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RESEARCH ARTICLE

Quantifying Risk Factors and Assessing Farmers' Perceptions in Vegetable Production: An Empirical Study of Kerala, India

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ABSTRACT

Vegetable production is a vital component of agriculture in Kerala, India, but it is also a high-risk enterprise due to several factors, such as biological and environmental uncertainties. Farmers' perceptions of the severity of risks and their management strategies are critical for decision-making and policy formulation in agriculture. This study was conducted in blocks of Devikulam in Idukki district, Kanjikuzhy in Alappuzha districts, Pazhayannur in Thrissur district and Chittoor- Kollengode in Palakkad district which were identified as Special Agricultural Zones for vegetables in Kerala. Purposive sampling technique was used to select a sample of 270 vegetable farmers. This study was to identify and quantify risk factors in vegetable production and assess farmers perceptions of the severity of risks. Pareto analysis was the tool used to prioritize the most severe risk factors in vegetable production using the 80-20 principles. The study disclosed major sources of production, market, institutional, financial and human risk sources in vegetable production. Further revealed that crop damage by wild animals, surplus production of the same crop, complicated banking procedures, climatic variations, lack of vegetable-oriented schemes, price fluctuation, high cost of production, lack of government support, import of produce from other states, labor shortage, high-interest rates, poor soil quality, fragmented land holdings, water scarcity, poor extension to farmer linkage, and incidences of pests and diseases account for 80 per cent of the risks in vegetable farming. The findings provide a comprehensive understanding of risk factors in vegetable production in Kerala and can guide policymakers, extension workers, and farmers in developing effective risk management strategies.

***Key words**: Sensitivity; Uncertainty; Risk perception; Pareto analysis;*

Agriculture plays a pivotal role in India's economy, and the vegetable sector contributes significantly to the Gross Value Added (GVA) of the country (*Anonymous, 2021a*). With smallholder farmers contributing over 50 per cent of the vegetable production, the sector is crucial for their livelihoods (*Kundu and Mandal, 2020*). Vegetable cultivation provides nutritional and income security and considered to replace subsistence farming in the rainfed hills, arid, dry land and coastal agro-ecosystem (*Noopur et al., 2021a*), besides vegetables are the important source of carbohydrates, proteins, vitamins, minerals and fibre (*Noopur et al., 2021b)*. The total horticulture production during 2021-22 was 341.63 million tons of which vegetable production was 200.45 million tons (*APEDA, 2023*) which indicated that vegetable play an important role in improving food, income and nutritional security at household level (*Panwar et al., 2019*) as well as at national level. In Kerala, vegetables acreage increased from 46500 ha in 2015 to 102000 ha in 2021. Likewise, the production increased from 6.3 lakh MT to 15.7 lakh MT (*Anonymous, 2022a*). There is a scope for increasing area and production of vegetables in the state of Kerala, which is highly dependent on the farmers behavior and the constraints being faced by the farmers. *Sharma et al. (2014)* reported entrepreneurial behavior of potato growers of Nagaland and highlighted the problems faced by them. A number of studies has enumerated about socio-economic constraints in vegetable production (*Noopur et al., 2023*). Besides lack of adequate data, the potential of vegetables suited to the specific agro-climatic conditions is not exploited (*Chikkeri et al., 2023*) necessitating the need to collect

risk data in detail to address the issue. However, little is known about farmers' perceptions of the severity of these risks. Therefore, this study aims to investigate the major sources of risk and their severity as perceived by vegetable farmers in Kerala with following research questions, what are the major sources of risk in vegetable production as perceived by farmers in Kerala? how do farmers perceive the severity of these risks? It was hypothesized that the farmers in Kerala perceive major risk in vegetable production which need to be related with weather-related factors, fragmented holdings, soil quality, water scarcity, pests and diseases, market risks, and input price risks. After overcoming the risk, climate smart technology can be adopted for sustainable production (*Chauhan et al., 2019*).

