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Examining the relationship between entrepreneurial orientation and performance of vegetable growers in Bangladesh

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Abstract

Purpose – This study investigates the relationship between entrepreneurial orientation (EO) and farm performance among vegetable growers in Bangladesh, with a specific focus on its implications for food security, economic stability and health outcomes.

Design/methodology/approach – Using a structural equation modelling (SEM) approach, data from 144 vegetable farmers are analyzed to assess the influence of key entrepreneurial attributes–knowledge acquisition, risk-taking, innovation, collaboration and proactiveness–on farm performance and its broader socio-economic impacts.

Findings – The results indicate a strong positive relationship between EO and farm performance. Enhanced farm performance, in turn, significantly contributes to food security, economic resilience and improved health outcomes. Entrepreneurial attributes such as innovation, risk-taking and collaboration are particularly influential in improving the productivity and market competitiveness of smallholder vegetable farmers. Additionally, the study underscores the critical role of EO in fostering economic security and enhancing the adaptive capacity of rural farmers in developing economies.

Research limitations/implications – The research implications from the data analysis suggest the need for a deeper examination of entrepreneurial behaviour (EB) dimensions among farmers. Future studies should explore how specific EB components identified through EFA and confirmed by reliability analysis, influence farm performance and security outcomes. The positive relationships established through SEM between EB and food, economic and health security highlight the importance of integrating EB into agricultural development strategies. Additionally, further research could investigate the role of contextual factors, such as education and farm size, in moderating these relationships, thereby refining interventions to enhance farm performance in challenging contexts.

Originality/value – This study provides empirical evidence linking EO to agricultural productivity, market access and food system resilience. By highlighting the role of entrepreneurial behaviour in strengthening economic and health security, it underscores the necessity of promoting entrepreneurial initiatives among smallholder farmers to enhance agricultural sustainability and rural livelihoods. The findings offer valuable insights for policymakers, agricultural extension services and development practitioners seeking to improve food security and economic stability through entrepreneurial capacity-building in the agricultural sector.

Keywords Economic security, Health security, Entrepreneurial orientation, Farm performance, Rural vegetable farmers, Agricultural resilience

Paper type Research article

1. Introduction

Covering approximately 147,570 km^2, Bangladesh is home to the world's largest delta, the Ganges-Brahmaputra Delta, characterized by a predominantly flat and fertile landscape with

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high susceptibility to fluctuating rainfall patterns (BBS, 2020). Agriculture remains a cornerstone of the nation's economy, employing over 40% of the labour force and contributing 13.47% to the country's GDP (BER, 2021). With a distinctive six-season climate, Bangladesh cultivates an impressive diversity of crops, including more than 150 vegetables (35 major varieties), 70 fruit species, and 60 types of spices (Terry, 2011; MoA, 2018). This diverse climatic advantage enables the country to sustain year-round agricultural production and support an extensive range of vegetable crops (FAO, 2020). As a result, Bangladesh ranks as the world's third-largest vegetable producer, following China and India.

With global dietary patterns shifting from cereal-based diets to lacto-vegan preferences (Miller *et al.*, 2020), vegetable production has surpassed cereal crop production, making it an increasingly attractive option for smallholder farmers (Hasan *et al.*, 2020). However, climate change poses a significant challenge to vegetable production in Bangladesh, disrupting yields and farming practices. In response, institutions such as the Bangladesh Agricultural Research Institute and allied organizations have developed high-yielding vegetable varieties (HYVs) and promoted modern agricultural technologies to support farmers (Farid *et al.*, 2015). Several studies suggest that vegetable cultivation, along with homestead gardening, diverse cropping patterns, and participation in cooperative societies, plays a crucial role in enhancing food security and building resilience among smallholder farmers (Mukaila*et al.*, 2021; Rahman*et al.*, 2008).

Vegetables play a crucial role in ensuring higher returns for farmers while contributing to a balanced and nutritious diet, particularly benefiting women and smallholder farmers in Bangladesh (Alam, 2011). The country's commitment to sustainable agricultural practices and the responsible production and consumption of vegetables was recognized with the SDG Progress Award (SDSN, 2021). Vegetables are rich sources of essential vitamins, including A, C, niacin, thiamine, and riboflavin, as well as important minerals and dietary fibre, which support digestion and help combat nutritional deficiencies (Terry, 2011). To achieve both economic growth and food and nutritional security, vegetable production in Bangladesh has created new income-generating opportunities, boosted trade, and contributed to progress toward the Sustainable Development Goals (MoA, 2018). Since its inception, Bangladesh has been endowed with vast expanses of fertile land, organized into 535 agroecological units and 30 distinct agroecological zones (BBS, 2017). Among these, the Madhupur Tract—intersected by the Brahmaputra-Jamuna River system—stands out for its high soil quality, favourable climate, and strategic location, which connects it to key markets (Hoq *et al.*, 2012; BARC, 2013; BBS, 2017). Covering 4,244 km^2, this region spans around Dhaka, Gazipur, Mymensingh, Narsingdi, Tangail, and Kishoreganj (Islam, 2012). Farmers here cultivate a diverse range of vegetables, including various gourds (bitter gourd, bottle gourd, pointed gourd, and ridge gourd), long yard beans, eggplant, tomato, cucumber, cauliflower, pumpkin, and aroids (BBS, 2020).

