

Mediating agricultural entrepreneurship through embracing innovative technology:

A tale from small rural enterprises in an emerging economy

Purpose: The study evaluates small marginal farmers' (SMFs) potential behavior, attitude and trust in the adoption of innovative emerging technologies.

Design/methodology/approach: The study employed an agile multi-factor approach to conceptualize a digital marketplace to connect a supply chain ecosystem for stakeholders.

Findings: The empirical findings suggest that most SMFs are willing to embrace innovative technologies. Nonetheless, they lack the necessary technological oriented education, training and funds to innovate. However, their reluctance to adapt changes is attributable to their fear of losing past customs and practices; they were threatened by the reaction of intermediaries (*arthyias*) to the adoption of technologies, which could result in them suffering huge losses.

Originality/value: This innovative disintermediation business model has a significant potential to reduce information asymmetry, cost and hoarding – and can thus increase the SMFs' profit margins. Agricultural technological innovations have a profound potential to impact their supply chain logistics positively by reducing the wastage of perishable food and thus enhancing the consumer experience.

- 1. Keywords:** *Farming, innovative technology, intermediaries, small and marginal farmers, India,*

Introduction and background

Indian agriculture remains vital for food security and employment and, further, as a major economic sector, it is an essential tool for poverty reduction (Gulati and Juneja, 2022; Sandhu and El-Gohary, 2022; Sandhu and Hussain, 2021). However, over recent years, the contribution of agriculture towards India's gross domestic product (GDP) has declined substantially from 53% (1950) to 18.6% (Reserve Bank of India (RBI), 2022). The decline in the share of agriculture is due to large-scale migration to cities, and a lack of access to modern technology, irrigation and energy in India's rural areas (Kant and Kanda, 2019; Randhawa *et al.*, 2022). The agriculture sector in Western economies, such as the United Kingdom (UK) (Bowen and Morris, 2019; Bowen and Morris, 2023), and emerging economies, such as India, are both constrained by inadequate internet connectivity that adversely impacts on their productivity and access to markets. Therefore, lags in the adoption of innovative farming technologies and techniques limit their productivity, growth and revenue optimization (*ibid*). The lack of access to information and communication technologies (ICT) and low levels of literacy amongst rural populations also both constrain the adoption of innovative farming practices for crop production and livestock husbandry (Gittins *et al.*, 2020; McElwee and Smith, 2012), although livestock is not the focus of this study. Whereas in the Indian context, ICT is embraced by wholesalers (*arthyias*) and consumers, the lack of ICT adoption amongst small and marginal farmers (SMFs) will further disadvantage the agriculture sector in India. Nonetheless, the adoption of technology can enhance productivity, create high value jobs and enable farmers to pursue sustainable livelihoods. Market and technological imperfections cause economic welfare losses that can adversely affect farmers' livelihood and their contribution towards GDP, as well as issues such as perishability (Yu and Nagurney, 2013) and the distribution system that impacts its quality, cost and the shelf life of produce.

The study investigates the existing agricultural market structure of the Indian Punjab that lacks optimal internet connectivity and an awareness of its use for agricultural purposes due to the lack of techn(olog)ical education amongst farmers. The novelty of this study is that it proposes a conceptual digital marketplace solution to establish a new supply chain ecosystem for both farmers and buyers. At a general level, the entrepreneurial process involves ‘why’, ‘when’ and ‘how’ opportunities are recognized and exploited (Shane and Venkataraman, 2000). Drawing on these scholars’ definition, the authors explore the presence of entrepreneurship within the agricultural sector in India. Thus, the motivation of this study is to examine how digital trading platform technologies enable farmers to exploit opportunities to benefit in terms of reducing waste and enhancing the network to optimize their financial gains. The study contributes towards an underexplored area of small rural farmers’ use of ICT to optimize their productivity and realize their full market value by using product and pricing information. The use of technology may enable farmers to bypass *arthyias* (middlemen) that enables them to realize higher returns and have a better control of their production, marketing and distribution. Farmers in the Indian Punjab are exploited by middlemen through market manipulation that impacts on their returns. Farmers perceive that they do not realize the full market value of their produce. Thus this study investigates small rural farmers’ perceptions, practices, actual or perceived barriers, regarding the adoption of innovative technologies to mitigate the negative role of *arthyias*.

To achieve its aim, the study applies the Theory of Planned Behavior (TPB) and the Theory of Trust (ToT) to analyse farmers’ behavioral and psychological traits. The study examines the use of emerging technologies in the production and marketing of their produce. This novel exploratory study is the first of its kind which the authors are aware of that examines the market structure of farming by applying psychological and sociological theories to the farming sector in the Indian Punjab.

