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RESEARCH ARTICLE

Smallholder Farmer's Preferences For Sustained Participation In High -Value Markets For Black Pepper In Kerala, India

Smija PK[1*], Neetha Rose CD[2], Roy Stephen[3], Sreekala GS[4], Pratheesh P Gopinath[5] & Yaman Chadar[6]

[1]Department of Agricultural Extension Education, Regional Agricultural Research Station, Vellayani, Kerala Agricultural University, Thiruvananthapuram 695 522, India

[2]Division of Social Sciences, Regional Agricultural Research Station, Pattambi, Kerala Agricultural University, Kerala 679 306, India

[3]Department of Plant Physiology, College of Agriculture, Vellayani, Thiruvananthapuram, Kerala Agricultural University, Kerala 695 522, India

[4]Department of Plantation Crops and Spices, Regional Agricultural Research Station, Vellayani, Thiruvananthapuram, Kerala Agricultural University, Kerala 695 522, India

[5]Department of Agricultural Statistics, College of Agriculture, Vellayani, Thiruvananthapuram, Kerala Agricultural University, Kerala 695 522, India

[6]Department of Agricultural Extension Education, College of Agriculture , Vellayani, Kerala Agricultural University, Thiruvananthapuram 695 522, India

*Email: smija.pk@kau.in

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Abstract

The sustainability concerns of the developed world together with increased tourism activities and migration have stimulated the growth and expansion of domestic and international High Value Markets (HVMs) of black pepper. This study is an attempt to identify the transactional attributes and farmer capabilities that influence the smallholder farmers' willingness to participate in black pepper HVMs and to examine the novel vertical integration mechanisms that connect them to HVMs. The study is based on primary data from randomly selected 198 smallholder farmers from eight prominent black pepper growing Agro-ecological Units (AEUs) in Kerala. The factors influencing the smallholder farmers' willingness to participate in black pepper HVMs were analysed in logistic regression framework. The trend analysis revealed the growth in black pepper cultivation area as well as export at national level, while a stagnation trend in area was observed at state level. A negative trend was observed in production as well as productivity at national and state levels. The results shows that 32.83 per cent of smallholder farmers were willing to participate in black pepper HVMs. The farmer capabilities such as number of international linkages and digital literacy and transactional attributes such as asset specificity and number of verticals integrated were found to be significantly influencing smallholder farmers' willingness to participate in HVMs. The study suggest that change agents may implement interventions to enhance the existing co-ordination mechanisms by exploiting the possibilities of digitisation and digital transformation. Also, efficient measures are required to protect farmers' rights on the asset specific resources and to mitigate unfavourable agroecological transformations that hinder the production of site-specific assets that ensures sustainable value chain for black pepper high value products.

Keywords

High Value Markets (HVMs); logistic regression; transactional attributes; vertical integration; willingness to participate

Introduction

Black pepper (*Piper nigrum*) is one of the oldest and most widely traded spices in the world, with significant production areas located in tropical climates. Due to its immense cultural, culinary and economic value, black pepper is often referred to as the "King of Spices" or "black gold." (1-3). This perennial climbing shrub from the

Piperaceae family was originated in the hills of India's South Western Ghats, specifically along the Malabar Coast in Kerala(4). Over time, black pepper has become an essential ingredient in culinary traditions across the globe. The pungency of black pepper is attributed to its piperine content, while its characteristic aroma and flavour are the result of its volatile oils (5,6).

The global production of black pepper is concentrated in a few countries, with Vietnam, India, Indonesia and Brazil being the largest producers. During the year 2022, the global production was 535 KMT from an area of 0.65 MHa (7). At present, Vietnam stands as the world's largest producer of black pepper, contributing over one third of the total global output. Since 1999, India has lost its crown as the leading producer and exporter to Vietnam (8). As of the 2022-23 period, India had 278000 hectares under pepper cultivation, with an estimated production of 64,000 tonnes. In India, black pepper farming is primarily concentrated in the southern states such as Kerala, Karnataka and Tamil Nadu, which collectively account for approximately 94.80 per cent of the total cultivation area (9). Karnataka stood first in term of area and production of pepper in country contributing to 56.00 per cent of total pepper production, followed by Kerala (10). Black pepper cultivation in Kerala state accounts for 27 per cent of the total black pepper cultivation in India, contributing 43 percent in national production. The two traditional major pepper producing districts in Kerala are Idukki and Wayanad situated in North hills and South hills respectively, together contributes 68 percent of total black pepper cultivation and 88 percent of total black pepper production in the state (11).

In 2022-23, India exported a total of 17958.26 metric tonnes of black pepper, valued at Rs. 72,686.40 lakhs (9).The global black pepper market is experiencing growth and transformation, driven by shifts in consumer preferences such as expanding middle class and the effects of increased tourism and migration. Global consumer demand for black pepper is increasingly leaning towards value-added and specialty pepper products (12). Therefore, producers and exporters are forced to focus on quality, authenticity and sustainability to capitalize on these trends and to meet the demands of both domestic and international markets(13).

High-Value Products (HVPs) refer to agricultural goods that, due to processing or other factors, are more valuable than standard commodities. While black pepper, as a standard commodity, is typically not segmented into multiple products in general market transactions, HVPs differ significantly in consumer demand and command higher prices. Specialty crops and value-added products are considered as high-value, if they are successfully differentiated, allowing farmers to command premium prices and achieve higher earnings (14). High value markets (HVMs) seek products such as white pepper and its derivatives, green pepper-based items, premium-quality pepper berries with detailed farm or place of origin information, fair-trade black pepper, organic certified black pepper, spice blends incorporating black pepper for various cuisines, ground black pepper and black pepper oleoresin and oil.

The recent export trends from India indicate an increase in black pepper oleoresin exports, while black pepper oil exports show a decreasing trend. The nutraceutical and food processing industries are switching over to black pepper oleoresin and essential oil as it is easy to standardised and free from contamination. Recent research has uncovered novel applications for black pepper oleoresin and essential oil in the food processing and nutraceutical industries. Black pepper essential oil (BPEO) nano emulsion effectively mitigates fungal proliferation and reproduction by downregulating relevant enzymes expression (15).

Smallholder farmers participating in certified pepper production for HVMs saw significant income increase and more stable earnings compared to conventional markets resulting in improved living standards, reduced poverty and enabled better access to education and healthcare (11,12). A sustainable value chain approach is seen as effective for examining climate change-induced vulnerabilities, as it extends its focus beyond production and promotes an additional systemic process for managing these vulnerabilities(18). So, apart from the monetary benefits, accessing black pepper HVMs can also generate numerous ecological and social benefits. The adoption of organic and low-input farming practices in response to HVM requirements has been linked to reduced greenhouse gas emissions, thus contributing to climate change mitigation ensuring long-term agricultural sustainability (19). Recent study on organic spice farming in India, emphasized that farmers who engaged with High-Value Markets (HVMs) adopted sustainable practices such as organic farming and Integrated Pest Management (IPM), leading to reduced chemical inputs and improved soil health (20).