Historically, most farmers in this region practiced subsistence farming with little to no surplus for the market (World Bank, 2014). However, the expansion of commercial vegetable production has driven many to transition towards market-oriented farming, capitalizing on growing demand (Razzaque and Hossain, 2007; Karim *et al.*, 2011). Beyond meeting domestic needs, Bangladesh exports over 50 vegetable varieties to more than 100 countries, with major importers including Saudi Arabia, the UAE, Malaysia, Hong Kong, and the UK (MoA, 2018). Notably, a significant share of these exports originates from the Madhupur Tract (Hoq*et al.*, 2012). Recognizing the potential of vegetable cultivation to enhance income and livelihoods, increasing numbers of farmers have shifted to intensive vegetable farming (Begum *et al.*, 2011; Khandoker *et al.*, 2014; Hasan *et al.*, 2020). This rapid transition from subsistence grain farming to commercial vegetable production has far-reaching implications for staple food crop supply, water usage, women's empowerment, and rural livelihoods. Efforts have been made to assess the broader impact of this agricultural transformation, considering factors such as integrated pest management, women's participation, market dynamics, and household grain crop requirements. However, research in this area faces challenges related to data collection, analysis, and attribution of outcomes (Khandoker *et al.*, 2017; Hasan *et al.*, 2020).

Entrepreneurship, defined as the pursuit of opportunities through resource optimization beyond current possession (World Bank, 2022), plays a crucial role in this transformation. This concept is particularly relevant in developing nations (Acs and Armington, 2006), where most business owners are micro-entrepreneurs—typically employing fewer than ten individuals—and small-scale vegetable farmers. These farmers are driven by aspirations to increase income and improve their living standards (Mozumdar, 2018; Yessoufou *et al.*, 2018; Saad, 2019). Their success depends on their ability to maximize resource efficiency and profitability (Mozumdar *et al.*, 2023). In this context, Ward *et al.* (1995) define the farm environment as the framework within which business transactions take place.Many countries face challenges in providing adequate resources, infrastructure, and institutional support to enhance a livelihood, which in turn hinders farmers' efforts to improve their economic well-being (Zoogah *et al.*, 2015; Saad, 2019; Mozumdar*et al.*, 2020).

Entrepreneurial Orientation (EO) is a key driver of innovation and competitiveness, enabling individuals to identify opportunities and gain a strategic advantage (Wiklund and Shepherd, 2005). For vegetable farmers, EO influences how they acquire knowledge, adopt proactive strategies, collaborate, innovate, and take calculated risks—aligning with its five dimensions (Lumpkin and Dess, 1996; Yessoufou *et al.*, 2018). In agriculture, EO is particularly relevant as farmers navigate complex challenges, including climate change, which threatens food security and farm sustainability. Research suggests that EO plays a pivotal role in adopting climate-smart agriculture (CSA), reinforcing its impact beyond farm-level decision-making (Andati *et al.*, 2022). By fostering resilience, adaptability, and business acumen, entrepreneurial behaviour enhances farm performance and long-term sustainability in an evolving agricultural landscape (Covin and Wales, 2019). While existing studies establish a positive correlation between EO and farm performance (Lumpkin and Dess, 1996; Rauch *et al.*, 2009; Covin and Wales, 2019), empirical evidence on its direct impact among smallholder vegetable farmers in Bangladesh remains scarce. Furthermore, the extent to which EO influences food security, economic stability, and health security—especially in resource-constrained environments—has not been comprehensively examined. Prior research has largely focused on EO within broader agribusiness and commercial farming contexts (Boso *et al.*, 2013; Wales, 2016), overlooking its role among marginal and small-scale vegetable farmers who face distinct socio-economic and environmental challenges. Additionally, social capital is widely recognized as a key enabler of entrepreneurship (Inkpen and Tsang, 2005; Yli-Renko *et al.*, 2001), yet its interaction with EO and farm performance in vegetable cultivation remains underexplored.

This study examines EO's influence on farm performance, food security, economic stability, and health outcomes among smallholder vegetable farmers in Bangladesh. Given the sector's rapid expansion, understanding EO's role in shaping agricultural productivity and rural livelihoods is crucial. Unlike previous studies that focus on agribusinesses, this research centres on smallholder farmers, analyzing EO's direct effects and broader socio-economic implications. It also explores the role of social capital in facilitating access to critical resources, markets, and knowledge, particularly in resource-limited settings. By addressing these gaps, the study contributes to the existing agricultural entrepreneurship literature and provides valuable insights for policymakers, development agencies, and agricultural extension services. The findings will help design strategies that promote entrepreneurship in smallholder farming, drive sustainable agricultural development, and improve rural livelihoods.

1.1 Background and hypothesis development

The theoretical foundation of this study is constructed by integrating several entrepreneurial theories that collectively explain the relationship between Entrepreneurial Orientation (EO) and Farm Performance. The Resource-Based View (RBV) theory (Barney, 1991) emphasizes the critical role of resource mobilization in agricultural entrepreneurship, highlighting that

farmers with access to valuable, rare, and non-substitutable resources—such as knowledge networks and financial capital—possess a competitive advantage over others. This resource-based perspective is further reinforced by Schumpeter's Innovation Theory (1934), which links the innovativeness dimension of EO to economic growth. The theory underscores the use of novel market strategies, advanced production techniques, and continuous innovation to enhance farm performance and resilience.

Moreover, the adaptive decision-making processes of farmers, shaped by the strategic use of available resources to navigate market uncertainties, are drawn from Effectuation Theory (Sarasvathy, 2001). This theory highlights how entrepreneurs operate in dynamic environments by leveraging existing means to achieve evolving goals. In addition, Social Capital Theory (Bourdieu, 1986; Putnam, 1995) identifies social networks as key enablers of EO, facilitating knowledge exchange, collaboration, and access to market opportunities. Such social capital contributes both tangible and intangible assets that strengthen agricultural enterprises and promote farm sustainability.

To further delineate how entrepreneurial farmers must develop capabilities to reconfigure resources and adapt strategies in response to evolving market and environmental conditions, Dynamic Capabilities Theory (Teece *et al.*, 1997) is employed. This theory emphasizes the need for continuous environmental scanning, learning, and resource reconfiguration to maintain competitive advantage. Finally, Entrepreneurial Orientation Theory (Miller, 1983; Lumpkin and Dess, 1996) positions EO as a multidimensional construct, comprising innovativeness, proactiveness, and risk-taking—attributes pivotal for identifying and exploiting opportunities in changing agricultural and market contexts. By integrating these theoretical perspectives, the study aims to develop a comprehensive understanding of how EO interacts with key enabling factors to enhance farm performance, ultimately contributing to food security, economic stability, and the sustainable development of the agricultural sector.