The communities embedded within the agricultural sector have a strong association with the landholdings. Historically, land has not been viewed as a pure investment, but the norm is to maintain the land as an asset within the families. Farmers did not question the role of *arthiyas*, or their excessive exploitation. However, with their improved education and awareness of the external environment through social media and internet technology, changes in social norms have occurred. There is now a greater national and international connectivity that has raised their awareness of the true value of the produce and historical exploitation of the *arthiyas*. The agriculture sector is central in all economies and has multifaceted connections to all other industrial sectors (Elkafrawi *et al.*, 2022), such as the political, social, cultural, legal and general economic environment of the country (North and Smallbone, 2006; Saxena, 2012). The theory of planned behavior (TPB) and the Theory of Trust (ToT) captures the social behavior of rural India, which is different from urban India. Large swathes of Punjabi farmers experience an educational gap, as well as limited access to internet connectivity in comparison to the urban India; this deficiency limits farmers' ability to fully engage with the complex and developing interactions with the improved information flow. The existing structure makes it difficult for farmers to sell their produce directly or indirectly to the wider customer base. However, the emergence of technology has led to an improvement in information flows that has brought about changes in the relationship between customers, farmers, and *arthiyas*/wholesalers. Farming in the rural context can benefit from the adoption of technology to enhance both consumers' and producers' connectivity through the adoption of digital trading platform technologies. Although farmers in the Indian Punjab have a competitive advantage in the production of crops, they are constrained by access to ICT, which supports prior findings on entrepreneurship in the UK farming sector (e.g. Gittins *et al.*, 2022). The next section considers the empowerment that technology can enable in the Indian agriculture sector, resulting in the conceptual digital marketplace model.

2. How could technology empower the agriculture sector in India?

The Indian agriculture sector has been subject to major structural change and the acceleration of technology over several decades, and has experienced several transformations, (Sandhu *et al.*, 2023). However, a lack of adequate funds restricts SMFs from utilizing quality seeds, pesticides, chemical fertilizers, or from adopting appropriate tools and technology for irrigation, predicting climate, leading to both reduced yields and net profit margins (Sandhu and Hussain, 2021). As the world population increases alongside various regional conflicts, there is a growing concern about food security and the importance of agriculture. Thus, it is imperative to reform the sector through adapting digital technologies to maximize yields but, simultaneously, to improve the efficiency of distribution and preservation, and to ensure connectivity between the key stakeholders (producers, distributors and consumers). Indeed, a digital trading platform enables ‘just in time’ connectivity. This approach means that farmers can harvest produce in a timely manner depending on the needs of consumers, thus reducing wastage of perishable foods. In addition, by using a digital trading platform, farmer have the potential to realize market prices and thus increase their revenue. With increased internet access and computer literacy, especially via smartphones, SMFs can compete with larger and dominating wholesalers by bypassing middlemen and accessing consumers directly (Sandhu *et al.*, 2023).

The emergent literature suggests that agricultural production can be sustained by employing modern techniques and technologies to optimize the sector’s full potential. A digital trading platform can augment agricultural approaches to modernize small and marginal farmers since it improves their revenue, access to information technology (IT) and literacy (Sandhu and Hussain, 2021).

2.1 Innovative technologies and their significance for the agriculture sector

Indian agriculture techniques and technologies are outdated since farmers remain heavily reliant on traditional farming practices, such as using wooden ploughs, hand-planting and harvesting (Shah, 2022) and such practices need to be improved to cater for the modern interconnected world. However, Indian farmers experience a unique and contrasting environment where, on the one hand, their wooden ploughs continue to be used whilst, on the other hand, modern technology that is at par with the United States and Europe are used. Undoubtedly, it is a parallel universe that is more intriguing where development is sporadic.

A plethora of studies have examined structural constraints in the Indian agriculture sector, as well as farmers' access to finance and the impact of information asymmetry (Gulati and Juneja, 2022; Sandhu and Hussain, 2021). However, a rather limited literature examines: (a) market imperfections; (b) underperformance; (c) exploitation by intermediaries that threaten food security; and (d) the impact of migration into urban areas, especially cities. The digital trading platform has the potential to innovate and to address market supply chain imperfections. The interconnectedness between agricultural production and distribution ensures the optimal utilization of innovative technologies to enhance productivity and manage the supply chain (Gulati and Juneja, 2022), which leads to higher financial gains and reduces wastage. This enables farmers to raise appropriate finance for the acquisition of technology, seeds and fertilizers. Hence it can be hypothesized that:

H1: Innovative technologies positively impact farmers' ability to access adequate finance and synchronize all stages of production.