Unlike the intensive black pepper cultivation systems in countries like Vietnam, most of the smallholder farmers in Kerala grow black pepper by trailing it on multipurpose tree species. Research on tree species used as support structures by small holder farmers in black pepper gardens of Kerala has shown that these systems hold significant potential for carbon sequestration (21). Smallholder farmers cultivating black pepper often intercrop with species like coffee, cocoa and tree spices, enhancing agrobiodiversity, pest control and ecosystem stability. Coffee plants, in particular, provide shade and mulch, helping to prevent soil drying-an issue worsened by the 2018 and 2019 floods-emphasizing the need for diversified systems to meet the sustainability requirements of high-value markets (HVMs).

Programs linking smallholders to HVMs often include training in good agricultural practices (GAP), business skills and quality management. This has been documented to enhance farmers' knowledge and skills. Empowered farmers with better knowledge and skills can make informed decisions, improve productivity and manage resources more effectively, strengthening farmer cooperatives and social networks (22). The farmers accessing HVMs often do so through cooperatives, which provide social support, collective bargaining power and shared resources (23). Thus, stronger cooperatives enhance social cohesion and provide mutual support. Vietnam, world's largest producer of black pepper, provided training and market access to integrate women into the value chain, as part of their HVM initiatives. Greater gender equity leads to improved household welfare, economic empowerment of women and broader social inclusion (24).

Higher profits from HVMs can boost the appeal of pepper cultivation, attracts young farmers and has the potential to expand the cultivated acreage. This potential can be utilised to tackle the problem of stagnation in black pepper cultivation area

and production decline.

Despite potential benefits, smallholder farmers in developing countries often struggle to maintain stable participation in high-value markets, frequently exiting soon after entry due to substantial post-entry transaction risks (26-28). Participation in HVMs can be challenging for smallholder farmers due to various barriers such as limited resources, market information and quality standards (13,16,25,26). Thus, understanding patterns of HVM participation is crucial for developing policy, as it positively impacts household income, productivity and rural economic growth (29). The proposed study analyses the decision-making behaviour of small holder farmers to enter HVMs through the lens of transaction cost economics (TCE) theory. The study also proposes that the capabilities of small holder farmers to acquire the assets required to meet the quantity requirements and stringent food quality standards that characterise HVMs (27-31) also influence their decision-making behaviour. In this context, the current study attempts to find answers to the following research questions:

1. What are the general trends in area, production and productivity of black pepper in national and state level?
2. What are the transactional attributes and capabilities that may influence the smallholder farmers' willingness to participate in black pepper HVM?
3. What are the constraints faced by small holder farmers in entering HVMs?

Although, several studies have been conducted on coordination mechanisms within the black pepper value chain in Kerala (9,35), there is a lack of research focusing on the participation of smallholder farmers in HVM activities related to black pepper cultivation. Also, there is a lack of evidence on the factors which explain the willingness of small holder black pepper farmers to participate in HVMs. Thus, present study is a humble attempt to model this decision-making behaviour of black pepper HVM participants. The study also integrates the farm's physical resources and the farmer's capabilities into a transaction cost economics (TCE) based model and propose to test it in explaining the farmer's willingness to engage in high-value markets (HVMs).

Materials and Methods

2.1 Study area and sampling

The Idukki and Wayanad districts of Kerala state were purposively selected as study area in the initial stage. The unique agricultural practices, environmental conditions and socio-economic factors predominant in those districts offer valuable information on cultivation as well as primary and secondary level trading of black pepper. Further, Kerala state is divided into 23 agroecological units (AEUs) based on factors like climate, rainfall patterns, soil characteristics and topography (32).Thus 8 major black pepper producing AEUs in and around Idukki and Wayanad districts were selected as the study area at final stage. The selected AEUs are AEU 13 (Northern Foothills), AEU 14 (Southern High Hills), AEU 15 (Northern High Hills), AEU 16 (Kumily High Hills), AEU 17 (Marayur Hills), AEU 19 (Attappady Hills), AEU 20 (Wayanad Central Plateau) and AEU 21 (Wayanad Eastern Plateau), which were purposively chosen due to their significant black pepper cultivation area. Out of that, five AEUs covered in and around Wayanad district were classified as Northern AEUs and three AEUs covered in an around Idukki district were classified as Southern AEUs. The map of study area and survey sites were shown in Fig. 1. The panchayats from these AEUs were selected randomly. The small holder farmers who were having black pepper cultivation in more than 50 percent of their total land holdings were randomly selected from the list obtained from the *Krishibhavans*. Thus, a total of 198 farmers were randomly surveyed from these 8 major black peppers producing AEUs, through direct interview method. The survey was conducted

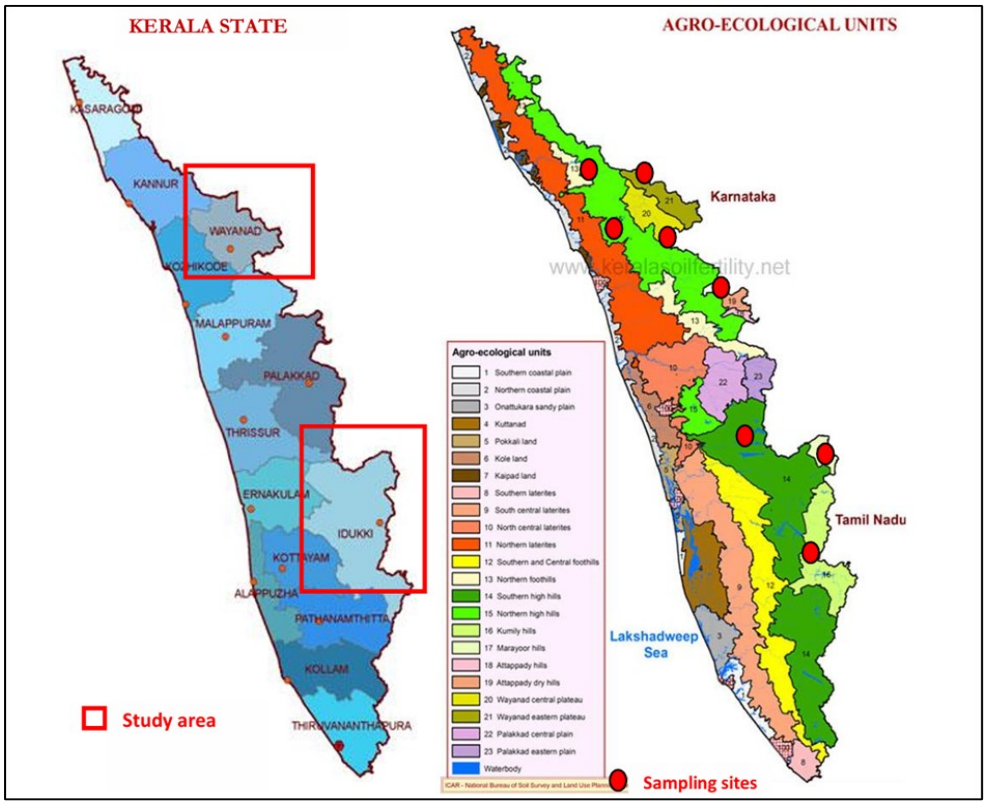

Fig. 1. Map of study area and Sampling sites (Sources: https://www.keralasoilfertility.net/en/agroecology.jsp)

using pre-tested schedule during the period 2022-23 and 2023-24.