Building on the aforementioned theoretical foundations, this study develops a conceptual framework (Figure 1) to elucidate the complexities of farm performance and its broader implications for food, economic, and health security. Anchored in the principles of EO and farm performance, the framework integrates resource mobilization with the strategic pursuit of entrepreneurial opportunities, thereby capturing the core dynamics of entrepreneurial activity in the agricultural sector. Within this framework, EO functions as a strategic compass, guiding the decision-making processes of agricultural entrepreneurs and enabling them to identify and capitalize on emerging opportunities in dynamic and uncertain environments (Covin and Lumpkin, 2011). Simultaneously, social capital is positioned as a key enabler of

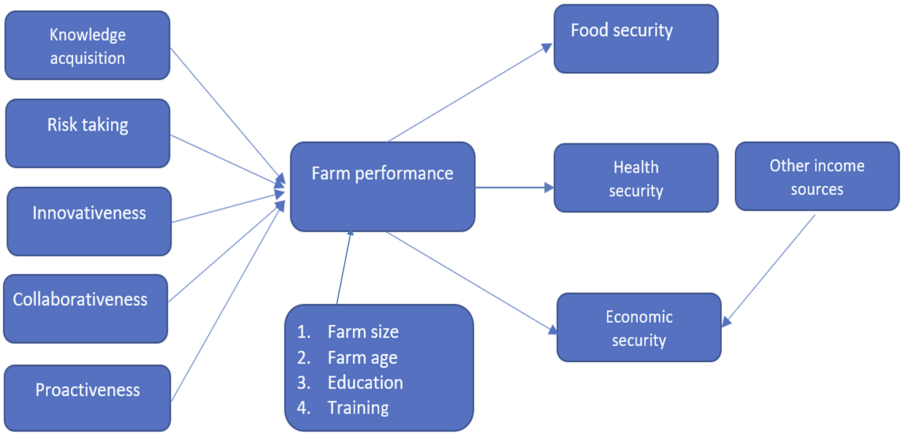

Figure 1. Hypothesized "Path to-Path from" conceptual framework

entrepreneurial behaviour, facilitating the development and mobilization of both tangible (physical) and intangible (cognitive) resources (Adler and Kwon, 2002). Social networks, by fostering trust, collaboration, and knowledge exchange, play a critical role in enhancing farm performance and improving market responsiveness (Inkpen and Tsang, 2005).

The proposed framework illustrates the complex and interdependent relationships between entrepreneurial behaviour, EO, and farm performance, highlighting their collective influence on agricultural resilience, food security, economic stability, and public health. Ultimately, this study underscores the centrality of EO and social capital in advancing sustainable agricultural practices. By delineating the mechanisms through which these constructs interact, the research offers a comprehensive perspective on strengthening the adaptive capacity and long-term sustainability of agricultural systems.

1.2 Entrepreneurial orientation and farm performance

Entrepreneurial Orientation (EO) reflects the integration of an entrepreneur's strategic mindset, attitudes, actions, and decision-making processes (Lumpkin and Dess, 1996). It has been widely explored in entrepreneurship literature (Mohammed *et al.*, 2020; Mozumdar *et al.*, 2020) and forms a foundational component of the present study's conceptual framework. EO is traditionally defined through three core dimensions: innovativeness, proactiveness, and risk-taking propensity (Miller, 1983). Innovativeness refers to the tendency to engage in and support new ideas and creative processes. Proactiveness involves anticipating and acting on future market demands, while risk-taking reflects the willingness to commit resources to opportunities with uncertain outcomes (Miller, 1983; Willebrands *et al.*, 2012). Extensive empirical research highlights the positive influence of EO on firm and farm performance (Wiklund and Shepherd, 2005; Rauch *et al.*, 2009; Mozumdar *et al.*, 2022). Agricultural entrepreneurs exhibiting high levels of innovativeness, proactiveness, and risk-taking are more likely to engage in continuous environmental scanning, identify emerging opportunities, and enhance their competitive advantage in dynamic agricultural markets (Bradley *et al.*, 2011; Covin and Wales, 2019).

In the agricultural context, additional dimensions such as knowledge acquisition and collaborativeness are increasingly recognized as integral to EO, particularly in resource-constrained environments where access to information, networks, and joint action can significantly influence farm outcomes. Building on this theoretical foundation, the following hypotheses are proposed to examine the relationship between dimensions of EO and farm performance among vegetable farmers in Bangladesh:

H1. Knowledge acquisition within entrepreneurial orientation (EO) has no covariance with farm performance.

H2. Risk-taking within EO has no covariance with farm performance.

H3. Innovativeness within EO has no covariance with farm performance.

H4. Collaborativeness within EO has no covariance with farm performance.

H5. Proactiveness within EO has no covariance with farm performance.

1.3 Farm performance and food, economic, and health security

In developing countries, enhancing farm performance is critical for improving farmers' incomes and overall well-being (Mozumdar *et al.*, 2023). Increased farm productivity contributes directly to food availability, stabilizing local food supply chains and strengthening food security (Pingali, 2012). Efficient farm operations can generate surplus production, enabling farmers to diversify their diets through the purchase of nutritious crops and thereby improving food accessibility (Godfray *et al.*, 2010). Additionally, well-managed farms adopt advanced processing and post-harvest strategies, reducing food losses and enhancing food

utilization (FAO, 2017). Collectively, these factors indicate that farm performance is positively associated with food security through improvements in availability, accessibility, and utilization.