2.2 Innovative technologies and the transformation of the agriculture sector

The agriculture sector, due to its market imperfections, continues to underperform (Jena and Bardhan, 2019;), especially in India. Further, the dominant position of *monopolistic* intermediaries now threatens food security and acts as a ‘push’ factor for outward migration. The existing agricultural supply chain system – as depicted in Figure 1 – comprises suppliers (farmers), intermediaries (agents, wholesalers, distributors, groceries) and buyers (end consumers) (Negi and Anand, 2015), and it demonstrates how intermediaries connect buyers and sellers. Malpractice from the dominant position of *arthiyas*/middlemen causes shortages and the exploitation of consumers. Figure 1 also demonstrates interconnectedness and supply chain complexities; it negatively impacts farmers’ profit margins and delays their harvesting and distribution of perishable goods, resulting in wastage. Sandhu *et al.* (2015) address how intermediaries manipulate market operations and suggest that there is a need to directly connect buyers with sellers. Thus the revised system will reduce information asymmetries and enhance transparency to empower farmers and enable buyers to access farming goods at a fair price. The proposed model illustrated in Figure 2 shows how a digital trading platform might connect buyers with sellers by providing direct connectivity between them to enhance transparency and improve the flow of information.

Please insert Figures 1 and 2

2.3 Digital technology: a transformational tool

Digital technology enables the development of a distributed ledger (encrypted) system based on peer-to-peer protocols to exchange data and information among multiple parties. This innovation cuts out the commission seeking market intermediaries. The proposed model provides security, transparency, price optimization and free farmers from the control of intermediaries/*arthiyas*; eradicating issues related to trust. The intermediaries used for

processing transactions (buying and selling) (Leg 1, Leg 2, and Leg 3 in Figure 1) could be amalgamated into Leg 1 (Figure 2) from the process to enhance efficiencies and reduce costs. The proposed digitally encrypted platform offers information sharing, security and pricing transparency to enable farmers to maximize their return. The financial data generated will improve the long-lasting issue of information asymmetry when accessing finance from the external lenders.

3. Theoretical perspective, research model and hypotheses development

This study examines farmers' potential behavior, attitudes and trust towards the adoption of innovative emergent technologies, thereby integrating the TPB and ToT. Prior studies have applied the TPB and ToT within different settings and disciplines (Baixauli-Soler *et al.*, 2021; Hagger *et al.*, 2022; Sandhu and El-Gohary, 2022). Farmers in the Punjab are characterized by their close-knit communities, where information flows and trust are key resources. However, the scope of examining social capital is beyond this study, yet it will provide a valuable insight. Figure 3 depicts the conceptual model designed to facilitate an understanding of attitudes, behavior, trust, and resources (i.e. the availability of finance) influencing a farmer's decision and willingness to adopt innovative technologies in the digital agricultural market.

3.1 The Theory of Planned Behavior (TPB)

The TPB explains the psychological causes of decision-making and postulates that people make rational decisions to engage in specific behaviors (Ajzen, 1991). The TPB has been used widely in entrepreneurship research. Although the extant literature has not integrated the psychological traits of farmers and trust in technology adoption, Ajzen (1991) claims that intention can be a good predictor of an actual decision, although this is rarely also tested.

3.1.1 Behavioral attitudes and intention

The TPB envisages that behavior is predicted by the behavioral intentions of individuals to determine their proximate or immediate behavior and decisions (Ajzen, 1991; Sandhu and El-Gohary, 2022). Behavioral intentions reflect motivations and cognitive planning for behavior. Intention is often determined by attitudes, subjective norms, and perceived behavioral control (Ajzen, 1991). However, subjective norms (Kumar and Smith, 2018) and perceived behavioral control are considered the weakest antecedents of intentions. These constructs have thus been omitted from this study. However, these constructs could be examined in future research. Therefore, the focus of this study is upon the attitude of farmers towards the use of innovative practices. Nevertheless, the behavioral intentions of farmers to use technology positively affect their attitude and associated outcomes.

***H2:** Behavioral attitudes to use the digital agricultural market for farming operations are positively associated with a farmer's intention to adopt innovative technologies.*

3.1.2 Perceived benefits

To explain farmers' endogenous rewards in terms of time, revenues and cost, the proposed model includes perceived benefits. The adoption of potentially disruptive digital innovations is growing in demand due to their convenience, flexibility, cost and time-efficient transactions (Bangkit *et al.*, 2022; Kim and Adler, 2015) and the agriculture sector is no exception. Prior evidence suggests that the expectation to gain benefits has positively influenced and holds a favourable attitude toward performing the behavior (Kim and Adler, 2015).

