

VALUE CHAIN ANALYSIS AND DESIGN OF A SUSTAINABLE CONSUMPTION LINKAGE MODEL FOR PHAN RANG GARLIC IN VINH HAI COMMUNE, KHANH HOA PROVINCE

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Abstract

Phan Rang garlic (*Allium sativum* L. var. Phan Rang) is an indigenous variety with the highest allicin content among domestic Vietnamese garlic cultivars (1.2-1.8 mg/g fresh weight), cultivated in the arid ecological zone of Vinh Hai commune, Khanh Hoa province. The study employs a mixed-methods approach, surveying 100 respondents across four stakeholder groups: 45 farming households, 10 distribution agents, 20 buyers and 25 end consumers, combined with SPSS statistical analysis and Value Chain Analysis (VCA). Findings confirm that Phan Rang garlic faces a quality-market paradox: product quality index $TC3 = 4.67/5$ whereas distribution linkage $TC6 = 1.40/5$ and price stability $TC7 = 1.87/5$; farmers capture only 22-27% of the final retail price while post-harvest

Key words: Phan Rang garlic; value chain; SPSS analysis; distribution linkage; origin traceability; specialty agricultural brand.

loss rates reach 15-25%. Pearson correlation analysis shows $r(\text{TC6} \times \text{TC7}) = +0.491$, establishing distribution linkage as the most critical strategic lever for improving price stability. The study proposes a five-tier integrated linkage model combining digital raw material zone management, brand identity, origin traceability and e-commerce, with a 10-indicator KPI monitoring framework for 2026-2030.

1. INTRODUCTION

Phan Rang garlic (**Allium sativum** L. var. Phan Rang) is a long-standing indigenous specialty variety that has been cultivated by the Cham people in Ninh Hai District since the 17th and 18th centuries. The distinctive semi-arid climate—characterized by annual rainfall of only 700–800 mm and 2,800–3,000 hours of sunshine—combined with sulfur-rich sandy-loam soil (a precursor for allicin biosynthesis), has created a unique, inimitable "terroir." This serves as a solid scientific basis for establishing a geographical indication in accordance with Article 79 of Vietnam's Law on Intellectual Property. From 2025, the key garlic cultivation area comprises the communes of Vinh Hai, Nhon Hai, and Xuan Hai, which now fall under Khanh Hoa Province following administrative boundary adjustments.

Ninh Thuan Province has officially recognized Phan Rang garlic as one of 12 signature local products, alongside Ninh Thuan grapes, sheep, and apples. According to data from the Ninh Thuan Department of Agriculture and Rural Development (Report No. 767/BC-SNNPTNT, dated November 17, 2023), the province's total garlic cultivation area stands at 72.9 hectares, with an average yield of 9–12 tonnes per hectare and a total output of 702.03 tonnes. With the potential to expand the cultivation area to 500–1,000 hectares and implement deep-processing technologies, the economic value of the Phan Rang garlic industry could reach VND 300–500 billion annually within the next five years.

The 3.27-point gap between product quality and market linkages serves as the clearest quantitative evidence that the issue lies not in quality itself, but in supply chain organization. This study aims to comprehensively analyze the value chain, quantify bottlenecks, and propose a sustainable linkage model for the 2026–2030 period.

2. RESEARCH OVERVIEW

The study's theoretical foundation rests on three main pillars. First, Akerlof's (1970) theory of information asymmetry—as presented in "The Market for Lemons"—explains the economic mechanism behind why Phan Rang garlic, despite its superior quality, fails to command a commensurate price: when the

market cannot distinguish between genuine and counterfeit goods, the price of high-quality products is dragged down to the general market level. Surveys confirm that 78% of distributors believe consumers struggle to differentiate authentic Phan Rang garlic from products labeled "Phan Rang" but of unclear origin. Second, the value chain theories of Porter (1985) and Kaplinsky & Morris (2003) provide an analytical framework for assessing value creation and distribution across each stage of the chain. Third, the VCA frameworks from FAO (2021) and USAID (2016) guide the methodology for measuring the performance of value chain actors and identifying optimal points for intervention.