Furthermore, farm performance directly influences farmers' livelihoods by increasing net profits and generating income, thus strengthening household financial stability and contributing to employment generation (Sisay *et al.*, 2017; Mozumdar, 2018; Saad, 2019). High-performing farms also create trade opportunities and the potential to benefit from high-value crops, contributing to long-term economic security (Timmer, 2017; Barrett *et al.*, 2020). Additionally, diversified and high-yielding farms enhance dietary quality by providing nutrient-rich crops that address the nutritional needs of farm households (Gillespie and van den Bold, 2017). The adoption of sustainable farming practices on well-performing farms further safeguards the health of farmers by reducing exposure to harmful chemicals and promoting environmentally sound production (Pretty *et al.*, 2018).

Although smallholder farmers, particularly in countries such as Bangladesh, India, and Ethiopia, represent a large share of the agricultural sector (Sisay *et al.*, 2017; Mozumdar, 2018; Saad, 2019), their primary objective remains the pursuit of livelihood security (Crossland *et al.*, 2021). While previous researches have explored farm performance largely in isolation or in relation to staple crop production (Pingali, 2012; Barrett *et al.*, 2020), there remains a gap in understanding the context-specific impact of farm performance among vegetable growers, particularly regarding household nutrition, access to essential services such as healthcare, and income stability (Fanzo *et al.*, 2020).

Smallholder vegetable growers face unique challenges, including significant post-harvest losses, price fluctuations, limited contributions to dietary diversity, and inadequate storage infrastructure due to the perishable nature of vegetables—all of which negatively affect food availability and accessibility (Minten *et al.*, 2020; Reardon *et al.*, 2019; Gómez and Ricketts, 2013). Few studies have explicitly examined the relationships between high-yielding vegetable production and outcomes related to financial and nutritional security (Markelova *et al.*, 2009). Moreover, existing literature often emphasizes yield and input factors, with limited focus on the broader effects of farm performance on farmers' well-being and access to basic services (Jallow *et al.*, 2017; Smith and Haddad, 2015).

To address this gap, the present study investigates the impact of farm performance on household livelihoods in the context of vegetable farmers in Bangladesh. Accordingly, the following hypotheses are proposed:

H6. Farm performance has no covariance with the food security.

H7. Farm performance has no covariance with the health security.

H8. Farm performance has no covariance with the economic security.

2. Methodology

2.1 Research setting, sample and data

Mymensingh district, a major vegetable-producing hub in Bangladesh, had high agricultural productivity, with food production 2.5 times the demand (Islam, 2023). Over 80% of its farmers were engaged in commercial vegetable cultivation, making it a key centre for profit-driven farming and an ideal study area. To conduct the study, a roster of 200 vegetable farmers from three unions in Mymensingh district (50 in Boyra, 94 in Charnilakkhia, and 56 in Bhabukhali Sadarthana) was obtained from the Department of Rural Sociology, Faculty of Agricultural Economics and Rural Sociology, Bangladesh Agricultural University. Using simple random sampling, a cohort of 150 commercial vegetable farmers was selected for the survey. To ensure a truly representative sample, all commercial vegetable farmers in the district had an equal chance of being selected. This was achieved by cross-checking farmer lists with local agricultural offices or cooperatives to include a more comprehensive pool of

farmers. Additionally, the sampling frame was designed to capture diversity in farming practices, land sizes, and economic backgrounds. As a result, the selected sample accurately reflected the broader farming population. This careful selection process ensured that the sampled farmers proportionally represented the broader population of 200 in terms of demographics, farming practices, and other relevant factors.

Data collection was conducted through an on-site survey employing structured interviews, guided by an interview schedule developed with input from local experts at the Department of Rural Sociology, Bangladesh Agricultural University (BAU). The questionnaire underwent a pilot test involving 50 farmers from the study area who were not included in the final sample. Based on the pilot results, necessary refinements were made to ensure alignment with the research objectives. Prior to data collection, farmers were informed that the study was solely for academic purposes and would not impact their farming operations. The interviews were conducted face-to-face by trained local interviewers, who were M.Sc. Students from the Department of Rural Sociology at BAU. These interviewers received comprehensive training on the theoretical and methodological aspects of the study to ensure data accuracy and reliability. Each interview lasted approximately 40 min. Following data collection, the responses were systematically reviewed and recorded in the interview schedules to ensure completeness and accuracy. The questionnaire covered eight key areas: (1) socio-demographic characteristics, (2) farm type, (3) physical attributes and valuation of farm facilities, (4) farm size, (5) entrepreneurial behaviour, (6) farm performance, (7) economic security, and (8) food and health security. The complete methodological sequence of the study, highlighting the significance of each stage and the key activities undertaken at each phase, is illustrated in Figure 2.