METHODOLOGY

The study conducted from 2020 to 2022 aimed to identify and categorize the major sources of risks faced by vegetable farmers in the Special Agricultural Zones (SAZs) for vegetables in Kerala namely, Chittoor and Kollengode in Palakkad district, Devikulam in Idukki district, Kanjikuzhy in Alappuzha district, Pazhayannur in Thrissur district. The study included 270 vegetable farmers representing different Agro-Ecological Units (AEUs) from all the five SAZs. The sampling procedure used was a purposive sampling technique to ensure representation from all the zones.

A list of risk sources was prepared based on the interaction with farmers and experts during pilot survey and through review of literature. The risk sources were categorised into five risk categories: production, market/price, financial/credit, institutional, and human risk source.

The data for the study was collected through personal interviews with selected farmers to identify the major sources of risks under the five risk categories. The data was collected using a three-point continuum of high (3), medium (2), and low risk (1) based on farmers' perceptions.

The analytical technique used in the study were Pareto analysis and factor analysis. Pareto analysis is a quality control tool based on 80:20 principle to assess the severity of risk sources, which helped in identifying a limited number of input factors that have the greatest effect on an outcome. Pareto charts were used to represent the results for each risk category. Factor analysis is a statistical technique that reduces a set of variables by extracting all their commonalities into a smaller number of factors.

The study employed a descriptive research design, and the data collected was analysed using SPSS software. The findings provide insights into the most impactful risks faced by vegetable farmers in Kerala and can help in finding solutions to those issues more efficiently and effectively.

RESULTS AND DISCUSSION

Pareto analysis of production risk sources : The relationship between input quantity and production risk is an important aspect of agricultural management. Certain inputs can intensify yield risk while others can mitigate it *(Tveterås and Wan, 2000)*. However, variations in weather, pest infestations, and plant diseases can still cause harm to the crop and reduce vegetable production *(Alamerie et al., 2014)*. Table 1 identifies major production risk sources affecting vegetable production. The table displays the production risks that are faced by vegetable farmers, along with their frequencies of occurrence sorted in ascending order based on the cumulative frequency percentage.

Based on the Pareto analysis of the production risk sources presented (Table 1), it can be observed that wild animal attacks, climatic variations, poor soil quality, fragmented land holdings, and water scarcity were the major sources contributing to 80 per cent of production risks in Kerala. The analysis revealed that the top three sources that contribute to 59.58 per cent of the total production risk were crop damage by wild animals, climatic variations and infertile land/ poor soil quality. This implies that efforts to reduce production risk should prioritize addressing these factors. Whereas risks due to incidence of pest and diseases and availability of non-effective pesticides have a relatively lower contribution to production risk at cumulative frequency 96.05 per cent and 100 per cent respectively.

Crop damage by wild animals contributes significantly to production risk at 23.68 per cent making the most important risk and thrust should be given to address this issue in particular. Human-wildlife conflict (HWC) was a significant issue, with the Asian elephant, wild pig, Indian crested porcupine, Indian giant squirrel, Indian peafowl, bonnet macaque, and sambar being the major culprits responsible for crop damage and similar results were reported by *Conover (2002) and Jayson (2013).*

Climatic variability also had adverse effects

Table 1. Major sources of risk perceived by vegetable farmers (N=270)

