant of market access, which is now seen as a function of transaction costs, information availability, bargaining power and institutional linkages (Kumar and Doan, 2025; Zakari et al., 2023).

The overall moderate average MAI seen in this study reveals that farmers have made some progress in becoming more integrated into markets, especially through their relationships with traders and market information, but still have some constraints regarding their ability to directly participate in markets and exert bargaining power. The finding is in line with the previous studies, which indicated that transaction costs and lack of market information, as well as the collective organization, limit the ability of smallholders to independently access the markets, so that they have to work with intermediaries (Magakwe and Olorunfemi, 2024; Rahman et al., 2025; Mujahed and Khamassi, 2026).

The differences in the individual components of the MAI also suggest that the concept of market access should not be viewed as a one-dimensional goal. Farmers might know what they need to know, yet still suffer from limitations in transportation, price negotiation or money. Composite indices like MAI can thus offer a more holistic lens for specific constraints and planned interventions.

Determinants of Market Access: Mechanisms and Relation to Prior Findings

This section explores the determinants of market access, covering mechanisms and how these relate to previous findings. Our regression analysis indicates that infrastructure, financial access, and institutional factors are important determinants of farmers' market access. The quality of roads was found to be one of the most significant factors affecting MAI, thus highlighting the importance of infrastructure in rural areas to lower transaction costs and enhance market participation. Road improvement has been consistently found to lower transportation costs in previous studies, raises the frequency of markets, improves access to input and output markets and promotes agricultural commercialization (Raitzer et al., 2019; Mukonyo et al., 2022).

The positive association between bank credit and MAI was explored through this study. Thus, indicate farmers' access to formal financial services has positive association with their ability to access the market in terms of liquidity constraints and better timing of marketings. Having access to finance enables farmers to not be forced to sell during distress times, invest in production, and market their output at better prices (Karlan et al., 2014; Hasan et al., 2025; Joy et al., 2024).

However, the negative relationship between cooperative credit and MAI may be attributed to the different levels of effectiveness of the cooperative services or loan utilization. This does not necessarily mean that cooperative credit leads to less market access rather that it may be the nature of farmers that use cooperative credit that is limiting access. Limited resources farmers might be more reliant on cooperative loans, which might lead to a negative association because of borrower characteristics and underlying constraints. Further, variations in loan access, and flexibility can affect the extent to which farmers can use credit efficiently for market-oriented operations. Past studies indicate that institutional conditions such as loan conditions and availability can have an impact on the efficiency of agricultural finance (Wielechowski et al., 2023). Moreover, cooperative credit can contribute to market participation only if it is backed by efficient market linkages, production support and marketing services. The present study, however, failed to gather detailed information on the conditions of the cooperative loan, repayment arrangement or utilization pattern of the loan; so these possibilities can be interpreted with caution and further investigation is needed.

Market distance/travel time is positively correlated with MAI in our regression findings. Although distance can be regarded as a limiting factor with regard to participation in the market, farmers who go further may be the ones who strive to improve their market prices, expand their markets, and cultivate better relationships with buyers. This contradicts the prevailing transaction-cost view that a closer distance to market leads to lower transaction costs and more market participation (Key et al., 2000) and the more typical finding in the literature on market participation, which is that greater distance to market reduces participation, due to higher transaction costs, as has been found (Aryal et al., 2018; Kumar and Doan, 2025; Zakari et al., 2023). The divergence could be due to the farmers coming in from the coastal sample being able to afford to go to the larger regional markets, which are located farther away, as they choose to do so because they are better off in terms of price, buyer representation and trader networks. This would align with the wider findings that a more distant, bigger and more connected market, as opposed to the closest market, can deliver higher agricultural incomes (Isah and Ogundele, 2025; Midamba et al., 2022). Similar observations have been reported where commercially oriented farmers overcome geographical barriers to access more profitable market opportunities (Rana and Maharjan, 2022; Beadgie and Zemedu, 2019).

The negative relationship between extension communication and MAI may be due to a targeting effect. Prior research has indicated that extension systems typically come to the attention of disadvantaged farmers at times when they have the most need for help (Lee et al., 2023; Promkhambut et al., 2023). The potential explanation is that extension contact in this sample continues to be mainly production and climate adaptation oriented, meaning that increased engagement with extension does not necessarily lead to increased bargaining power and/or market outcomes. The farmers who have already more limited market access might be more inclined to use extra extension services as coping mechanism. This finding implies that extension services need to shift from "production" systems to "markets" systems that include market information, buyer relationships, and marketable assistance (Promkhambut et al., 2023).

Policy interventions should focus on improving rural transport infrastructure, especially the upgrading of poorly connected village roads to improve farmers' physical access to markets, as it is one of the

important determinants identified in this study. Access to formal bank finance could also enhance market participation of farmers by lowering liquidity constraints and enhancing farmers' capacity to access markets. Market access was also associated with travel time and alternative market access, suggesting that interventions that enhance farmers' access to larger and more competitive markets, such as market information and buyer linkages, could further boost market opportunities. Besides, extension services must be reoriented to provide market oriented services like price information and buyer information along with production related information. These interventions should be combined with future research to understand the mechanism of the observed relationship between cooperative credit and market access, particularly since several predictors are worth noting as they have a cross-sectional design and thus cannot be interpreted causally. One explanation for the negative association between cooperative credit and extension communication is that there may be a reverse causality or selection effect, that is, that farmers with less market access may be more likely to use cooperative credit and/or extension communication services than the opposite. Likewise, there may be other unobserved farmer traits (e.g., entrepreneurial orientation or risk-taking) that affect both the willingness to travel to distant markets and market access in general, which may lead to endogeneity of the distance-related coefficients. Additional research using instrumental variable methods could be helpful to separate these causal flows.

Conclusion

This study explored the determinants of market access of smallholder farmers based on a composite index of physical connectivity, market participation, information access and bargaining power in the central coast of Bangladesh. The results show that market access is a complex phenomenon, and is more influenced by the quality of the road infrastructure, the availability of formal credit and institutional arrangements, rather than by proximity alone. Trader contact and market information were relatively well done, whereas transport access and direct selling and independence from middlemen were poorly done, suggesting that access is not uniformly weak, but rather unevenly composed in this population. This changes the focus on market access from a spatial and transaction cost approach to one that also takes into account institutional linkages and financial resources. The positive relationship between travel time and market access also suggests that access is not necessarily better when markets are closer, but does not rule out the possibility that farmers who are more market-oriented intentionally avoid local markets in favor of greater distance to higher prices and better buyer relationships. Road quality and the source of credit were the most obvious, with pucca roads and bank credit associated with higher access, and cooperative credit with lower access. Extension communication, on the other hand, was negatively correlated with market access, which is in line with the fact that extension contact is likely to be more focused among more constrained farmers, and the production orientation of the channels by which farmers receive information. The results emphasize in upgrading kutchra road sections that serve farming villages, widening access of smallholders to formal bank loans, while reviewing the terms of cooperative credit, and embedding price, buyer and negotiation content into the interpersonal channels that farmers already use. Market access improvement is not necessarily about reducing distances, but about enhancing rural infrastructure, formal financial inclusion and market-oriented information systems. The model accounted for a small proportion of the variance and the study has yet to examine the link between market access and the uptake of climate-smart practices.

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