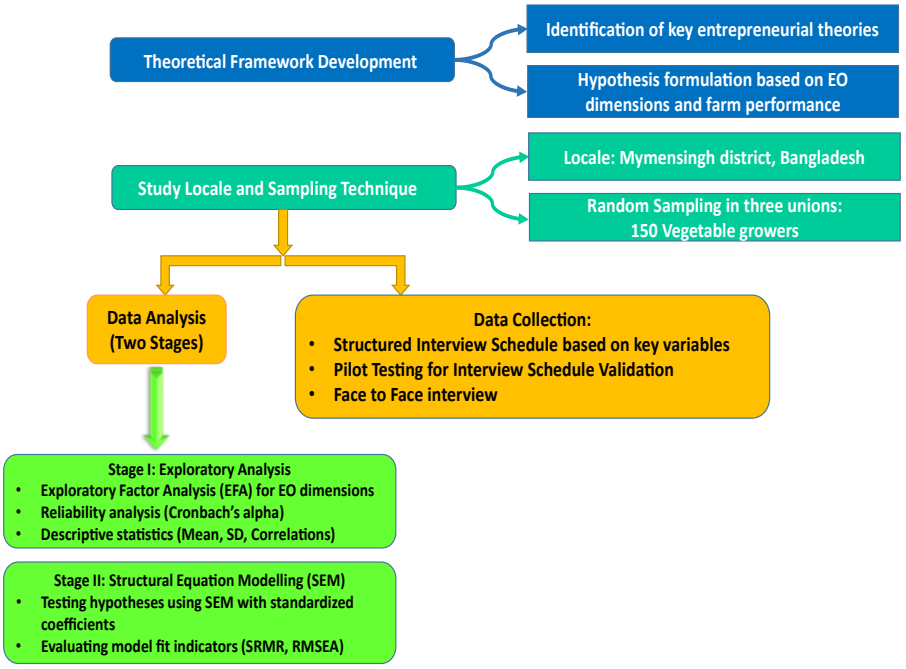

Figure 2. Schematic representation of the methodological framework of the study

2.2 Variables of the model

2.2.1 Food, economic, and health security. The economic, dietary, and health well-being of vegetable producers and their families were assessed using their self-reported perceptions (Mozumdar, 2018). Fifteen key indicators were identified, reflecting three domains: financial security, health security (Lindenberg, 2002), and food security (Coleman-Jensen *et al.*, 2014). Each indicator was measured on a seven-point Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree). The summated score, derived by aggregating these fifteen items, served as a composite measure of the overall food, financial, and health security of Bangladeshi vegetable producers (Supplementary table I).

2.2.2 Farm performance. Farm performance was evaluated using both objective and subjective measures. Objective measures were based on verifiable financial data, including annual profit and total sales, derived from participants' business records. Subjective measures, in contrast, relied on self-reported assessments using rating scales (Zulkiffli, 2014; Mozumdar *et al.*, 2019). In this study, farm performance was primarily assessed through net profit, calculated by deducting total production costs from total sales revenue (Stam and Elfring, 2008) (Supplementary table I).

2.2.3 Entrepreneurial behaviour/orientation. Entrepreneurial orientation (EO) among vegetable producers was assessed using an adapted EO scale (Mozumdar, 2018; Saad, 2019). The scale consisted of twenty-two items encompassing five dimensions: knowledge acquisition, risk-taking, innovativeness, collaborativeness, and proactiveness. Respondents rated each item on a seven-point Likert scale, where 1 = Completely Disagree and 7 = Completely Agree. Exploratory factor analysis was conducted to validate the dimensions of EO within this specific context. The results of this analysis are presented in Table 2.

2.2.4 Control variables. Given agriculture's critical role in ensuring food, financial, and health security, it was essential to account for factors that may influence farm performance. One such variable was entrepreneurial disposition, which was controlled by aggregating current investments in vegetable inventory and the valuation of on-farm facilities (Mozumdar *et al.*, 2020).

Education has been widely recognized as a determinant of farm performance (Coleman, 2007). Accordingly, educational attainment was measured by the highest level of formal education completed by the respondent at the time of the survey. Additionally, the impact of training was captured by measuring the average annual training hours received by farmers, given its known influence on farm productivity and decision-making (Kantor, 2005; Inmyxai and Takahashi, 2010).

Farm experience was measured by the duration of involvement in vegetable farming, as experience is known to shape farm management practices and outcomes (Arregle *et al.*, 2015; Mozumdar *et al.*, 2020). Social networks, also identified as important contributors to farm performance (Welter and Smallbone, 2011; Zoogah *et al.*, 2015), were accounted for indirectly through variables including farm size, age of the farmer, educational level, and training. These four variables, adapted from Mozumdar (2018), were measured using the same seven-point Likert scale format.

Finally, recognizing that vegetable producers' livelihoods often depend on multiple income streams, the study included non-farm income sources (e.g. household income) as an additional control variable. Such income sources can influence farmers' capacity to ensure food, financial, and health security (Mozumdar, 2018; Mozumdar *et al.*, 2023).

2.3 Data analysis

Data analysis was conducted in two stages, utilizing SPSS (version 20) and STATA (version 14). In the first stage, three primary analyses were undertaken: (1) exploratory factor analysis to identify the underlying dimensions of entrepreneurial behaviour among vegetable producers, (2) reliability analysis to assess the internal consistency of items representing latent constructs, and (3) descriptive statistics to summarize the data and evaluate correlations among key variables (Table 1).

Table 1. Descriptive statistics and correlations ($n = 144$)

Variables	Mean	SD	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Farm Performance	37.97	3.70	1													
Knowledge acquisition	5.98	0.984	223**	1												
Innovativeness	4.98	1.107	0.206*	−011	1											
Risk-Taking	4.97	1.126	279**	0.006	011	1										
Collaborativeness	5.20	1.00	299**	−022	001	021	1									
Proactiveness	5.11	1.021	178*	015	004	−001	045	1								
Farm size	56.29	42.38	0.165*	193*	−038	−037	043	086	1							
Farm age	20.77	12.64	121	−091	−106	111	231**	−096	−071	1						
Education	0.79	0.40	−165*	−032	−013	−218**	−231**	190*	008	−170*	1					
Training	0.35	0.48	196*	008	112	203*	−063	135	085	−050	112	1				
Food security	31.92	3.97	488**	474**	152	260**	092	236**	223**	005	−105	150	1			
Economic Security	21.38	2.89	478**	283**	185*	229**	114	204*	142	062	−121	027	612**	1		
Health security	26.19	4.04	274**	304**	−042	206*	177*	192*	155	007	−234**	026	538**	511**	1	
Other sources of income	127209.49	134052.43	−128	092	057	−261**	−081	169*	114	−127	378**	−095	−039	106	−01	1

Note(s): *Significant at $p < 10$ level and SD=Standard Deviation
**Significant at $p < 5$ level