2.2 Data sources

The study was based on both primary and secondary data. The primary quantitative data on socio-economic status, capabilities of farmer, transactional attributes, details about verticals, marketing, cost of cultivation etc were collected from sample farmers using a pretested schedule through direct interview method. The primary qualitative data was collected through interactions with active members of Pepper Samitis in the study area, as well as through Multidisciplinary Diagnostic Team visits conducted by RARS (SZ), Vellayani, from 2022 to 2024. Additionally, Focus Group Discussions (FGDs) were held with spice technology firms in Kochi and agricultural NGOs in the study area, organized by the Department of Agricultural Education, College of Agriculture, Vellayani. The secondary data on area, production and productivity over a period of twenty years were collected from annual economic review reports of Kerla state government (33) and economic survey reports of India government(34). Export statistics of black pepper high value products for period of seven years were extracted using Harmonized System of Nomenclature (HSN) codes obtained from Spices board of India (33)and from Indian pepper and spice trade association (IPSTA) reports (35). All type of secondary data were used exclusively for trend analysis.

2.3 Theoretical Framework

Empirical research on market analysis involving commercial exchanges or transactions largely draws from Transaction Cost Economics (TCE). Under TCE, an economic agent selects the organisational mode that minimises the expected transaction cost to consummate the series of transactions. The cost minimising process is based on the premise that transactions differ in their attributes and are aligned to organizational modes, which differ in cost and competence (36,37).

The concept of transaction costs was operationalised through attributes (asset specificity, frequency and uncertainty) emphasizing the basic assumptions of opportunism and bounded rationality of economic actors participating in trade transactions an (36). Asset specificity is the most tested transactional attribute along with uncertainty and frequency of transactions (38,39)

Asset specificity refers to specialised or dedicated transactions and investments, involving tangible or intangible assets, that are specific, tailored or more convenient to operate with a particular type of partner or structure to avoid opportunistic behaviour. Asset specificity increases farmers transaction costs because farmers need to apply special governance structures to enter into HVMs. In our study asset specificity variables were derived through grounded observations during pilot surveys and later validated by subject matter experts.

Uncertainty derives from unexpected changes that may occur in a transaction (36). When uncertainty arises, it increases the possibility of opportunistic behaviour in transactions (40). As the level of uncertainty increases, so does the risk of opportunism, which often leads to more centralized coordination (41).

Contract farming reduces uncertainties for farmers by transferring risk to processors through linear contracts, whereas cooperatives manage risk by pooling resources and sharing it among members.(42).Spot market is considered as an externally coordinated price mechanism having high uncertainty. When there are high levels of uncertainties around a transaction, involved parties are required to put more time and effort on completing the transaction, which result in higher degrees of transaction costs (43).

As per TCE literature, frequency is the degree to which transactions recur. In the current study frequency of transactions is assumed to reflect the storage facilities and liquidity position of the farmer. Properly stored and dried black pepper is considered as 'black gold' owing to its high liquidity. Farmers with adequate storage and post-harvest handling facilities can strategically sell their produce in response to market price changes. So, frequent transactions may reduce uncertainty over the transaction, whilst creating trust between actors involved (44,45).

TCE proposes that firms seeking product differentiation are motivated to reduce transaction costs and vertically integrate because this allows for product quality improvements through control of the input quality and output distribution and service (46). The governance mechanisms such as agricultural contracts, farmers' groups, estate farming and farm nongovernmental organisations (NGOs further improve existing vertical integration and horizontal coordination and thereby facilitating small farmers' ability to access HVMs (47).

Apart from transactional attributes of the market evidence from literature suggest that capabilities of the farmer influence their willingness to participate in high value markets. "Capabilities' is operationalised as capabilities of small holder farmers to acquire the assets required to meet the quantity requirements and stringent food quality standards that characterise HVMs (48).

Studies have emphasized the critical impact of agricultural supply chain capabilities on shaping food product prices in the market (49,50). The research evidence shows that capabilities such as advanced farming practices-like irrigation, pest management and post-harvest handling-alongside access to extension services and credit, significantly boost the production of both high-quality and sufficient food quantities. Digital skills can be powerful enablers of the Sustainable Development Goals (SDGs), as proficiency in digital tools can accelerate advancements across multiple sectors. For instance, digital skills enable access to essential information on markets, weather and agricultural techniques, enhancing farmers' productivity and income. This, in turn, supports efforts to reduce poverty and improve food security (51).Cooperatives with an access to internet were more likely to notice the positive impact of E-commerce on sales (52).

For smallholders, possessing these capabilities fosters a level of independence, enabling them to set fair prices and secure premium pricing for superior-quality products (53,54). Additionally, well-developed storage, distribution and transportation infrastructure ensures a stable market supply while reducing risks and minimizing losses due to shortages, spoilage, or high transportation costs in specific regions. These factors, as noted by (55) play a key role in driving price fluctuations in the food market. Access to real-time market information is also crucial, allowing smallholders to adapt swiftly to changing market conditions and adjust prices more effectively according to supply and demand trends (56-58).

So, the smallholders' ability to access and benefit from HVMs depends not only on the structure and requirements of these

markets (e.g., asset specificity, frequency and uncertainty) but also on the farmers' capabilities.

By integrating these dimensions, the study provides a more comprehensive understanding of the enabling and constraining factors that influence smallholder participation in such markets. Hypotheses are developed accordingly, as outlined in Table 1.

2.4 Analytical framework

The probability of participation in HVMs were analysed in logistic regression framework. The willingness to participate measured as probability of participation can take binary values yes=1 and No= 0. Therefore, logit model was used to analyse the factors that influence the probability as given below.

$$Ln [Pi/ (1-Pi)] = A + \Sigma \beta i Xi + Ui \ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Pi = Probability of willingness to participate (Yes = 1)

1-Pi = Probability of willingness to participate (No = 0)

A – Intercept, Ui - Error term, βi – Regression coefficients, Xi – Dependent variable

X1 – Education (years)

X2 – Farming experience (years)

X3 – Average monthly income (Rs.)

X4 – Landholding size (Acre)

X5 – Number of domestic value chain linkages

X6 – Number of international value chain linkages

X7– Digital literacy,

X8 – Asset Specificity (X8 is a combination of X 81, X 82, X83 and X84)

X 81 - (Black pepper from organically certified farm (1), not certified = 0)

X 82- Black Pepper as a sole crop or intercropped with coffee and tree spices which is considered possibly organic (gets a score of 1 if intercropped with cardamom and a score of 0 otherwise)

X83 -Number of special cultivars of black pepper in the farm

X84 - Number of trade transactions done with the primary product

X9 - Frequency of transactions

X10 - Number of stages vertically integrated with black pepper farming

X11 - Uncertainty in transaction

The variable value chain linkage refers to the connections and interactions between different stages of a value chain, which is the series of activities that are performed to deliver a product or service to the market(59). Physical connectivity to domestic value chain involves linking farmer to primary trader, secondary trader, wholesaler and exporter. One score for each linkage was given for domestic as well as international linkage and the sum of the scores would provide the total score.

Digital literacy is the ability to effectively use information and communication technologies, including the internet, to meet various needs. (60). As per the sample data, the farmers' digital literacy is categorised into five. The five levels include the non-use of mobile phone (score 0), use of mobile phone or smart phone (score 1), smart phone + Facebook/WhatsApp groups (Score 2), mobile Phone + Facebook/WhatsApp groups + data entry skills (score 3) and mobile phone + Facebook/WhatsApp groups + data management skills + portals + online Marketing (score 4 and 5).