Risk sources	No.	CF	%	CF%
Production risk sources				
Crop damage by wild animals	246	246	23.68	23.68
Climatic variations	233	479	22.42	46.10
Infertile land /poor soil quality	140	619	13.48	59.58
Fragmented land holdings	133	752	12.80	72.38
Water scarcity/drought	129	881	12.41	84.79
Pest and diseases	117	998	11.26	96.05
Non effective pesticides	41	1039	03.95	100
Market/ Price risk sources				
Surplus production of same crop	241	241	23.91	23.91
Price fluctuation	225	466	22.32	46.23
High cost of production	214	680	21.23	67.46
Perishability of horticultural produce	109	789	10.81	78.27
Exploitation by middlemen	92	881	9.13	87.40
Untimely payment after produce sale	82	963	8.14	95.54
Poor storage and transportation	45	1008	4.46	100
Financial risk sources				
Complicated banking procedures	238	238	48.18	48.18
High interest rate	159	397	32.18	80.36
High demand of collaterals by banks	51	448	10.33	90.69
Timely unavailability of credits	46	494	9.31	100
Institutional risk sources				
Lack of vegetable-oriented schemes	232	232	27.99	27.99
Lack of government support	214	446	25.81	53.80
Import of produce from other states	181	627	21.83	75.63
Poor extension to farmer linkage	129	756	15.56	91.19
Changing govt. regulations	73	829	9.81	100
Human risk sources				
Labour shortage	179	179	59.08	59.08
Farm accidents	84	263	27.72	86.80
Inadequate family labour	22	285	7.26	94.06
Conflict and violence among producers	18	303	5.94	100.0

on agricultural productivity, disrupting product market equilibrium and prices. Furthermore, small and fragmented land holdings were identified as a significant problem, leading to low agricultural productivity and farming activities becoming challenging and costly. Another major risk source affecting vegetable production was water scarcity, which was compounded by the low water retention capacity of the soil and high run-off losses. The results were in agreement with the findings of *Rao (2008) and Jacob (2021).*

Pareto analysis of market/ price risk sources : Market / price risk are associated with changes in prices which are affected by the supply, demand of the product, and the cost of production. Unexpected changes in supply or demand affects the market price. There is often uncertainty with regard to prices farmers will obtain for their products. Table 1 displays the market risks that are faced by vegetable farmers.

The analysis revealed that surplus production of same crop, price fluctuation, high cost of production and perishability of vegetables produced were the most frequent market risk occurring (78.27%). Farmers indulge in surplus production of same crop was found as the most important risk source. Due to this VFPCK (Vegetables and Fruits Promotion Council, Keralam) and APMC (Agricultural Produce Market Committees) markets get overloaded with vegetable supplies of same produce leading to glut in the market and farmers get forced to sell at low prices. As price is the risk factor about which farmers get highly worried and concerned about, price fluctuations add to their agony. Price peaks can jeopardize food security, whereas low prices threaten farm profitability and expected income from farm *(Heidelbach 2007)*. The prices of vegetable produce immediately after harvest tend to be low, compelling the small and marginal farmers with low or no holding capacity to resort to distress sale.

Vegetables being highly perishable in nature making it difficult for the farmers to store the produce. The results implies that these risks can be managed through measures such as improving production efficiency, implementing effective pricing strategies, diversifying crop production and provisions for processing techniques to increase the shelf life of horticultural products. The Pareto table helps to identify the most significant market risks faced by the industry, allowing for a targeted approach to risk management and mitigation. In this case, addressing the issues of surplus production of same crop, price fluctuation of produce, high cost of production and perishability of vegetable produce could have the greatest impact on reducing overall market risk.

Exploitation by middlemen, untimely payment of money after produce sale and poor storage and transportation facilities together accounted for the rest 21.73 per cent of all occurrences. This highlights the need for a fair and transparent pricing system that allows producers to receive a fair price for their produce and reduce their dependency on middlemen. In case of untimely payment of money after produce sale that occurring 82 times indicates that there is a need for a more reliable and efficient payment system to ensure that producers are paid on time and in full. Even though occurring 45 times only, the issues of poor storage and transportation facilities needs to be

addressed and it suggests that there is a need for better storage and transportation infrastructure to reduce the risk of spoilage, loss, or damage during transportation.

Overall, the Pareto table provides a clear picture of the most significant market risks faced by the industry, allowing for a targeted approach to risk management and mitigation. By addressing the most frequent risks, the industry can reduce its overall exposure to market risks and improve its long-term sustainability.