Therefore, it is expected that the potential perceived benefits to be realized by adopting innovative technologies to promote disintermediation and to develop lean market structures would encourage farmers to have a more favourable attitude towards the digital trading platform for the agricultural market. Thus:

***H3:** Perceived benefits would positively affect a farmer's attitude towards the adoption of a digital trading platform.*

Please insert Figure 3

3.1.3 Perceived risk

The agriculture sector is complex, uncertain and risky as it is environment-dependent, including external markets. Thus, decision-making within the agriculture sector is dependent upon the behavior of farmers (Lin, 2008), as well as their availability and access to resources. It is expected that perceived risks, such as acceptance by family members, knowledge barriers, ICT literacy, or associated costs, would discourage farmers from adopting favourable attitudes towards the digital agricultural market or innovative technologies. Therefore, the benefits of adopting a digital trading platform should outweigh the costs for consumers and producers/farmers to embrace innovative technologies for a progressive market structure.

***H4:** Perceived risk negatively affects a farmer's attitude towards the adoption of a digital trading platform.*

3.1.4 Attitude

The main factors determining an individual's attitude towards using technology are contingent upon the perceived benefit, or perceived risks, as stated above. When an individual holds a positive attitude about a particular behavior, it positively affects his or her intention to perform a particular act and that intention subsequently impacts upon an individual's actions and performing a behavior (Ajzen, 1991). Therefore, it is expected that farmers' attitudes towards adopting innovative technologies are evaluated purely quantitatively to identify gains and the associated costs that directly impact upon the intention to adopt the digital agricultural market. Hence it is hypothesized that:

***H5:** A farmer's attitude towards the adoption of the proposed digital trading platform would positively affect his or her intentions to adopt innovative technologies.*

***H6:** The attitude to use innovative technologies positively affect a farmer's use of the digital trading platform for the agricultural market.*

3.2 The Theory of Trust (ToT)

This study uses the ToT, along with TPB, that conceptualizes trust as a belief, expectation, and willingness of the trusting party in transactions. Trust plays a significant role in the decision-making process, thus individuals need to trust the product, system, or service they are intending to acquire and use judgement to confirm whether it is genuine (Nuttavuthisit and Thøgersen, 2017). In practice, Punjabi farmers rely much more on an informal exchange of information (social capital) about the adoption of new techniques or technologies. Therefore, this study builds on the role of trust and social capital to promote the adoption of technologies. Therefore,

it is expected that trust in the adoption of technology can affect farmers' attitudes to adopt the digital technologies:

***H7:** The ability to trust technologies positively affects a farmer's attitude towards the adoption of the digital trading platform.*

3.2.1 Competencies

Prior studies (McElwee and Smith, 2012; Zayadin *et al.*, 2022) posited the value of key competencies to enhance value creation. Individuals can manage the innovation process by deploying acquired suitable skills and competencies enabling a party to influence them within some specific domain. Individuals with relevant skill sets are likely to renew their business competencies to respond to development and to produce change to gain a competitive advantage (Bryson *et al.*, 2015). This study has investigated how farmers' ability to use technology is positively related to developing their trust of the system and encouraging farmers to adopt innovative technologies. Thus:

***H8:** Competencies to use technology positively affect a farmer's trust and intention to adopt the digital trading platform.*

Building on a prior study (McElwee and Smith, 2012), the conceptual framework specifically relates to Indian farmers and bridges a gap between Western countries and emerging economies. It introduces the application of IT to enhance connectivity between farmers and end users with the use of the digital trading platform framework.

4. Methodology and research design

This study employs a mixed methods approach and builds on the methodology of earlier studies on small and medium-sized enterprises (SMEs) in general and SMFs in particular (McElwee, 2022; Sandhu and Hussain, 2021;). Entrepreneurship research adopts diverse methodologies, but relatively few studies specifically address the agriculture sector (Bowen and Morris, 2023). The broader approaches used in the farming literature mirror the mainstream literature. However, rural entrepreneurship in India (or, for that matter, elsewhere) is a distinct sector as it is operated by successive generations who occupy their native place. This study specifically examines the constraints related to slacks in operations, the connectivity between farmers and buyers by deploying TPB and ToT as theoretical lenses. Although the TPB has been mainly adopted in multidisciplinary research – such as psychology and sociology – it also lends itself to the methodological approach in this study where the authors examined SMFs’ behaviors and attitudes to changing technologies, the market and the environment within which they operate (Baixauli-Soler *et al.*, 2021; Hagger *et al.*, 2022; Sandhu and El-Gohary, 2022). The farmer’s ecosystem is complex, and is intertwined with human behavior and the vested interest of multiple stakeholders. To examine the intentions of farmers to adopt technologies, the authors draw upon some elements of the TPB: intention as a predictor of farmers’ attitudes to act. Second, they draw on ToT, a novel approach to explain the potential behavior, responses and adoption of digital trading platforms by SMFs.