Table 2. Exploratory factor analysis for items of Entrepreneurial Orientation

Items	Entrepreneurial orientation dimension R-T[a] (EO)	KA[b] (EO)	I[c] (EO)	P[d] (EO)	C[e] (EO)
I allocate greater financial resources to ventures with higher profitability potential					
I am willing to take risks in pursuit of greater financial returns	0.78				
When the likelihood of success is high, I am prepared to take calculated risks	0.75				
I invest more in services that demonstrate the potential for higher profit margins	0.71				
I am skilled in managing financial risks effectively	0.70				
I have the ability to undertake calculated risks to capitalize on business opportunities	0.69				
I consistently remain focused on my goals and priorities		0.81			
I continuously learn from the strengths, weaknesses, opportunities, and threats (SWOT) of my vegetable farming business		0.78			
I actively acquire knowledge about internal business operations, including transaction management and vegetable production processes		0.77			
I consistently seek out new techniques to improve and maximize customer relationships through value-added services		0.76			
I regularly focus on understanding the requirements for expanding my vegetable farm		0.62			
I am eager to experiment with new farming methods I have recently learnt			0.75		
I frequently test innovative techniques on my farm			0.74		
I exercise caution when adopting new farming techniques			0.70		
I believe that modern farming methods are highly effective in improving farm performance			0.67		
I actively seek to stay updated on current farming practices and innovations			0.65		
I am capable of anticipating future market demands and making necessary adjustments in vegetable production				0.83	
I respond more quickly to market changes than my competitors				0.76	
I can predict competitor actions and adjust my strategies accordingly				0.76	
I derive satisfaction from selling my vegetables to regular customers and work to maintain strong relationships with them					0.84
I have a strong tendency to collaborate with other vegetable producers					0.81
I have established exclusive arrangements with certain customers for selling my vegetables					0.62

Note(s): Date fit statistics,
Bartlett's test chi-square (d f = 231) = 2355.29 level of significance (p)=<0.01,
KMO: 0.86,
Total variance explained:72.59%,
Factor loading () smaller than 44 is suppressed, [a]R-T: Risk Taking, [b]KA: Knowledge Acquisition, [c]I: Innovativeness, [d]P: Proactiveness, [e]C: Collaborativeness

The second stage involved structural equation modelling (SEM), which was employed to test the hypothesized relationships between food, financial, and health security, farm performance, and entrepreneurial orientation. This model provided insights into the direct and indirect effects of entrepreneurial behaviour and control variables on farm performance outcomes (Figure 3).

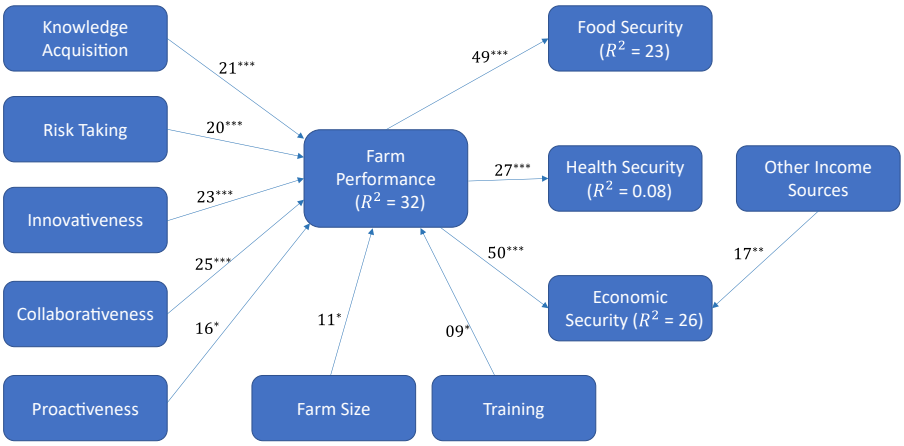

Figure 3. Overview of results of structural equation model

2.3.1 Exploratory factor analysis. This study employed exploratory factor analysis (EFA) to identify and validate the underlying dimensions of entrepreneurial behaviour (EB) among vegetable producers in Bangladesh. EFA was conducted using Principal Component Analysis with Varimax rotation and Kaiser's criterion (eigenvalues >1) to ensure robust factor extraction (Kraus *et al.*, 2012).

A total of 22 items from the survey instrument were included in the analysis, focussing on five core dimensions of EB: knowledge acquisition, risk-taking, innovativeness, teamwork (collaborativeness), and proactiveness (Table 1). Each of these dimensions is recognized in the literature as a key driver of entrepreneurial behaviour (Wales, 2016). Understanding the structure and relative influence of these factors is crucial, as they can impact farm performance in different ways—potentially enhancing or constraining productivity and growth. Moreover, it is acknowledged that the effect of each factor may vary in magnitude and direction across the identified dimensions of entrepreneurial behaviour, reflecting the complexity and context-specific nature of entrepreneurial engagement in the agricultural sector.

2.3.2 Reliability analysis. Reliability analysis was conducted to assess the internal consistency of the items measuring the latent constructs in the study. Cronbach's alpha (α) values were calculated for each latent variable, with the following results: food security ($\alpha = 0.83$), health security ($\alpha = 0.87$), economic security ($\alpha = 0.83$), farm performance ($\alpha = 0.84$), knowledge acquisition ($\alpha = 0.86$), innovativeness ($\alpha = 0.84$), risk-taking ($\alpha = 0.91$), collaboration ($\alpha = 0.85$), and proactiveness ($\alpha = 0.82$). All values exceeded the recommended threshold of 0.70 (Nunnally, 1978), indicating a high level of internal consistency and confirming the reliability of the measurement scales used for the nine latent variables (Supplementary table I).

2.3.3 Structural equation modelling (SEM). Structural equation modelling (SEM) was employed in this study due to its capacity to assess complex relationships, including both direct and indirect causal pathways among variables, and to account for potential mediating effects. Hypothesis testing was conducted using standardized path coefficients within the SEM framework. The analysis was based on a final sample of 144 vegetable producers, drawn from an initial sample of 150 participants. Six cases were identified and excluded as outliers in accordance with the criteria established by Mozumdar and Islam (2022).