Regarding the scientific foundation for the garlic variety, the project "Selection and restoration of the Phan Rang garlic variety"—led by Nong Lam University – Ho Chi Minh City—was approved by the Ninh Thuan Province Science and Technology Council on February 16, 2023. This work established a scientific basis regarding genetic characteristics, allicin content, dry matter content (30–35%), and the restoration process, serving as a foundation for ongoing research aimed at commercialization and the development of value chains. Furthermore, the Institute of Applied Science and Technology at Van Lang University has recognized the potential of Phan Rang garlic as a raw material for the pharmaceutical and functional food industries—a market segment offering 5 to 10 times the value-added compared to standard commercial garlic.

Regarding the comparison of market positioning, studies by the Ninh Thuan Department of Industry and Trade (2024) and VECOM (2024) indicate that Ly Son garlic—despite lacking a distinct advantage in medicinal properties—commands a retail price four to six times higher than that of Phan Rang garlic. This demonstrates that commercial value stems not merely from product quality, but from a combination of brand recognition, an organized distribution system, and market trust. A research gap exists in the lack of comprehensive quantitative analyses of the Phan Rang garlic supply chain based on field-collected SPSS data that also examine market barriers and propose a value chain digitization model. This study aims to address that gap.

3. RESEARCH METHODS

3.1. Research design and data collection

The study employed a mixed-methods approach, combining quantitative surveys and qualitative interviews. The sample size was determined using Yamane's formula (1967)— $n = N/(1 + N.e^2)$ —with a margin of error (e) of 0.069 and a 95% confidence level. A stratified sampling method based on the commune was used, followed by systematic random sampling. A total of 100 valid responses were collected between February and April 2026 in Vinh Hai commune and regional markets, comprising 45 garlic-growing households, 10 distributors, 20 buyers (traders and small-scale purchasing enterprises), and 25

end consumers. Additionally, direct field observations were conducted at cultivation areas, collection facilities, and supermarkets over a three-month period (September–November 2024).

3.2. SPSS analysis and Likert scale.

The quantitative questionnaire for the farming households (45 responses) was designed using a 5-point Likert scale (1 = Strongly disagree; 5 = Strongly agree) comprising eight criteria: (TC1) Variety is easy to cultivate and suited to soil conditions; (TC2) Stable yield across crop seasons; (TC3) Quality meets commercial standards; (TC4) Variety rejuvenation techniques are easy to apply; (TC5) Availability of technical training support; (TC6) Linkage with enterprises/cooperatives for product sales; (TC7) Stable selling price due to contracts; (TC8) Willingness to continue cultivation. Data processing involved five SPSS steps: (i) Data entry and coding; (ii) Data cleaning (Missing Values = 0); (iii) Descriptive statistics (Mean, SD, Median, CV %); (iv) Statistical testing (Cronbach's Alpha, independent t-test, Pearson Correlation, Shapiro-Wilk); (v) Construction of composite variables based on criteria groups.

3.3. Value chain analysis and economic indicators for chain actors

The value chain analysis (VCA) was conducted using the FAO/USAID framework to assess: (i) the traditional trade flow of fresh garlic; and (ii) the value-added processing chain segment. Economic indicators for each actor included: gross output (GO), intermediate costs (IC), net value added ($VA = GO - IC$), the profit ratio (VA/IC), and the benefit distribution ratio. This integrated set of indicators helps identify inequitable benefit distribution across the different tiers of the chain.

4. RESEARCH RESULTS AND DISCUSSIONS

4.1. Product characteristics and competitive position

Phan Rang garlic exhibits "paradoxical" physical characteristics regarding the relationship between size and quality: the bulbs are 30–40% smaller than Chinese garlic, with an average diameter of 3–4.5 cm and 15–20 cloves per bulb. However, its dry matter content (DM%) reaches 30–35%, surpassing that of Chinese garlic (20–25%) and Ly Son garlic (28–32%). Its allicin content—ranging from 1.2 to 1.8 mg/g of fresh garlic—is the highest among garlic varieties analyzed in Vietnam; combined with bioactive compounds such as

organic selenium, flavonoids, polyphenols, and fructo-oligosaccharides (FOS), this provides a foundation for developing functional food and medicinal products with a value-added potential 5 to 10 times higher than that of commercial garlic.