To achieve the desired outcome, the study employed an agile multi-factor approach to conceptualize a digital marketplace to connect the proposed supply chain ecosystem for stakeholders. To operationalize the approach, 110 farmers, 5 buyers and 10 intermediaries from the Indian Punjab region participated in the study. The study was conducted in three stages. First, the authors investigated the current, existing processes and practices employed by farmers in their supply chain. Second, the conceptual digital trading platform model was

developed. Third, the proposed model was shared with farmers and end users to seek their views, perceptions, acceptability, and its feasibility. Given the complex socio-economic factors surrounding farming communities, it is considered imperative to triangulate quantitative and qualitative approaches to gain a deeper insight of the evolving market structures to respond to the changing technologies, markets and environment.

The study used a purposive sampling approach augmented by personal networking. The researchers were mindful of the possible bias and endeavoured to mitigate personal biases or influences to develop questions that avoided the personalities of the interviewer. The qualitative data was collected through semi-structured interviews (using a self-administered questionnaire), and two focus groups (with five participants each) to capture their experiences, attitudes and beliefs (ex-ante proposal). The self-administered questionnaire included open- and closed-ended questions along with a five-point Likert scale developed to measure farmers cognitive and behavioral characteristics to adopt innovative technology or the digital trading platform for the agricultural supply chain system. Therefore, initially, a questionnaire was distributed to 250 farmers and, after persistent persuasion, 130 were returned. 20 of 130 responses were discarded due to incomplete information: a response rate of 44 per cent, which is within the acceptable range (Scandura and Williams, 2000). Hence a t-test was conducted to assess the non-response bias (Tsou and Hsu, 2015). To reduce the possibility of unintended bias, the data sources were triangulated by conducting face-to-face in-depth interviews with 110 participants in person .

The proposed model was shown to the respondents and explained in Punjabi by one of the authors (who is of Punjabi origin). The proposed model is included in the paper as Figure 2. The questionnaires were translated and implemented in the Punjabi language. Each interview lasted between 30-50 minutes and the recorded interviews were transcribed. These transcripts were further coded to prepare for the qualitative data analysis. Hence relevant themes were

derived using NVivo to assist in categorizing and mapping the patterns of the captured data. The findings of the qualitative analysis are, therefore, reported in the next section to compare and contrast these findings with the quantitative results.

5. Results

Descriptive analysis and structured equation modelling (SEM) were used to evaluate the proposed research questions and hypotheses. SEM has been extensively employed within social science to explore complex structural interrelationships (Tsou and Hsu, 2015). SEM aims to extend factor analysis and evaluate substantive theory using empirical data (Sinharay, 2010). In this study, the justification to use SEM is that the study tests the interplay between TPB and ToT using the empirical data for farmers in the Indian Punjab. The research design adopted provides a deeper insight between competing and contrasting behaviors of farmers when they interact with technologies and human practices whilst making complex decisions.

5.1 Reliability and validity

Cronbach's alpha was used to assess the internal consistency of each construct (Gliem and Gliem, 2003) and Composite Reliability. All constructs had a high alpha value for the multi-item constructs ranging from 0.92 to 0.80 and composite reliability (CR) ranging between 0.96-0.88 (Gliem and Gliem, 2003; Sandhu and El-Gohary, 2022; Taber, 2018). Moreover, Average Variance Extracted (AVE), was also applied to evaluate the validity of each construct, showed that all values were greater than the recommended value of 0.50 (Hair *et al.*, 2006).

Please insert Tables 1 and 2

5.2 Supply side: Socio-economic characteristics

The demographics of the 110 respondents – their (1) age, (2) gender, (3) qualifications, (4) occupation, (5) land size and (6) landholdings status (Table 1) – revealed, first, that: 23 per cent were aged between 31-40 years old, 27 per cent were 41-50 years old, 18 per cent above 51 years old, while 22 were younger than 30 years old.