To evaluate model fit, multiple indices were considered, with particular attention given to the Standardized Root Mean Squared Residual (SRMR), as recommended by Hu and Bentler (1999). The SRMR, alongside other goodness-of-fit indices, provided a comprehensive assessment of the model's adequacy in explaining the relationships among the latent constructs.

3. Results

Table 3 presents a comprehensive summary of all variables included in the structural equation model (SEM), along with descriptive statistics and bivariate correlations. The average educational attainment among respondents was at the junior secondary level, indicating moderate formal education. The mean farm age of approximately 21 years reflects considerable farming experience. However, despite their experience, participants reported receiving less than one hour of formal training annually on farm performance improvement.

The mean scores for key entrepreneurial behaviour (EB) dimensions were notably high: knowledge acquisition (5.98), risk-taking (4.98), innovativeness (4.97), collaborativeness (5.20), and proactiveness (5.10), measured on a seven-point scale. The average farm size, indicated by actual cultivated land (56.29 decimals), was substantial, further highlighting the scale of vegetable production in the study area.

Additionally, participants demonstrated high levels of household well-being: food security (mean score of 31.92 out of 42), economic security (21.38 out of 24), and health security (26.19 out of 35). These findings underscore the critical contribution of vegetable farming to the food, economic, and health security of producers and their families. The average annual income from non-farm activities was approximately BDT 127,209.49, reflecting the role of alternative income streams in livelihood diversification. Farm performance, assessed through a composite score, averaged 37.97 out of 49, indicating satisfactory overall business outcomes.

Figure 2 visually illustrates the key relationships identified in the SEM, while detailed results are provided in Table 3. The SEM demonstrated an acceptable model fit, with an SRMR value of 0.086, aligning with the criteria for a reasonable fit (Hu and Bentler, 1999).

Hypothesis testing results are summarized as follows:

H1. Entrepreneurial orientation exhibited a positive and statistically significant effect on farm performance ($\beta = 0.21$, $p < 0.01$).

H2. Risk-taking entrepreneurial behaviour demonstrated a direct, positive, and significant association with farm performance ($\beta = 0.20$, $p < 0.01$).

H3. Innovativeness showed a positive and significant relationship with farm performance ($\beta = 0.23$, $p < 0.01$).

Table 3. Model fit summary of structural equation model

Path to	Path from	Coefficient	Z value
Farm Performance EB ($R^2 = 32$)	Knowledge Acquisition	0.21***	3.07
	Risk-Taking	0.20***	3.06
	Innovativeness	0.23***	3.26
	Collaborativeness	0.25***	3.62
	Proactiveness	0.16**	2.35
	Farm Size	0.11*	1.63
	Farm Age	0.09	1.30
	Education	0.07	−0.98
	Training	0.09*	1.31
Economic Security ($R^2 = 26$)	Farm Performance	0.50***	7.99
	Other Source Income	0.17**	2.40
Food Security ($R^2 = 23$)	Farm Performance	0.49***	7.73
	Other Source Income	0.02	0.33
Health Security ($R^2 = 0.08$)	Farm Performance	0.27***	3.57
	Other Source Income	0.02	0.31

Note(s): **Significant at <05 level, ***Significant at <01 level and *Significant at<10 level

H4. Collaborativeness in entrepreneurial behaviour had a direct, positive, and significant impact on farm performance ($\beta = 0.25$, $p < 0.01$).

H5. Proactiveness also displayed a positive and significant relationship with farm performance ($\beta = 0.16$, $p < 0.01$).

Control variables revealed the following patterns:

Farm size ($\beta = 0.11$, $p < 0.05$) and training ($\beta = 0.09$, $p < 0.05$) were positively and significantly associated with farm performance.

Farm age ($\beta = 0.09$, $p > 0.05$) and education ($\beta = 0.07$, $p > 0.05$) did not show statistically significant relationships with farm performance.

Additional outcomes included:

H6. Entrepreneurial behaviour exhibited a strong, positive, and significant effect on food security ($\beta = 0.49$, $p < 0.01$).

H7. Entrepreneurial behaviour showed a significant positive association with economic security ($\beta = 0.50$, $p < 0.01$).

H8. Farm performance was positively associated with health security ($\beta = 0.27$, $p < 0.01$).

Furthermore, entrepreneurial behaviour related to non-farm income sources demonstrated a significant positive relationship with economic security ($\beta = 0.17$, $p < 0.05$), indicating that diversified income streams further enhance household financial well-being. Overall, these findings highlight the pivotal role of entrepreneurial behaviour and farm performance in improving the food, economic, and health security of Bangladeshi vegetable producers, emphasizing their contributions to rural socio-economic development.

4. Discussion

This study aimed to advance understanding of how entrepreneurial orientation (EO) among vegetable farmers enhances farm performance and contributes to food, economic, and health security in Bangladesh. By employing an EO framework and integrating theoretical perspectives, the study developed a structural model that captures the relationships between farm performance and key dimensions of household security. Through this approach, the study offers deeper insights into how EO and farm performance function as critical drivers of livelihood sustainability for vegetable farmers operating in challenging environments.

The analysis treated EO as a multidimensional construct, incorporating key entrepreneurial traits: knowledge acquisition, risk-taking, innovativeness, collaborativeness, and proactiveness. Several notable findings emerged. Knowledge acquisition demonstrated a direct and significant positive relationship with farm performance ($\beta = 0.21$, $p < 0.01$), explaining a substantial proportion of its variance ($R^2 = 0.32$). This underscores the importance of continuous learning and information gathering in strengthening entrepreneurial competencies and farm-level outcomes.

Risk-taking behaviour ($\beta = 0.20$, $p < 0.01$) also had a direct, positive effect on farm performance, highlighting its critical role in enabling vegetable farmers to navigate uncertainties and seize emerging opportunities. Likewise, innovativeness ($\beta = 0.23$, $p < 0.01$) was significantly associated with improved farm performance, suggesting that the adoption of new technologies and cultivation methods directly enhances agricultural productivity and income.