However, the small size of the cloves creates a significant "labor barrier": the cost of processing Phan Rang garlic in industrial kitchens and HORECA establishments is 40–60% higher than that of Chinese garlic, resulting in an 85% rejection rate within the B2B segment. This technical hurdle requires investment in semi-automated peeling lines; it cannot be resolved through variety improvement, as doing so would compromise the garlic's distinctive quality characteristics.

A competitive matrix analysis confirms that Phan Rang garlic is caught in a strategic "pincer" (or "stuck in the middle" scenario, per Porter, 1985): squeezed between Ly Son garlic (a strong brand commanding a high price of 200,000–500,000 VND/kg) at the high end and imported Chinese garlic (low-priced at 22,000–28,000 VND/kg with large cloves) at the low end. A particularly striking branding paradox exists: Phan Rang black garlic (a processed product) fetches 1,400,000–2,500,000 VND/kg, whereas fresh Phan Rang garlic (the raw material) commands only 50,000–90,000 VND/kg and is lumped into the "ordinary garlic" category in the retail market. This demonstrates that the market is willing to pay a premium when a product possesses a clear brand identity and established processing standards.

Table 1. Comparison of the competitive position of Phan Rang garlic against key market competitors

Comparative indicators	Phan Rang	Lý Sơn	China	Domestic Northern
DM content (%)	30-35 (highest)	28-32	20-25	22-28
Allicin content	★★★★★	★★★★☆	★★★★☆	★★★★☆
Retail price (VND/kg)	50.000-90.000	200.000-500.000	50.000-80.000	60.000-120.000
Brand identity	Medium	Very powerful	weak	Weak
Traceability	★☆☆☆☆	★★★★☆	★☆☆☆☆	★★★★☆
Suitable for B2C	★★★★★	★★★★★	★★★★☆	★★★★☆
Suitable for B2B/HORECA	★☆☆☆☆	★☆☆☆☆	★★★★★	★★★★☆

Source: Surveys of dealers and consumers, food sample analysis, and compilation 2026

4.2. Supply chain status and economic efficiency

The Phan Rang garlic supply chain currently operates under a traditional model with the primary flow: Farmers → Traders/Collection agents → Urban wholesalers → Retailers (traditional markets: 55–60%; supermarkets: 15–20%; e-commerce: 8–12%; other channels: 10–15%) → End consumers. Parallel to this is a value-added processing branch—involving cooperatives and processing enterprises—that produces black garlic, dried garlic, and garlic powder for distribution as specialty products. Although this processing branch generates the highest value-added, it currently accounts for less than 10% of total output.

A notable point: The detailed production efficiency table (Table 2) reveals that, despite relatively high economic efficiency per unit of area ($GO/IC = 2.22$; $VA/IC = 1.22$; profit margin of 122%), the bulk of the value added remains concentrated in the raw material production stage. Farmers have not yet engaged in deep processing, branding, or direct distribution—activities that generate significantly higher profit margins within the value chain. While the value added of 38.47 million VND per *sao* per crop is a positive figure, it is entirely dependent on market price fluctuations, posing a significant risk due to the absence of off-take contracts.

Table 2. Garlic production efficiency of households in Vinh Hai Commune (sao/crop/year)

No	Index	Unit	value (VND)
1	Gross Output (GO)	VND/sao/crop	70.000.000
2	Total production cost (IC)	VND/sao/crop	31.532.000
2.1	Material costs (including converted seeds*)	VND	27.788.000
2.2	Irrigation electricity and water costs	VND	1.744.000
2.3	Labor costs (family + hired)	VND	2.000.000
3	Value added ($VA = GO - IC$)	VND/sao/crop	38.468.000
4	Revenue-to-cost efficiency (GO/IC)	times	2,22
5	Value-added efficiency relative to cost (VA/IC)	times	1,22
6	Estimated profit margin ($VA/IC \times 100\%$)	%	122

(*) Seed value is converted based on market prices to fully reflect opportunity costs; the majority of households use seeds retained from the previous season.

Source: 2025 field survey; compilation and calculations by the research team, 2026.