Second, 32 per cent were women and the remaining 68 per cent were men; indeed, the data is reflective of the gender mix of the population engaged in agriculture in the Indian Punjab (Sandhu and Hussain, 2021; Sandhu *et al.*, 2023). It was observed that, out of 32 per cent, only 7 per cent of women respondents owned land. These were widows with no sons or other surviving family members. The remaining 25 per cent were farmers since the family's male(s) went abroad for jobs or to earn a livelihood. When were asked about their intention to adopt innovative technology, women with surviving males in their households clearly stated: *'I cannot make this decision. Only my husband and son can decide what they want.'* Some women said, *'We do not have enough funds to avail all these facilities.'* They also added, *'I will prefer going to arthyias as they can arrange buying/selling of produce for me. We always take our produce to them.'* When the same was asked of their male counterparts, they also stated, *'We are associated with our arthyias for generations.'*; *'I won't like to go anywhere else as arthyias financially help us in a time of need'*; and *'We can take an advance from arthyias, [because] these technical machines are not going to help us during an emergency.'*

Third, 18 per cent had a basic level of education or under; less than 29 per cent had a bachelor's degree; 25 per cent had a bachelor's degree and above; while 18 per cent had a professional qualification. Fourth, 45 per cent stated that farming was their main occupation. A further 32 per cent of farmers were also involved in allied services such as dairy or poultry to supplement their earnings, while 23 per cent were part-time farmers to help their elderly siblings or parents along with their main full-time employment.

Qualified youngsters, who were not directly linked with farming, showed enthusiasm and willingness to adopt technologies to increase their farming input (70 per cent). However, the elderly farmers were reluctant because of unwillingness to trust, '*the new system and give up their old practices*'. In terms of entrepreneurial or IT training, only 23 per cent had some training, while the remaining 77 per cent never had any vocational training.

The assertion that IT access is universal is contestable. There is wider access to the internet and smartphones amongst SMFs. However, their IT literacy has been reported in the study to be a concern. The analysis undertaken using quantitative and qualitative approaches suggests that both access to ICT and levels of literacy are sporadic and remain a problematic issue. The farmers understood the benefit of 'just in time' connectivity that enables them to optimize their yields and revenues. The need to develop and establish an experimental digital trading platform can evaluate the farmers' experiences and test acceptance. However, operationalizing the digital trading platform is beyond the scope of this study.

The analysis of responses from farmers revealed that a lack of competencies impacted farmers' decision-making; some respondents reported that: '*they do not know anything about technology or the internet*'; and some stated that, '*they won't be comfortable using technology as unknown people can take away their money as they have heard about so many internet scams in the news.*'

5.3 Supply side: Perceived behavior of farmers

By applying a behavioral structural model, farmers' perceptions and the reality were tested. The findings reported in Figures 3 and 4 draw upon the hypotheses formulated from the literature review in Section 3. In this analysis, farmers' perceptions were tested using SEM, an approach extensively applied in other studies (e.g. Sandhu and El-Gohary, 2022). The

behavioral structural model tests the hypothesized relationships between various constructs (Sandhu and El-Gohary, 2022) to gain an insight into the interplay between competing and contrasting behaviors of farmers when they interact with technologies and human practices when they are making complex decisions.

Please insert Figure 4

Behavioral intentions ($\beta= 0.185$, $p<0.001$) and attitudes ($\beta= 0.323$, $p<0.001$) to use the digital trading platform and the ability to trust ($\beta= 0.222$, $p<0.001$) were detected to have statistically significant relationships with farmers' attitudes towards the adoption of innovative technology and the digital trading platform. It was also found that farmers with competencies ($\beta= 0.375$, $p<0.001$) were able to trust the digital supply chain system and also have behavioral intentions ($\beta= 0.315$, $p<0.001$) to use innovative technologies. Perceived benefit, however, has shown a statistically higher significance ($\beta= 0.455$, $p<0.001$) than other constructs, while perceived risks showed a significant negative relationship ($\beta= -0.151$, $p<0.001$) with farmers' attitude towards the adoption of innovative technologies.

Interestingly, Table 2 also revealed that farmers were willing to use technology in the form of machinery. However, they were hesitant to use it for '*buying and selling*'. Some of them stated, '*we are happy to buy new machines or any technology that can help to increase our production but cannot take risk of trading it through net.*' However, in terms of resources, the availability of finance ($\beta= 0.250$, $p<0.001$) has a significant positive effect on farmers' attitudes to adopt innovative practices. Farmers' attitude to adopting innovative technologies was explained by factors such as behavioral, trust and resource constructs, as their total variance were explained by all these factors (32.1 per cent ($R^2=0.321$)), whereas their adoption enabled the digital trading platform (38.5 per cent ($R^2=0.385$)).

5.4 Demand Side

Inductive thematic analysis revealed the following findings from the semi-structured interviews conducted with buyers.

Ease of use: 75 per cent of buyers reported being ‘comfortable’ using technology, much higher than expected. There was also a higher familiarity with computers and their use. Respondents reported a high ability and willingness to adopt technology. Moreover, most respondents (73 per cent) saw the adoption of a digital trading platform to execute transactions in a timely fashion. They liked the idea of ‘click and order’ whenever and whatever they need, and hence do not have to *hoard products or tie capital*. Thus, they can release capital for alternative purposes earlier.