Pareto analysis of financial risk sources : Financial risk occurs when money is borrowed to finance the operation of the vegetable production. Results of Table 1 based on Pareto analysis of financial risk sources in vegetable production revealed that complicated banking procedures and high interest rates were the major sources contributing to financial risks. These two factors alone accounted for 80.36 per cent of the total financial risks faced by farmers. The cumbersome banking procedures makes it difficult for the farmers to access credit, while high interest rates make it expensive to borrow. Furthermore, the demand for collateral by banks and the timely unavailability of credit are also significant factors contributing to 19.64 per cent financial risks together in vegetable production. These factors exacerbate the credit constraints faced by farmers, limiting their ability to invest in their production and generate income.

The findings agree to the observations made by *Amanullah et al., 2019* who reported that timely unavailability of credit, fluctuating interest rates, demand of collaterals by banks and complicated banking procedures aggravates the financial instability of the farmer. The credit requirements of farmers are highly related to their expenditure pattern (*Kumar et al., 2023*). The credit constraints mainly influence the farmers output, investments, income, and welfare. The inability to access credit or obtaining credit at the wrong time hampers the farmers' ability to purchase inputs, pay for labour, and invest in new technologies, leading to reduced productivity and lower incomes *(Thakur, 2016)*.

To address these financial risks, it is essential to simplify banking procedures and reduce interest rates to make credit more accessible and affordable for farmers. Additionally, alternative financing mechanisms such as microfinance and crop insurance could be explored to provide farmers with financial safety nets and mitigate the effects of credit constraints on their production and livelihoods.

Pareto analysis of institutional risk sources : Institutional risk is a significant challenge that affects the provision of services from formal and informal organisations that support farming, such as banks, cooperatives, input dealers, and government extension agencies. In the context of vegetable production, the Pareto analysis as mentioned in Table 1 has identified lack of vegetable-oriented schemes (27.99%), lack of government support (25.81%), and import of produce from other states (21.83%) as the top three institutional risk sources that constitutes 75.63 per cent of risks together.

The import of produce from other states poses a serious threat to the local vegetable market, causing flooding of produce and leading the farmers to sell their stock at a lower price. Furthermore, imported vegetables are found to contain pesticide residues higher than the permissible limit, posing a health risk to the consumers and the findings were in tandem with the studies of *Suchitra (2015)* who reported that vegetables bought from neighbouring states contained pesticide residues three to five times higher than the permissible limit. To ensure safe and sustainable vegetable production, it is crucial to address this institutional risk source.

Lack of vegetable-oriented schemes and government support are also significant institutional risk sources that require attention. Vegetable-oriented schemes can support farmers in accessing inputs, technology, and marketing channels that are tailored to their needs. This support can go a long way in ensuring that farmers receive fair prices for their produce and promoting the production of safe vegetables. Additionally, government support in the form of policy interventions, such as regulation and financial support, can improve the vegetable production and marketing ecosystem. Addressing these institutional risk sources will help mitigate the challenges faced by vegetable farmers, promoting sustainable vegetable production and ensuring that the farmers receive fair prices for their produce. Furthermore, this will ensure that consumers can access safe and healthy vegetables without being exposed to harmful pesticide residues.

Pareto analysis of human risk sources : Human risks in vegetable production are primarily associated with the human resources involved, including labour, family members and producers. These risks can have a significant impact on the production process and, ultimately, on the yield of the crop. The Pareto analysis of human risk sources in vegetable production as

mentioned in Table 1 has identified four major sources: labour shortage, farm accidents, inadequate family labour, and conflict and violence among producers. Among these, labour shortage and farm accidents emerged as the most severe sources of human risk together attributing to 86.80 per cent of the risks.