The asset specificity variable includes certified organic black pepper, black pepper as sole crop or intercropped with coffee and tree spices, number of special cultivars in the farm and number of trade transactions done with primary product. Number of trade transactions is operationalised as the number of forms in which black pepper is sold. One score is assigned to each one of the items. The score was classified as low (1-3), medium (4-6), high (7-9) and very high (10-12). Frequency of trade transactions refers to frequency with which the transactions recur during a year. For each transaction one score is awarded. The variable uncertainty in trade transactions is indicated by spot market trading, which uses an externally coordinated price mechanism, resulting in high uncertainty. Contract farming arrangements are seen to reduce this uncertainty, while farmer producer organizations (FPOs) minimize it the most. Scores of 3, 2 and 1 were assigned for spot market trading, contract farming arrangements and FPOs, respectively.

The variable levels for vertical integration were derived from the field and later validated by subject matter experts. These levels include the production of special cultivar planting materials, nursery business, organic manure production, post-harvest operations like mechanical threshing and grading, as well as direct marketing and farm tourism. Each level is assigned a value of 1 and sum of these values give the number of vertically integrated stages.

The trend in black pepper cultivation area, production and productivity at national and state level over a period of twenty

Table 1: Logical framework for Hypothesis testing

	Transactional attributes of HVMs of black pepper and expected market participation outcome	**Capabilities of farmer and expected market participation outcome**
Hypothesis H_1: Transactional attributes of high value market (HVM) and capabilities of farmer jointly influence the willingness to participate in HVMs of black pepper in Kerala. H_0: Transactional attributes of high value market (HVM) and capabilities of farmer has no effect on willingness of farmers to participate in	Alignment of transactional attributes with existing coordination structures minimises transaction costs that results in market participation outcomes. (YES/NO)	Capabilities of farmer to meet the quantity and quality requirements of HVMs results in market participation outcomes. (YES/NO)
Empirical variables	Asset specificity, uncertainty in transaction, frequency of transactions, Number of stages vertically integrated with production.	Education, Farming experience, Average monthly income, Landholding size, Number of domestic value chain linkages, Number of international value chain linkages, Digital literacy,

years were analysed by plotting graphs. Overall as well as specific segmented period trends was deeply analysed. The export trends of raw pepper as well as high value pepper products were also analysed graphically.

Apart from this, descriptive statistical analysis was used to derive general conclusions.

Results

3.1 Trend in black pepper cultivation area, production and productivity

The trends in cultivation area and production of black pepper at national and state level is depicted in (Fig. 2). An increasing trend in cultivation area has been observed at national level, while a stagnation trend was observed at state level. A slight negative trend was observed in black pepper production at national level (Fig. 3). The declining trend in production was obvious in Kerala. The negative trend in black pepper productivity was evident both at the state and national levels, as illustrated in (Fig. 3).

3.2 Trend in black pepper exports

The export of black pepper mainly happens in the form of dry pepper. The (Table 2) shows the quantity of black pepper exports from India from 2016 onwards. The physical quantity of national exports shows a gradual increase while national export value is fluctuating irregularly.

3.3 Trend in high value product (HVP) exports

The graph in (Fig.4) shows only the trend in exports of HVPs and lacks data on domestic demand of HVPs. Industry experts and sourcing teams of spice firms experience an increase in demand from domestic market too. Recent export trends indicate a growth in black pepper oleoresin exports, while black pepper oil exports show a negative growth.

3.4 Socio-economic characteristics of sample farmers

The socio-economic characteristics of the sample farmers were given in (Table 3). The average age was 53 indicating the involvement of old generation in black pepper farming. The farmers were highly experienced with an average farming experience of 17 years. All sample farmers were literate and

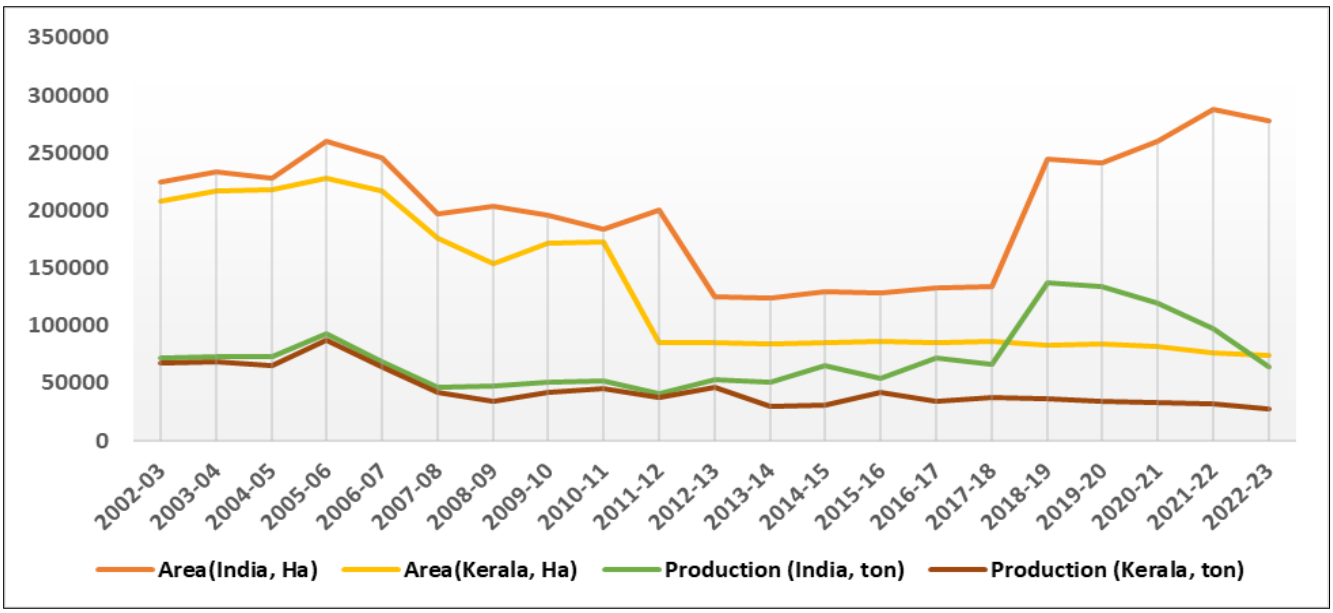

Fig. 2. Black pepper area and production trends in India and Kerala (**Source**: Spices Board of India,2023)