Product quality: However, 3 out of 5 of respondents expressed their concern about the quality of the produce. They stated, ‘*We won’t be aware of the quality of the product,*’ ‘*we would like to see the product before buying*’, and ‘*what if products provided are not fresh then who will take guarantee*’, etc.

Prices: In terms of product prices, 2 out of 5 participants believed they can know the market price adjustment in a timely manner and can control prices and ‘*appreciated the transparency, which this digital market will bring.*’ Participants who were interested in adopting the digital trading platform were mainly owner-managers buying vegetables or fruit for their restaurants. The remaining three were managers who were less excited about buying products directly, which may be because of the commission they receive from intermediaries when placing orders. Further, they widely accepted that intermediaries often colluded with purchasing managers. Nonetheless, participants were aware of a greater usage of technology and the potential benefits of direct buying. The proposed digital market could potentially reduce information asymmetry, enhance profitability and empower consumers and farmers.

5.5 Intermediaries

When intermediaries were approached and briefed about the research and the proposed conceptual digital market, 5 out of 10 had mixed reactions. Of a sample of 10, 5 *arthiyas* were also farmers. On the one hand, they believed that technology can help farmers and, on the other hand, they had a fear of its negative impact on their business. The remaining 5 intermediaries were not from farming backgrounds and were representative of the industry. They believed that farmers would be reluctant to engage with technology or would not have the ability to undertake transactions themselves. One of them said: *‘this idea won’t work here. It can work in foreign countries’*; and, *‘Indian farmers take money from us even before selling their produce.’* Another said, *‘we operate on trust and farmers trust us; we are the one who helped them whether there is birth, death or marriage in the family’*; and *‘even when they send their children abroad for studies,’* he added.

Interestingly, 3 out of 10 *arthiyas* were interested to know how these digital markets or technology can be an enabler to diversify their business(es), whereas another 7 perceived technology as a tool of disempowerment. These 3 intermediaries were interested in using technology as an empowering tool and how it provides new directions to their business, and thus increases their clientele base using innovative and disruptive practices. It was noticed that those who were interested in technology were largely between 20-35 years old. Given the small sample, it was not possible to conduct an in-depth evaluation of the acceptability of technology in relation to the age profile of respondents. Therefore, further research is required with a larger sample to understand this phenomenon fully.

6. Discussion

This study examined the evolving role of innovative technologies and the proposed digital trading model, its possible adoption and perceptions of farmers and end users. *Firstly*, the study

proposes a digital agricultural supply chain system to overcome the challenges of the traditional supply chain constraints faced by farmers. The proposed digital trading platform is likely to enhance the transparency and efficiency leading to potential increases in tax revenues and income for farmers. The key differences and their advantages between two processes are tabulated in Table 3 below:

Please insert Table 3

Secondly, as stated in 5.2, young farmers are very enthusiastic about the use of innovative practices and technologies in farming. The analysis suggests that (older) farmers are threatened by the use of technology as they fear repercussions resulting from intermediaries. Consequently, intermediaries force them to sell their produce at a lower price. Therefore, to free farmers from these traditional shackles, Government and financial institutions must facilitate accessible financial assistance in providing loans.

Thirdly, the authors proposed and tested a psychological model to explain farmers' behavioral traits to adopt innovative technologies and the digital agricultural market. This model integrates the TPB and the ToT theoretical frameworks. The TPB has been selected to capture farmers' motives related to the use or adoption of technology decision-making process, such as evaluations of the perceived risks and benefits of using technologies. This integrated model also incorporates the dimension of trust in the usage of technology. Most farmers (95 per cent) are concerned about their unfamiliarity with the new system, their lack of skills and knowledge, and fraud due to which they are unable to trust the new systems.

Table 2 and Figure 4 show that the perception of risk and benefits are inversely related, as are risk and the adoption of technology. These inverse relationships are robust and indicative of the confounding and mystifying of risk and benefit in people's mind. This finding provides

an increased understanding of farmers' risk perceptions which can be used to devise risk reducing strategies and trust building mechanisms to encourage farmers in the digital agricultural market and to develop innovative tools. Using trust in the digital market supply chain disintermediates SMFs from middlemen ('*arthyias*') and they are ready to adopt technology, although some were unable to trust the technology for buying and selling.