Labour shortage (59.08%) is attributed to the increased opportunities in the non-farm rural sector, which attracts the shrinking labour force with higher wages and more regular incomes. This shortage can result in lower yields, delayed harvests, and even loss of crops. To mitigate this risk, it is important to provide incentives for labour to stay in the farming sector, such as higher wages, better working conditions, and training programs.

Farm accidents (27.72%) are the second most severe source of human risk, with farmers exposed to various hazards, including injuries from tools, machinery, and chemicals. These accidents can result in significant medical expenses, loss of work time, and even permanent disability or death.

Inadequate family labour and conflict and violence among producers are also human risk sources constituting 13.20 per cent together. Family labour is often a crucial resource for vegetable farmers, but inadequate labour can lead to insufficient crop care and lower yields. To mitigate this risk, it is important to involve family members in the planning and execution

Table 2. Overall risk sources (N=270)

Risk sources	No.	CF	%	CF%
Crop damage by wild animals	246	246	6.70	06.7
Surplus production of same crop	241	487	6.56	13.3
Complicated banking procedures	238	725	6.48	19.7
Climatic variations	233	958	6.34	26.1
Lack of vegetable-oriented schemes	232	1190	6.32	32.4
Price fluctuation	225	1415	6.13	38.5
High cost of production	214	1629	5.83	44.4
Lack of government support	214	1843	5.83	50.2
Import of produce from other states	181	2024	4.93	55.1
Labour shortage	179	2203	4.87	60.0
High interest rate	159	2362	4.33	64.3
Infertile land /poor soil quality	140	2502	3.81	68.1
Fragmented land holdings	133	2635	3.62	71.7
Water scarcity/drought	129	2764	3.51	75.3
Poor extension to farmer linkage	129	2893	3.51	78.8
Pest and diseases incidences	117	3010	3.19	81.9
Perishability of horti produce	109	3119	2.97	84.9
Exploitation by middlemen	92	3211	2.50	87.4
Farm accidents	84	3295	2.29	89.7
Untimely payment after produce sale	82	3377	2.23	91.9
Changing government regulations	73	3450	1.99	93.9
High demand of collaterals by banks	51	3501	1.39	95.3
Timely unavailability of credits	46	3547	1.25	96.6
Poor storage and transportation facilities	45	3592	1.23	97.8
Non effective pesticides	41	3633	1.12	98.9
Inadequate family labour	22	3655	0.60	99.5
Conflict and violence among producers	18	3673	0.49	100