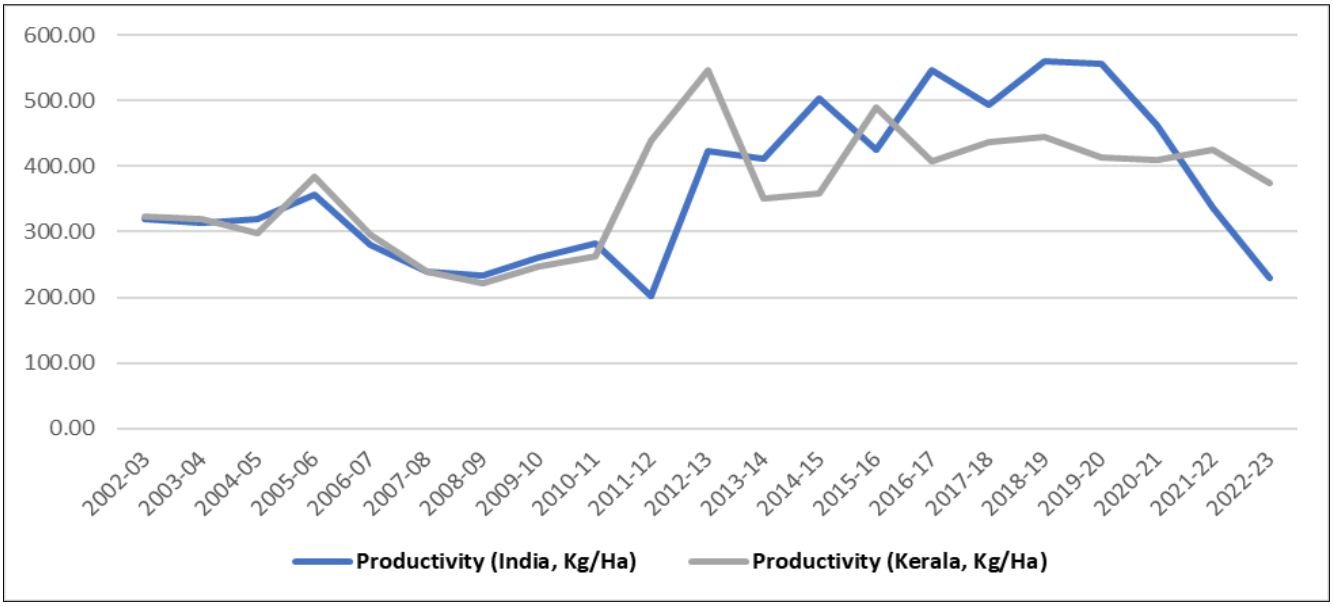

Fig 3. Black pepper productivity trends in India and Kerala (**Source:** Spices Board of India,2023)

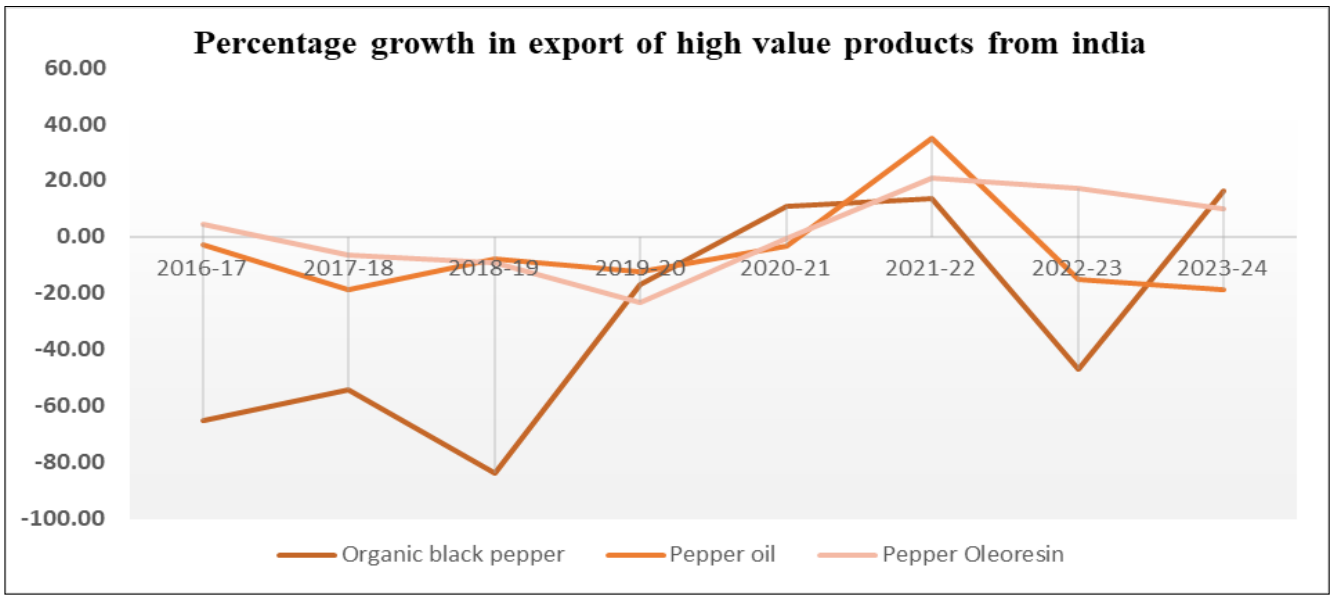

Fig. 4. HVM status in black pepper trade

(**Source:** constructed by researchers using data extracted through HSN codes)

Table 2: Export statistics of black pepper from India

Year	Export (Tonnes)	Export value (Rs.)
2016-17	17,600	1,14,313
2017-18	16,840	82,078
2018-19	13,540	56,868
2019-20	17,000	57,371
2020-21	16,300	56,446
2022-23 (AE)	17,958.	72,686

Note: AE - advance estimate (Source: Spice Board of India,2023)

Table 3: Descriptive statistics of Socio-economic variables

Socio- economic variables	Mean	Std Devn	Min	Max
Age (Years)	53	9	34	80
Education (Years)	10	3	4	15
Farming experience (Years)	17	7	5	40
Average monthly household income (Rs.)	20427	17984	4000	96000
Land holding size (Acres)	2.02	1.71	0.25	10.00

recorded mean education of 10 years. Small holder farmers were dominant in the study area with an average land holding size of 0.81 Ha. As the average land holding size is small, the farmers were classified based on the total land holding size as marginal (< 1Ha), small (1-2 Ha) and semi-medium (2-4 Ha). Majority of the farmers (71%) participated in the survey belonged to marginal category.

3.5 Characteristics of other category and farmer capability variables

***3.5.1 Gender*:** The farmer respondents were classified into male and female. It was obvious from the (Fig. 5) that 84 per cent of sample farmers belonged to male category showing a gender imbalance among the respondents. The direct participation of female in black pepper cultivation was very low. The trailing nature and height of the black pepper crop, along with the challenging terrain where it is cultivated, make farm management difficult for women. Tasks such as shade regulation, maintaining standards and harvesting with ladders further add to these challenges.

***3.5.2 Digital literacy*:** The (Fig. 5) shows that a significant majority (41%) utilize both smart phones and Facebook/ WhatsApp groups; (22%) have advanced data entry skills but only 4 percent use it for data management and online marketing. The groups with advanced skills (mobile phone, Facebook/WhatsApp, data management and online marketing) likely represent the farmers who have evolved their operations to include more sophisticated digital tools and thus are more willing to participate in HVMs.

***3.5.3 Value chain linkages*:** In the sample, the total score of domestic linkage ranged from 1 to 7 and that of international linkage ranged from 0 to 2. The frequency distribution of farmers according to the total score of domestic as well as international linkage is presented in (Fig. 5). Most of the farmers (39%) restricted the marketing linkage to one primary trader indicating the chances of distress sale. International value chain linkage was completely absent among significant majority (88%) of the farmers which adds to low participation in HVMs or very low level of value addition.

***3.5.4 Asset specificity*:** From (Fig. 6), it is clear that majority of farmers (65%) was having low asset specificity, while one percent of farmers had very high asset specificity. Broadening the assets at farm level was considered as critical to support greater participation in HVMs.