4.3. Results of the multi-factor SPSS analysis

Descriptive statistics from 45 household surveys (Table 3) reveal a stark contrast between the two groups of criteria. The group concerning quality and production commitment scored very highly: TC3 "Product quality" (Mean =

4.67; SD = 0.62), TC8 "Willingness to continue farming" (Mean = 4.93; SD = 0.26—reflecting near-total consensus), and TC2 "Stable yield" (Mean = 4.60). Conversely, the market linkage group showed alarming results: TC6 "Linkage with enterprises/cooperatives" (Mean = 1.40; SD = 0.51) and TC7 "Stable selling price" (Mean = 1.87; SD = 0.52). The 3.27-point gap between TC3 and TC6 serves as the clearest quantitative evidence of the quality-market paradox. Pearson correlation analysis (Figure 1) reveals three significant findings with

Table 3. SPSS descriptive statistics – 8 Likert-scale criteria for the survey of Phan Rang garlic-growing households (n = 45)

No	Index	Mean	SD	Min	Max	Assessment
1	An easy-to-grow variety well-suited to the local soil.	4,13	0,35	4	5	Good ✓
2	Stable yield across seasons	4.60	0.51	4	5	Very good ✓
3	Quality (aroma, taste, size, dryness) meets commercial standards	4.67	0.62	3	5	Very good ✓
4	Easy-to-apply variety restoration techniques	3,67	0,49	3	4	Medium
5	Support for training and technical guidance	3,47	0,64	3	5	Medium
6	Linkages with businesses/cooperatives for product sales	1,40	0,51	1	2	Very weak ✗
7	Stable selling prices through partnership contracts	1,87	0,52	1	3	Very weak ✗
8	Aiming to continue developing the revitalized Phan Rang garlic variety.	4,93	0,26	4	5	Excellent ✓

Source: SPSS analysis of 45 household surveys, Vinh Hai Commune, Khanh Hoa, 2026.

strategic implications: (i) TC6 and TC7 are positively correlated ($r = +0.491$), confirming that addressing consumption linkages leads to improved sales price stability—this represents the most critical "strategic leverage point"; (ii) TC3 and TC7 are negatively correlated ($r = -0.598$), confirming the paradox where high quality does not translate into stable sales prices; and (iii) TC3 and TC6 are negatively correlated ($r = -0.456$), indicating that product quality has not yet translated into market linkage capability. Shapiro-Wilk test for productivity data: $W = 0.931$; $p = 0.26$. → Normal distribution, mean = 9.87 tonnes/ha, 95% confidence interval: [9.01–10.73 tonnes/ha]. Independent t-test for TC5 (training): $t = -0.579$; $p = 0.573$ → No statistically significant difference was found between the groups that did and did not participate in the training; this suggests a need to improve training content and methods, rather than simply