Fourthly, the findings clearly depict that farming in rural India is still a male-dominated sector. Female farmers' limited ownership rights have an adverse effect on their access to finance that limits their adoption of technology. Gender imbalance is evident in the literature (Ahl *et al.*, 2023;). Women play a significant role in agriculture and in emerging economies they are very enterprising, but their contribution is often not proportionately recognized. Due to the changing roles of women, the emergent entrepreneurial ecosystem needs to support women to be fully functional. The changing role of women and their contribution to emergent entrepreneurial ecosystems has been rarely discussed and, therefore, these topics require further investigation.

Fifthly, on the demand side, there is a greater usage of technology and awareness of the potential benefits resulting from direct procurement from farmers. The existing system provides the end users the security of access to goods and services at a fair price. The study concludes that, by deploying innovative techniques, farmers can bypass the intermediaries (wholesalers) to reach their consumers directly, which has the potential to reduce information asymmetry and hoarding that can increase profit margins.

Finally, without a doubt, conflict can emerge between traditional and innovation intermediaries. However, it becomes necessary to see which ones are more sustainable and innovative to meet the demands of the times. The findings revealed that fear of technology will negatively impact their business. These traditional intermediaries provide guaranteed access to

farmers but pay low prices to them and charge higher prices to buyers, hence making a supernormal profit. The proposed markets can, therefore, be more transparent, whilst also being time- and cost-effective.

It may take time to change the culture by educating farmers so that they can trust the innovative technologies to enhance their income without any constraints. The new intermediaries (digital technologies) can have comparative advantage over the traditional intermediaries as supply chain coordinators. Nevertheless, relevant training and changes of mindset can help farmers to trust technology more.

7. Conclusion

This study examines the benefits and challenges of introducing a digital trading platform model to enable SMFs to sell directly to customers by pivoting to a technology-enabled disintermediation business model which excludes the commission-seeking intermediaries (*arthyias*). The novel theoretical and empirical contributions of the study are four-fold. First, it proposes a digital agricultural supply chain system to overcome the challenges of the traditional supply chain constraints faced by farmers. Second, it introduced a psychological model to explain farmers' behavioral traits to adopt innovative technologies and the digital agricultural market integrating the TPB and the ToT. Third, it emphasized the potential benefits resulting from direct procurement from farmers. Fourth, it revealed emergent conflicts between traditional and innovation intermediaries. . The study provides practical solutions to enhance the market environment, reduce the role of intermediaries and enable prompt pricing.

The main practical implications of this study are that the Punjabi farmers are constrained by poor internet connectivity, technological oriented skills and a greater awareness of market operations.

The findings also suggest that there is a lack of Government policy to promote greater internet connectivity. Thus, there is a need to provide enhanced internet infrastructure to create better connectivity, enhance productivity through education and training. This proposal will lead to improved awareness of the rapidly changing national and international markets, commodity prices and thus position them to exploit emerging opportunities.

The study provides a new perspective for SMFs, academics, and policymakers to develop innovative alternatives to support these farmers to increase their return and promote innovation in the agriculture sector – thus disintermediation demarginalizes them. Agricultural technology innovations can positively impact supply chain logistics by reducing the wastage of perishable food and positively impacting consumers' experiences. This study is cross-disciplinary, the proposed model is transferable and could be customized both for Western and emerging economies. Nonetheless, the proposed model lends itself to replication across wider regions within Western and emerging economies and future research with other demographic conditions may be replicated. Developing digital agricultural markets using a digital trading platform is an innovative product and its effectiveness is yet to be established. Furthermore, digitalization in a poor rural context is highly risky, as it requires a large investment in equipment, training and infrastructure. Further issues relating to trust and governance need to be resolved prior to the introduction of the digital trading platform.

The study builds on earlier work by Sandhu and Hussain (2021) that examined access to entrepreneurial education, resources and entrepreneurial skills for small farmers in India. However, the agriculture sector has not gained the same level of scrutiny. No prior studies have examined the impact of innovative technologies upon the efficiency of the agricultural supply chain and its social implications in the emerging economy context, such as India. This novel study, therefore, has practical implications for stakeholders, such as farmers, buyers, lenders, academics, Government and policymakers. This study bridges these gaps in prior research by

exploring the potential benefits of a digital trading platform/model to improve the supply chain as well as barriers to acceptance. These barriers also suggest implications for both policy and practice to provide a conducive enabling ecosystem for SMFs to access technologies and the provision of training and improved technology literacy.

The limitation of the study is the small sample size that limits generalization of the findings. Due to educational limitations, technical propositions and terminologies need to be omitted to help farmers understand terms (such as digital trading platforms). There is a need for a larger empirical study to demonstrate the benefits of innovative digital trading platforms before arriving at a conclusive judgment for the adoption of technologies for small and marginal Indian Punjabi farmers.

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