***3.5.5 Frequency of transactions*:** The frequency of transactions is assumed to reflect the storage facilities. Properly stored and dried black pepper is considered as 'black gold' owing to its high liquidity. Farmers with adequate storage and post-harvest handling facilities can strategically sell their produce in response to market price changes. So, frequent transactions may reduce uncertainty over the trade transaction. Low category is dominant in the sample (Fig. 6) indicating high level of uncertainty.

***3.5.6 Number of stages vertically integrated*:** Number of stages in the production process integrated by the farm gives more control for farmer over the operations. The sample data shows that 76 percent of farmers were not vertically integrated at any stage (Fig. 6). Meagre proportion (12%) of farmers had at least one vertical integration at any of the stage.

***3.5.7 Trade transaction uncertainty*:** Unexpected deviations in trade transactions give rise to uncertainties. In this context, contract farming lowers uncertainty, farmer producer organisations make it least, while spot market intensifies uncertainty. From (Fig. 6), it is obvious that majority (63%) of

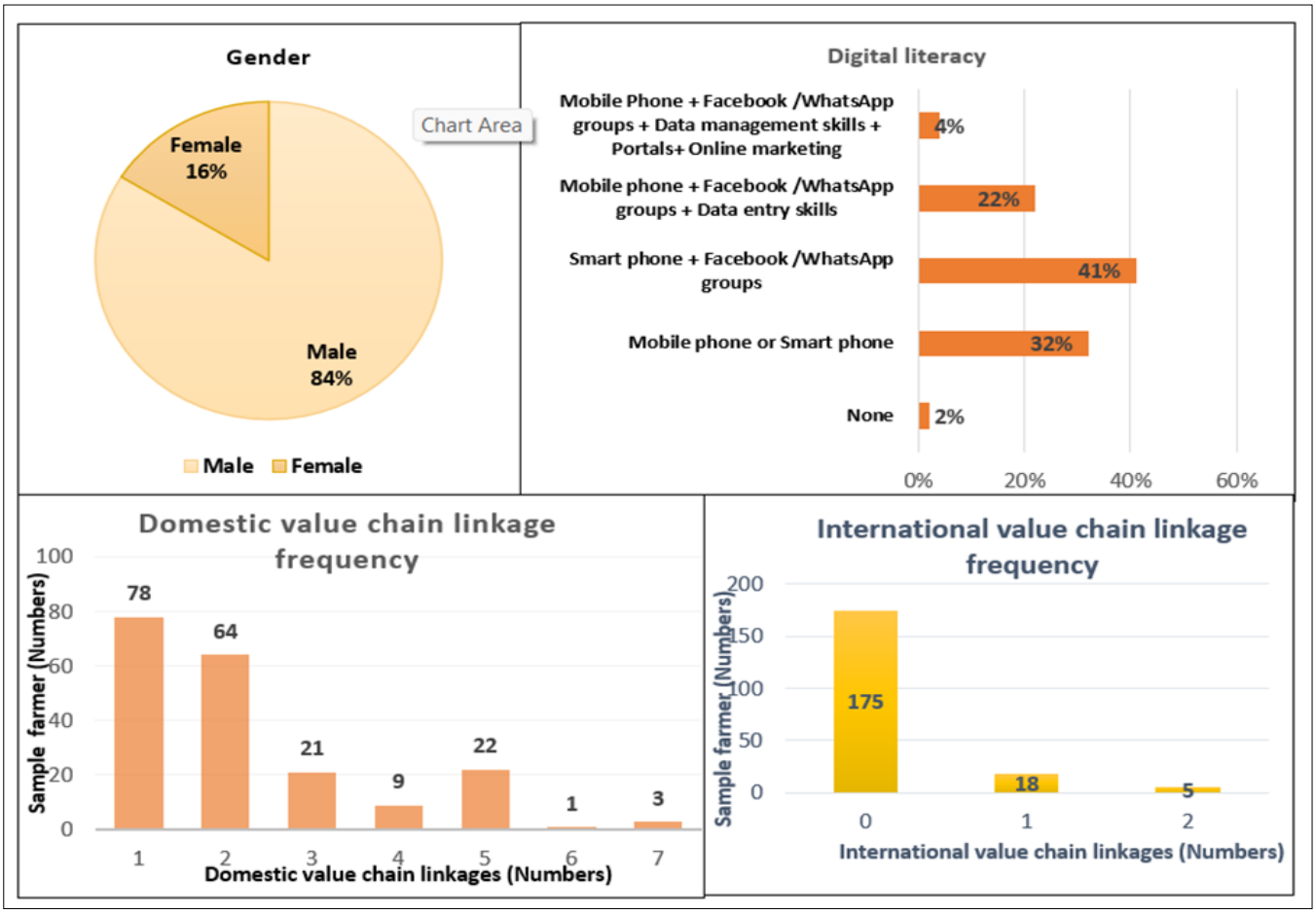

Fig. 5. Characteristics of gender, digital literacy and value chain linkages (**Source:** constructed by researchers using the