increasing the frequency of sessions. A survey of additional stakeholder groups

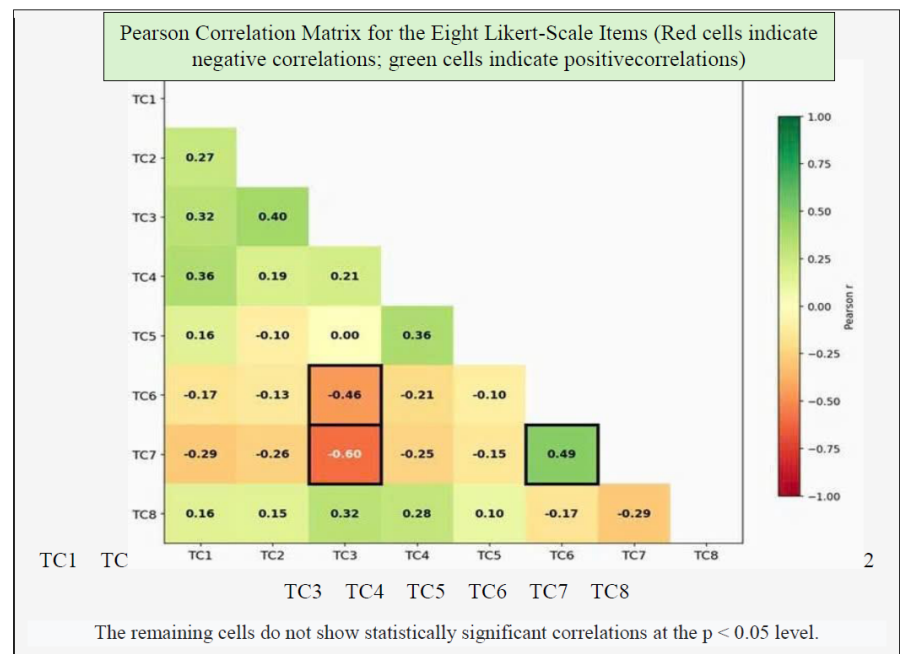


Figure 1. Pearson correlation matrix of 8 survey criteria for Phan Rang garlic-growing households (n = 45)

revealed the following: (i) Distributors (n = 10): Criterion TC6 ("Desire to expand distribution channels") scored a mean of 4.30/5, indicating a positive market signal; however, TC4 ("Trade and marketing support") scored only 2.40/5, and 67% of distributors had encountered products of unknown origin or counterfeits labeled as "Phan Rang." (ii) Buyers (n = 20): TC7 ("Desire to expand procurement") scored a mean of 4.30/5; however, 90% of transactions lacked formal contracts, and 85% required preliminary processing after purchase. (iii) Consumers (n = 25): TC1 ("Awareness and usage") scored a mean of 4.64/5, and TC2 ("Flavor assessment") scored 4.60/5; the majority were willing to pay a premium for products featuring traceability QR codes.

Market Barrier System and Strategic Bottlenecks Based on a synthesis of SPSS analysis and field surveys, the study identified eight types of market barriers preventing Phan Rang garlic from achieving a value commensurate with its quality (Table 4). Notably, two barriers rated as "Very High" are the lack of a synchronized traceability and origin verification system (Traceability Gap) and weak brand recognition coupled with the prevalence of counterfeit goods (Brand Equity Gap). According to Akerlof's theory (1970), in the ab-

sence of a mechanism to distinguish between genuine and counterfeit products, the value of high-quality goods is dragged down to the general market average; this economic mechanism directly accounts for the scores of $TC6 = 1.40$ and $TC7 = 1.87$.

Table 4. Trade barrier system for Phan Rang garlic and priority solutions

Type of barrier	Specific manifestations	Level	Priority solutions
Origin traceability and authentication (Traceability Gap)	Lack of comprehensive digital identification; 78% of dealers confirm widespread counterfeit goods	Very high	Identification code system + QR + multi-party digital authentication
Brand (Brand Equity Gap)	Low recognition; lumped together with "ordinary garlic" in the retail market	Very high	Registration of geographical indication + collective mark
Processing labor (Labor Barrier)	Small, hard-to-peel cloves; high B2B/HORECA processing costs (40–60%)	High	Semi-automated peeling lines + vacuum-packed peeled garlic
Post-harvest handling (Post-harvest Loss)	15–25% loss; lack of cold storage and standardized processing facilities	High	Controlled-temperature curing technology + MAP + cold storage
Contract Gap	< 5% have formal contracts; 90% of transactions rely on verbal agreements	High	Farmer-Cooperative-Enterprise linkage model
Standard Gap	Lack of consistent VietGAP/GlobalGAP compliance; ESG requirements not yet met	High	VietGAP training + digital farm logs
Marketing (Marketing Gap)	Lack of promotion and product storytelling; distributors left to fend for themselves	Mode rate	Integrated digital communication campaign
Production Capital (Capital Barrier)	Farmers lack early-season capital; limited access to formal credit	Mode rate	Preferential loan support via cooperative guarantee mechanisms

Source: Compiled from dealer interviews, SPSS analysis, and market surveys, 2026.

5. Proposed linkage chain model and set of solutions

5.1. Digitally integrated 5-tier linkage chain model

Based on the SPSS analysis results—specifically the two lowest-scoring criteria ($TC6 = 1.40/5$ and $TC7 = 1.87/5$) and the strategic correlation of $r(TC6 \times TC7) = +0.491$ —the study proposes a 5-tier linkage chain model oriented towards agricultural digital transformation (Figure 2). The fundamental difference compared to traditional models is that cultivation area data, digital identifiers, and traceability QR codes serve not merely as supplementary management tools, but as a foundational infrastructure connecting all five tiers, thereby transforming product information into valuable commercial assets.