Collaborativeness ($\beta = 0.25$, $p < 0.01$) emerged as the strongest EO dimension influencing farm performance. This finding highlights the value of cooperative relationships, knowledge sharing, and integration of diverse agricultural practices in achieving superior outcomes. Additionally, proactiveness ($\beta = 0.16$, $p < 0.01$) significantly contributed to farm performance, suggesting that forward-thinking farmers who anticipate market needs and adjust strategies accordingly are better positioned to improve livelihoods.

The influence of EO on broader economic outcomes was also evident. Farm performance had a substantial positive effect on economic security ($\beta = 0.50$, $p < 0.01$), underscoring the role of entrepreneurial initiatives in strengthening household financial resilience. When compared with income from alternative sources ($\beta = 0.17$, $p < 0.05$), farm performance was found to be a more dominant contributor to economic security. This finding aligns with prior research demonstrating the positive link between EO and farm performance (Mozumdar, 2018; Mozumdar *et al.*, 2020; Wiklund and Shepherd, 2005). In line with contingency theory, farmers with strong EO are more capable of adapting to changing conditions and capitalizing on opportunities, even in volatile environments (Wiklund and Shepherd, 2005; Mozumdar *et al.*, 2020).

The relationships between control variables and farm performance further illuminate the factors driving agricultural success. Farm size ($\beta = 0.11$, $p < 0.05$) showed a positive effect, suggesting that larger farms benefit from economies of scale, improved bargaining power, and access to higher-quality inputs (Manyise *et al.*, 2023; Prah *et al.*, 2025). Similarly, training ($\beta = 0.09$, $p < 0.05$) was positively associated with farm performance, indicating that capacity-building interventions by agricultural agencies play a critical role in the dissemination of sustainable farming practices (Pandey *et al.*, 2024).

The role of social and professional networks also emerged as significant. Network ties provide vital access to resources, financial support, technical knowledge, and market intelligence, all of which enhance farmers' resilience in adverse conditions. Informal collaboration among farmers helps them adapt to dynamic markets and unfamiliar challenges, reinforcing the importance of collaborative entrepreneurial behaviour observed in this study.

Beyond farm performance, EO exhibited a significant and positive effect on both food and economic security, highlighting its broader role in improving household well-being. Farm performance itself was found to be a key determinant of food, economic, and health security, reinforcing its central role in the rural socioeconomic landscape.

Overall, the findings suggest that entrepreneurial orientation and the resulting farm performance are central to the livelihoods of Bangladeshi vegetable farmers. In developing country contexts, where institutional support is often limited, EO enables farmers to harness informal networks, capitalize on economies of scale, and diversify income sources. This approach not only enhances profitability but also improves resilience against environmental and market shocks. The benefits of scale and diversification within integrated agricultural systems reduce transaction costs, expand market reach, and enable resource optimization.

In conclusion, this study provides a comprehensive understanding of how EO influences farm performance and contributes to key dimensions of food, economic, and health security among vegetable farmers in Bangladesh. The findings emphasize that fostering entrepreneurial behaviour—through knowledge development, risk management, innovation, collaboration, and proactive engagement—can significantly enhance agricultural productivity and rural livelihoods. These insights are particularly valuable for policymakers, development agencies, and agricultural extension services seeking to design targeted interventions aimed at strengthening entrepreneurial capacities and securing sustainable farming futures.

5. Conclusions

This study provides robust empirical evidence on the pivotal role of entrepreneurial orientation (EO) in enhancing farm performance and its subsequent impact on food, economic, and health security among Bangladeshi vegetable farmers. The findings demonstrate that all five EO dimensions—knowledge acquisition, risk-taking, innovativeness, collaborativeness, and proactiveness—are positively and significantly associated with farm performance. Among these, collaborativeness exerted the strongest influence, underscoring the critical importance of social and professional networks in driving agricultural success.

Farm performance emerged as a key determinant of food, economic, and health security, reinforcing the idea that higher agricultural productivity directly translates into improved

livelihoods and well-being for farming households. The results also highlight that entrepreneurial behaviour significantly contributes to economic security, with farm income serving as a more substantial driver of financial stability than alternative income sources. This suggests that fostering entrepreneurial capacity among farmers can serve as a strategic tool for rural economic development and poverty alleviation.

The study further emphasizes that EO-driven farm performance enhances farmers' access to food and healthcare, demonstrating the far-reaching socio-economic benefits of cultivating an entrepreneurial mindset in agriculture. From a policy perspective, these findings call for concerted efforts by governments, development agencies, and academic institutions to design and implement targeted interventions. Training programs aimed at promoting modern agro-technologies, improving risk management capabilities, and strengthening market linkages will be essential. Furthermore, initiatives that encourage innovation and facilitate strategic collaboration among farmers can catalyze sustainable agricultural growth and contribute to national and regional food security. Beyond the Bangladeshi context, this research holds broader implications for smallholder farming systems in other developing economies facing similar agricultural and socio-economic challenges. Strengthening EO within farming communities can be a scalable strategy for improving global food security, fostering rural economic development, and enhancing public health outcomes.

Nevertheless, this study acknowledges certain limitations. The reliance on self-reported data may introduce potential biases, and the geographic focus on Bangladeshi vegetable farmers may restrict the generalizability of findings. Future research should employ longitudinal designs, objective farm performance metrics, and cross-country analyses to validate and expand upon these results. Additionally, examining the socio-psychological dimensions of food and nutritional security could enrich understanding of how EO influences long-term sustainability in agriculture. In conclusion, this study underscores the transformative potential of entrepreneurial orientation in smallholder farming systems. By strengthening EO within farming communities, policymakers and stakeholders can unlock substantial gains in farm productivity, household resilience, and overall quality of life. Ultimately, entrepreneurial strategies in agriculture represent a critical pathway toward achieving sustainable development, economic stability, and improved well-being for smallholder farmers in Bangladesh and beyond.

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Supplementary material

The supplementary material for this article can be found online.

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