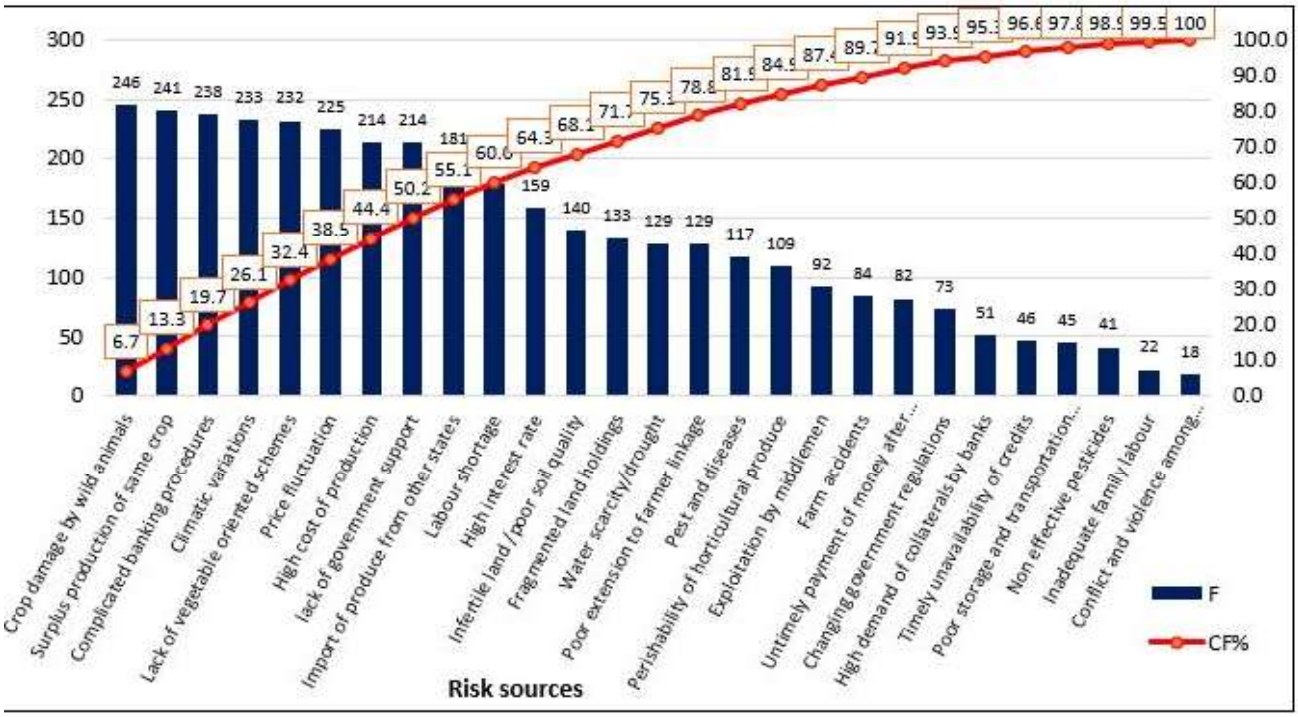

Fig. 1. Pareto Chart of overall risk sources

of farming activities and provide them with training and support as needed. Conflict among producers can also result in unpredictable yield loss, emotional distress, and physical harm to the farmers involved. To address this risk, it is important to encourage dialogue and mediation to resolve conflicts and promote peaceful coexistence among producers where extension functionaries have a great role. To summarise the risks identified needs to be attended to for promoting safe and sustainable vegetable production.

Severity of risk - Pareto analysis for the overall risk sources : The study considered all risk sources, regardless of their classification, to evaluate the severity of risks in vegetable production. The farmers' perceptions of the most severe risk sources were identified using Pareto analysis as presented in Table 2 and fig. 1.

The analysis of risk sources in vegetable production considered all potential risks and categorized them according to their perceived severity by farmers. A total of 27 risk sources were analyzed, and a Pareto chart (Fig. 1) was created to identify the top risks that had the most impact on vegetable production. The chart revealed that 80 per cent of the severity of risks were caused by 15 main risk sources, including crop damage by wild animals, surplus production of the same crop, complicated banking procedures, climatic variations, lack of vegetable-oriented schemes, price fluctuation, high cost of production, lack of government support, import of produce from other states, labour shortage, high interest rate, infertile land /poor soil quality, fragmented land holdings, water scarcity/drought, and poor extension to farmer linkage.

Among these, labour shortage and farm accidents were identified as the most severe human risks, while lack of vegetable-oriented schemes, lack of government support, and import of produce from other states were identified as the major institutional risks. The results of the analysis suggest that addressing these risk sources can significantly improve vegetable production and the livelihoods of farmers.

Addressing these 15 top risk sources would help to prioritize management strategies and mitigate the severity of risks in vegetable production (*Shelar et al., 2022*). For instance, managing wild animal attacks on crops would also reduce farm accidents caused by animals. Additionally, excessive production of crops without adequate storage and transportation facilities can lead to market glut and reduced prices, as well as post-harvest losses. Therefore, proper management of stock level and proper post-harvest handling of vegetables due to perishability are critical for reducing risks and ensuring sustainable vegetable production. These findings are consistent with previous studies on risk sources in vegetable production. The results support the views of *Pandit and Basak (2013), Kubwimana (2020) and Sulewski et al., (2020).*