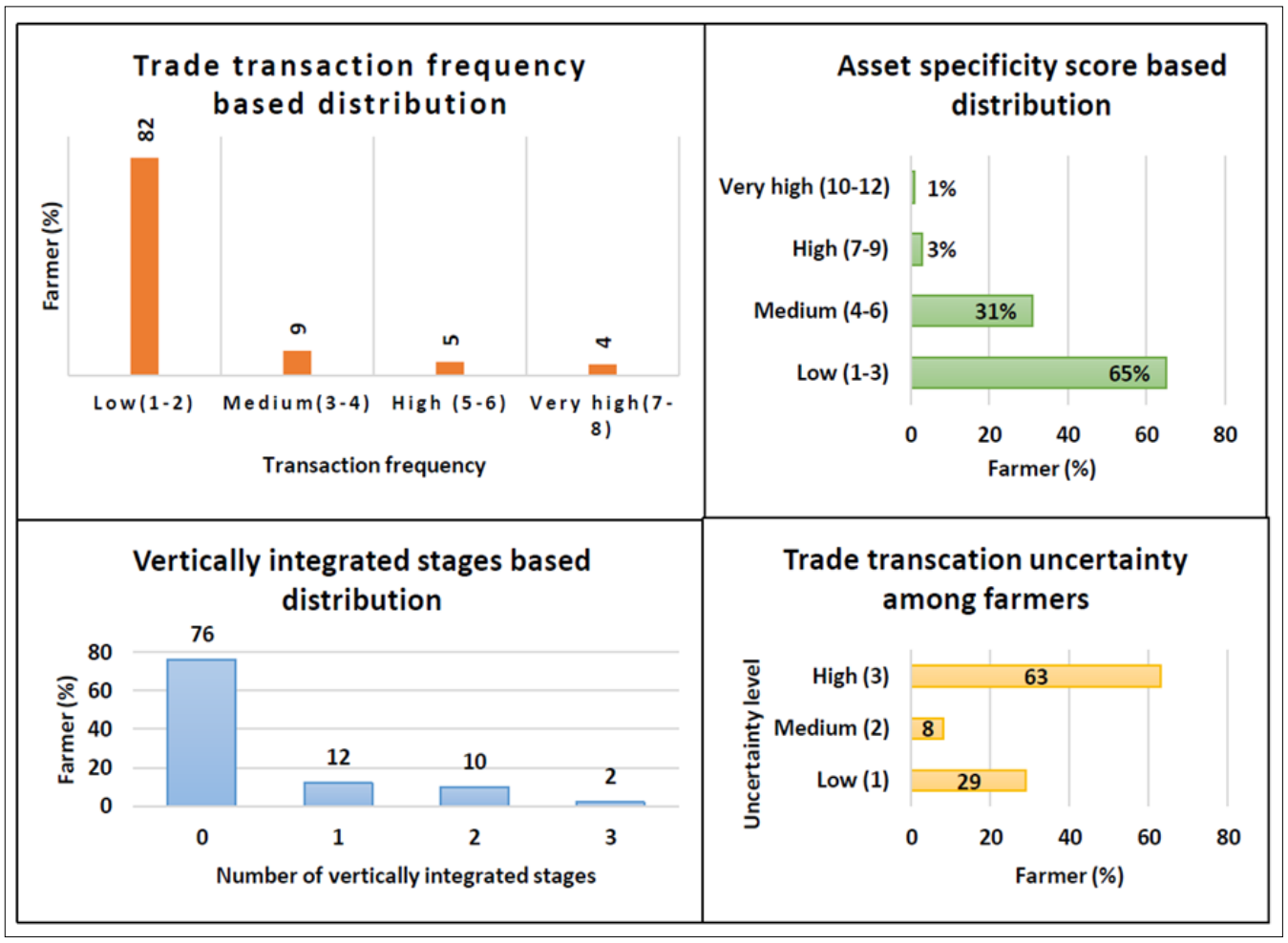

Fig.6. Characteristics of transaction frequency, asset specificity, vertical integration and uncertainty. (**Source :** constructed by researchers using survey data)

Table 4: Percentage analysis of willingness to participate in HVMs

Particulars	Willingness to participate (Percentage)
North Kerala AEUs	23.70
South Kerala AEUs	52.38
Sample total	32.83

farmers experience high level of uncertainty.

3.6 Willingness to participate in HVMS: A percentage analysis of the willing ness to participate in HVMs of the respondents revealed that willingness was higher in AEUs of Southern Kerala shown in (Table 4).

3.7 Factors affecting willingness to participate in HVMs: As per the theoretical model the market characteristics and capabilities of the respondents affect the dependent variable 'willingness to participate in HVMs. The independent variables could explain 86. 31 percent of the total variation in the dependant variable. The variables digital literacy, asset specificity, frequency of trade transactions and number of verticals integrated showed significance as shown in the (Table 5).

Table 5: Logit regression coefficients

Independent variables	Coefficient	Std. Error	P value
Education	0.0387	0.2038	0.85
Farming Experience	-0.0901	0.1040	0.39
Monthly income	0.000006	0.000028	0.81
Land Holding size	-0.4096	0.4555	0.37
Number of domestic value chain linkages	-0.0746	0.4141	0.86
Number of international value chain linkages	-2.739	1.428	0.05*
Digital literacy	1.249	0.5490	0.02**
Asset specificity	1.8990	0.5399	0.004***
Frequency of transactions	0.8770	0.4775	0.06*
Number of verticals integrated	7.447	2.595	0.004***
Uncertainty in transactions	0.9279	0.6145	0.13
Intercept	-12.34	4.038	0.0023***
Number of observations		197	
R Square		0.8631	
AIC		59.534	

Note: ***denotes P < 0.01, **denotes P < 0.05, *denotes P < 0.1

Discussion

4.1 Willingness to participate in HVMs

Out of 198 smallholder farmers, 32.83 per cent were willing to participate in black pepper HVMs. A significantly higher proportion of farmers in South Kerala (52.38%) are willing to participate in these markets compared to North Kerala (23.70%). This suggests potential regional variations in factors influencing farmers' decisions to engage in high-value black pepper markets. Subsequent field surveys showed that farmers in South Kerala have better access to infrastructure and facilities needed to connect with high-value markets, such as collection centres, processing units, or transportation networks. There could be a gap in awareness or knowledge about high-value black pepper markets among farmers in North Kerala. Farmers in North Kerala perceive higher risks associated with entering high-value markets, such as strict quality requirements or difficulty in establishing linkages with domestic and international value chain actors.

4.2 Factors affecting willingness to participate in HVMs

The logistic regression analysis provides valuable insights into the factors influencing smallholder farmers' willingness to participate in black pepper high-value markets. By identifying the significant variables, you can focus on understanding the underlying reasons behind these associations and develop targeted strategies to encourage more participation from farmers.

4.2.1 Asset specificity: The variable turned to be highly significant in the study, which is in agreement with propositions the Transaction Cost Theory. The specific assets possessed by the farmers positively influences their willingness to participate in HVMs(38)The highly significant asset specificity variable highlights that developing the bioeconomy in this region is crucial(69). This region possesses unique site-specific assets, including distinctive varietal characteristics and favourable geographic conditions such as altitude and latitude, which are optimal for producing high-quality black pepper.

A study on the effects of quality uncertainty and asset specificity on the coordination of fruit supply chains found that growers targeting niche markets, such as the baby food industry, often dedicate specific orchards to meet the industry's particular requirements. These transactions are typically governed by pre-harvest contracts or hierarchical arrangements (61). Similarly, research conducted in the Mbeya region of Tanzania on the factors influencing rice growers' choice of marketing channels revealed that asset specificity is crucial for gaining access to distant and more profitable markets (62). The policymakers should further enhance measures to protect farmers' rights on the asset specific resources such as local varieties to reduce the uncertainty in sharing the knowledge with others.

The agroecological transformations in the major growing regions that may hinder the production of site-specific assets such as sole cropped pepper and pepper intercropped with coffee and tree spices have to be mitigated to ensure sustainable value chain for High value Products (HVPs) from black pepper.

4.2.2. Number of verticals integrated with farming: The regression shows a significant relationship between number of stages integrated and willingness to participate in HVMs. Backward integration was mostly observed with verticals such as organic manure production and production of planting materials of special cultivars. The production of rooted cuttings of climate resilient cultivars, grafted seedlings of bush pepper and grafted seedlings of black pepper for field planting boosts farm income and enhances the capabilities of farmer family for maintaining site specific assets.

Farm tourism ventures that incorporate high-value product outlets offer a bunch of farm grown products along with a few products sourced from processors and exporters on marketing contracts. So, they follow a tapered integration mode, outsourcing the production of oleoresins and oils while integrating the sales of these products into their supply chain.

Farm women form joint liability groups (JLGs) and engage informal production contracts with super markets and premium outlets to supply packed premium-quality pepper berries with detailed farm or place of origin information. The JLGs undertakes microlevel aggregation, sorting, grading, negotiating contracts to run this model. Managing such verticals is a capability that contributes to the willingness for participating in HVMs.