Table 3. Market risk sources and their corresponding MSA

Item	MSA
Price fluctuation	0.71
Poor storage and transportation facilities	0.73
Perishability of horticultural produce	0.75
High cost of production	0.57
Surplus production of same crop	0.71
Untimely payment after produce sale	0.67
Exploitation by middlemen	0.66

Factor Analysis of risk sources : Factor analysis was employed to delineate major risk sources by the principle of extracting maximum common variance from all variables and put them into factors. Kaiser–Meyer–Olkin (KMO) test was conducted to determine how suited the data was for factor analysis. The test measures the sampling adequacy for each variable in the model with values ranging from 0 to 1. The KMO measure of sampling adequacy was less than 0.7 for production risk (0.48), institutional risk (0.48), financial risk (0.68) and human risk (0.4). A KMO value below 0.7 indicates that the common variance among the variables is relatively low compared to the individual variance, making it challenging to identify meaningful factors. This suggests that all the four categories of risk except market risk data were not suitable for factor analysis.

KMO test was conducted on the dataset of market risk with seven variables: price fluctuation, poor storage and transportation facilities, perishability of horticultural produce, high cost of production, surplus production of same crop, untimely payment of money after produce sale, exploitation by middlemen and the overall measure of sampling adequacy, called the Overall MSA was found to be 0.71. This value suggested that the variables had a moderate level of interrelation, indicating factor analysis to be appropriate.

The Table 3 below displays the individual market risk sources and their corresponding MSA values as calculated by the Kaiser-Meyer-Olkin (KMO) test. These values indicate the extent to which each item shares common variance with the other variables.

The results revealed that MSA values was above 0.7 for all risk sources except high cost of Production (0.57), indicating a satisfactory level of sampling adequacy. Generally, MSA values above 0.7 are considered acceptable. Therefore, high cost of production variable was removed from further analysis.

Paralell anlaysis : A Parallel analysis (Fig. 2) was conducted on the dataset. Parallel analysis is a technique used to determine the number of factors or components to retain in a factor analysis. It is a statistical procedure that compares the observed eigen values from the factor analysis with the eigen values obtained from randomly generated data sets. According to the parallel analysis (Fig. 2), two factors were considered statistically significant and were retained for further analysis.

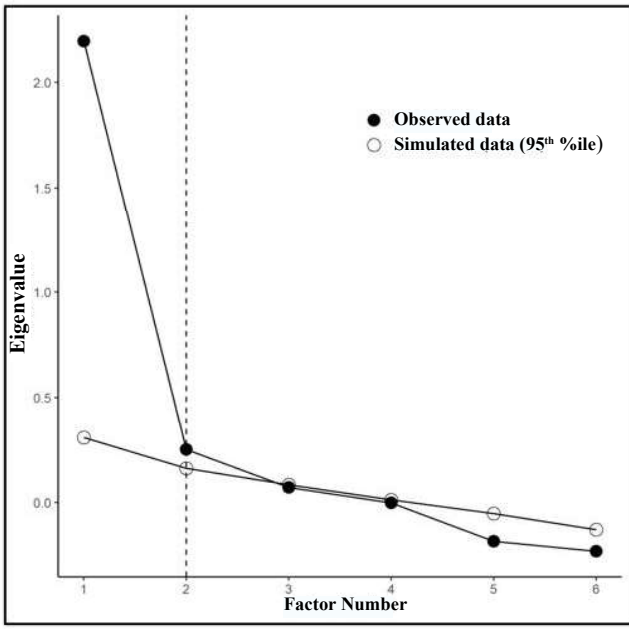

Fig. 2. Parallel analysis

Table 4. Strength and direction of relationships with Factor1 and Factor 2

Variable	Factor1	Factor2
Price fluctuation	0.760	0.126
Poor storage and transportation facilities	0.601	
Perishability of horticultural produce	0.832	
Surplus production of same crop		0.967
Untimely payment after produce sale	0.458	-0.189
Exploitation by middlemen		0.265

Table 5. Variance, including the sum of squares loadings and the proportion of variance explained by each factor, along with the cumulative variance.