4.2.3 Digital literacy : Digital literacy of black pepper farmers showed significant relationship with the dependent variable. The black pepper farmers overcome their physical and geographical barriers to access market information, better production practices and innovations through digital platforms and chat bots available in public and private domain. Existing research defines digital literacy as the ability of individuals to effectively obtain and appropriately use relevant information through internet platforms (63). Farmers with higher digital literacy can overcome geographical limitations in obtaining loans by using digital financial tools. They can also apply for some unsecured and fast-loan credit services, thereby breaking financial constraints and enhancing their perceived behavioural control(64). So, digital literacy would lead to more favourable decision-making toward participating in high-value markets

From the Focus Group Discussions (FGDS) conducted as part of this study, it was revealed that the spice tech firms in Kerala are shifting the traditional physical procurement networks for HVPs to digital platforms to ensure farm to fork traceability and sustainability. Farmer groups and traders can directly participate in such platforms. Agricultural supply chains now use technology like mobile apps for market information and precision farming equipment. This helps smallholders make better decisions. It also improves their productivity. With these tools, smallholders can enter niche markets. This expands their customer base and raises their income. Thus, digital literacy enables farmers to participate actively in social networks for value chain involvement, increasing their willingness to engage more effectively in high-value markets (HVMs).

The study reiterates that digital literacy is a critical independent variable influencing the participation of smallholder black pepper farmers in High-Value Markets (HVMs). Therefore, policymakers should focus on implementing training programs to enhance farmers' digital literacy and data management skills. Given that the average age of farmers in our sample is 58, empowering the immediate descendants of these farmers with digital skills offers a practical approach to addressing the low levels of digital literacy among the farming population.

***4.2.4 Number of international value chain linkages*:** Physical connectivity to domestic value chain linkages did not appear significant in the analysis, as those involved in high-value products are not limited by physical space, primarily using smartphones to connect with others(65).

The traditional domestic value chain-farmer, primary trader, secondary trader, wholesaler, exporter-is not used for selling high-value products. But, connections to international value chains are established through membership in hierarchical structures, such as export divisions of farm NGOs or linkages with sustainability divisions of spice firms. The digital platform based vertical coordination also demands aggregation under a certified agency for further entry into international value chains. Apparently, the migrated families abroad, foreign students from the region and international tourists also link the farmers to HVMs. Therefore, this variable is positively significant in the analysis.

***4.2.5 Frequency of transactions*:** The study finds a marginally significant relationship between transaction frequency and participation in HVMs (66). As frequency of transactions in the existing market situation is assumed to reflect the debt equity ratio, a positive relationship indicates that farmer tend to favour more transactions in high-value products to meet their immediate financial requirements. The products with different storage life and different temporal specificity in plucking and processing offer a scenario of multiple transactions. As per TCE literature to reduce the overhead on more transactions, better vertical coordination in the form of hierarchical structures is needed. (36) also identified a positive link between transaction frequency and vertical control. The study highlights the need for improved coordination mechanisms to ensure timely payments to farmers, addressing their immediate financial needs.

4.2.6 Uncertainty in transaction : The asset specificity of the product category studied here reflects a market situation with high uncertainty (67), However, the respondents expect that the trade of HVPs would mostly be operated through digitally mediated platforms and other coordination mechanisms that have control on environmental, behavioural and technological uncertainty. They expect that their lack of knowledge on benefits derived from high-value markets (HVMs) and the actions of other actors in the value chain will be insignificant in the presence such coordination mechanisms that reduce opportunism and bounded rationality.

Despite low productivity trends and fluctuating market prices, black pepper farmers in Kerala have high aspirations to continue farming. This commitment is evident in their innovative strategies to boost farm income from black pepper farming. This may also explain why the size of land holdings, has an insignificant relationship with the dependent variable. Instead, farmers' capabilities and aspirations play a more crucial role in sustaining participation in high-value markets (HVMs).

Based on the results of statistical analysis and the evidence gathered we fail to reject the null hypothesis.

Overall, the logistic regression analysis provides valuable insights into the factors influencing smallholder farmers' willingness to participate in black pepper high-value markets. By identifying the significant variables, the change agents can focus on understanding the underlying reasons behind these associations and develop targeted strategies to encourage more participation especially from North Kerala farmers. The results also suggest further interventions for enhancing the existing co-ordination mechanisms exploiting the possibilities of digitisation and digital transformation.

4.3 Constraints faced by farmers in entering HVMs

From the field survey we identified a list of constraints which were perceived as important and subsequently the respondents were asked to rank the constraints. The constraints are listed in the order of ranks given by respondents.

1. Insufficient quality testing centres in key production areas.
2. High costs associated with testing for quality attributes.
3. Limited awareness programs on market sustainability requirements.

4. Inadequate infrastructure for pesticide residue analysis.
5. Poor knowledge of the participatory guarantee system for organic certification and fair-trade alliances in Kerala.
6. Inadequate financial support from the government for black pepper and other spice crops compared to cereals and vegetables.
7. A shortage of farmer-friendly digital tools in local languages for farm management and accounting.
8. A high prevalence of pests and diseases impacting crops.

The study highlights the need for enhancing the capabilities of small holder farmers for participation in agricultural value chain of high value products in black pepper in the region. Providing training on high-value pepper production techniques, organic practices and market access strategies can equip farmers to meet stringent quality standards and navigate the complexities of these markets. There is a need for assistance in providing quality liming materials, true-to-type planting materials, organic amendments and biofertilizers for better pest management.

Encouraging farmer cooperatives and Farmer Producer Organisations (FPOs) can help smallholders pool resources, negotiate better prices with bulk buyers and potentially access certification programs more easily. The linkages of such organisations with sustainability divisions of spice firms and digital technology-based marketing plat forms would reduce transaction costs and enable better vertical integration. The agroecological transformations in the region that may hinder the production of site-specific assets have to be mitigated to ensure sustainable value chain for HVPs from black pepper. By strategically promoting high-value market participation alongside infrastructure development, farmer support and cooperative structures, Kerala can incentivize smallholders and potentially reverse the decline in black pepper production.

Conclusion

The study is a novel attempt to understand the transactional interface between small holder farmers and high value market players of black pepper. Out of 198 smallholder farmers, 32.83 per cent were willing to participate in black pepper HVMs. The farmers in North Kerala perceive higher risks associated with entering high-value markets. The positive relationship between asset specificity and the willingness to participate in HVMs has to be explored to bring back the lost glory of black pepper of Kerala origin. The policymakers should further enhance measures to protect farmers' rights on the asset specific resources such as local varieties to reduce the uncertainty in sharing the knowledge with others. The asset specificity variable underscores the importance of advancing the bioeconomy in this region, which benefits from unique varietal and geographic attributes ideal for high-quality black pepper production. To maintain a sustainable value chain for high-value black pepper products, agroecological shifts that could impact sole-cropped pepper and intercropping with coffee and tree spices must be carefully managed.

Farmer capabilities such as number of international linkages and digital literacy and transactional attributes frequency of trade transactions and number of verticals integrated were also found to be significantly influencing smallholder farmers' willingness to participate in HVMs. The study sheds light on potential verticals that could be integrated into black pepper farming, recommending further research to develop profitable avenues that support sustainable production. Capacity-building programs to enhance farmers' skills, particularly the digital literacy of farm families, are highly recommended.

Future research could focus on conducting similar studies with other value chain actors such as primary traders, secondary traders and terminal market players to provide more insights for policy-making. Exploring both qualitative and quantitative aspects of the aspirations of black pepper farmers in Kerala-especially in the context of climate change and its associated extreme events like shifting rainfall patterns, floods and landslides and resulting migration of immediate descendants of farm families -would be valuable. Action-oriented research on strategies to mitigate agroecological changes in the region could offer practical solutions for the sustainable development of the spice economy in Kerala.

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