	Factor 1	Factor 2
SS loadings	1.847	1.061
Proportion Var	0.308	0.177
Cumulative Var	0.308	0.485

Factor analysis : Then a factor analysis was conducted on the dataset to further explore the underlying structure and relationships among the variables (Table 4 and 5). The analysis was performed using `factanal` function in R 4.3.0, specifying a two-factor solution with a promax rotation.

The results (Table 4) revealed interesting patterns in the data, indicating the presence of two distinct factors. Factor1 demonstrated high loadings for variables price fluctuation, poor storage and transportation facilities, perishability of horticultural produce and untimely payment of money after produce sale, suggesting that these variables are closely related and contribute significantly to the underlying construct represented by Factor1 which can be named as price factors. Factor 2, on the other hand, exhibited a high loading for variable surplus production of same crop, indicating its strong association with this particular variable. Factor 2 can be named as over production factor. The analysis further showed that Factor 1 explained 30.8 per cent of the variance, while Factor 2 accounted for an additional 17.7 per cent, collectively explaining 48.5 per cent of the total variance in the data (Table 5). These findings provide valuable insights into the structure and interrelationships within the risk sources, shedding light on the underlying factors that contribute to observed patterns.

The results of the study also affirm the findings of *Roy et al. (2022) and Vasanthi, (2022)* highlighting the significance of addressing risks and establishing an efficient marketing system. By doing so, the agricultural sector can experience substantial development providing outlets and incentives for increased production while contributing to the commercialization of subsistence farmers. The proper marketing facilities such as improved packaging and reduced transportation costs, effectively tackle the challenges posed by perishable produce and reduce dependence on intermediaries. Consequently, these measures lead to a reduction in overall production costs, fostering the growth and prosperity of the agricultural industry.

CONCLUSION

Vegetable production occurs in an environment pigeon-holed by several types of risk. Risks and uncertainty significantly lower production level and

causes major losses. Farmers decisions under risky situations are best analysed by considering their perception towards risk.

The study identifies major risk sources contributing to 80 per cent of risk under production, market, financial, institutional and human risk category based on farmer's perception. Further 15 major risk factors were identified from the Pareto analysis of overall risk sources according to their perceived severity by farmers. The results of the factor analysis revealed that Factor 1 explained 30.8 per cent of the variance, while Factor 2 accounted for an additional 17.7 per cent, collectively explaining 48.5 per cent of the total variance in the data highlighting price fluctuation, poor storage and transportation facilities, perishability of horticultural produce, untimely payment of money after produce sale and surplus production of same crop as major sources contributing to market/price risk.

Some policy implications :

- Prioritize the management of top risk sources: Addressing the 15 main risk sources identified in the study can help to mitigate the severity of risks in vegetable production. The management of these risk sources should be prioritized in policy planning and implementation.
- Increase support for vegetable-oriented schemes: Lack of vegetable-oriented schemes was identified as a major institutional risk. Policy interventions that increase support for such schemes, such as subsidies for vegetable production, could be implemented to reduce this risk.
- Improve storage and transportation facilities: Excessive production of crops without adequate storage and transportation facilities can lead to market glut and reduced prices. Thus, improving storage and transportation facilities can help to reduce this risk.
- Enhance government support: Lack of government support was identified as a major risk source. Policy interventions that enhance govt. support, such as credit availability and provision of infrastructure, could be implemented to reduce this risk.
- Address labour shortage: Labour shortage was identified as one of the most severe human risks. Policy interventions that address this issue, such as increasing wages and providing training and education for farmers, could be implemented to reduce this risk.

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CONFLICT OF INTEREST

There is no conflict of interest among the authors.

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