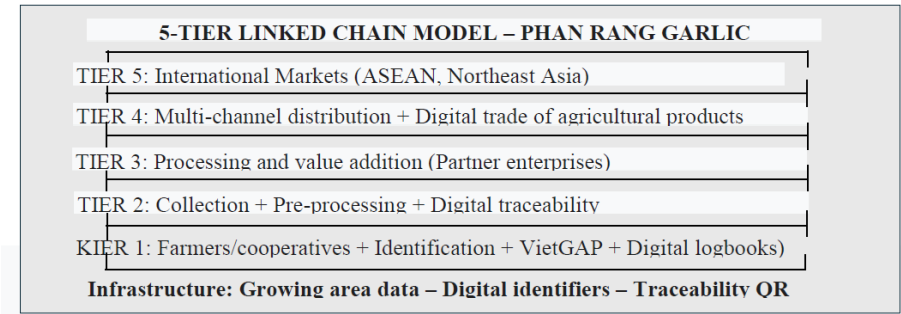


Figure 2. Structural diagram of the integrated 5-tier linkage chain model – Phan Rang garlic.

Source: Research team's proposal, 2026.

Tier 1 – Organized Production: The specialized cooperative acts as a “coordination hub and production satellite,” assigning digital IDs to individual member households, managing electronic farming logs and revitalized seed varieties, and ensuring VietGAP compliance. Linkage mechanisms and accountability commitments are established through the digital identification system; the cooperative serves not only as the production organizer but also as the core entity for managing digital value-chain data.

Tier 2 – Collection and Primary Processing: The coordination center oversees input quality control, assigns electronic IDs to each product batch, and authenticates origins via dynamic QR codes. A semi-automated peeling line catering to the HORECA segment directly addresses the “labor barrier”—the most significant obstacle for the B2B market.

Tier 3 – Processing and Value Addition: Partner enterprises develop value-added product lines (fermented black garlic priced at 1,400,000–2,500,000 VND/kg; dried garlic; garlic powder; garlic essential oil; FOS functional foods). Each

post-processing batch is assigned an electronic identifier linked to cultivation area data and production logs.

Tier 4 – Multi-channel Distribution: Integration of traditional channels (supermarkets, clean food stores, wholesale markets) with digital channels (agricultural e-commerce platforms, B2B, HORECA). Particular priority is given to developing tourism and local specialty channels linked to Khanh Hoa’s tourism ecosystem, leveraging local advantages following the merger.

Tier 5 – International Market: A three-stage roadmap: (i) Standardizing cultivation area codes and electronic product dossiers; (ii) Connecting to regional e-commerce platforms and facilitating official exports within ASEAN; (iii) Accessing high-end markets in Japan and South Korea through Global-GAP certification and multi-layered traceability data.

5.2. Production and technology solutions

Priority is given to addressing the three most significant technical bottlenecks. First, implementing a curing process that maintains temperatures of 32–38°C and humidity levels of 65–70% for 10–14 days—replacing natural sun-drying—combined with controlled-atmosphere cold storage and Modified Atmosphere Packaging (MAP), aims to reduce losses from the current 15–25% range to below 8%. Second, investing in semi-automated peeling lines (utilizing pneumatic or water-pressure technology) and developing vacuum-packed peeled garlic for the HORECA sector will overcome labor-related constraints and unlock the B2B market, which currently accounts for less than 3% of sales. Third, implementing electronic farming logs, cultivation area identifiers, and QR-code-based traceability systems for individual product batches to establish a unified data platform for the entire supply chain.

5.3. Branding and digital marketing solutions

The “White Gem from the Land of Sunshine” brand strategy is built upon three synchronized layers: (i) Legal layer – registering geographical indication protection for “Phan Rang Garlic” in accordance with Article 79 of Vietnam’s Intellectual Property Law, alongside a collective trademark for all chain participants; (ii) Digital identity layer – a multi-layered traceability system utilizing dynamic QR codes that link cultivation area data, farming logs, and distribution history; (iii) Brand storytelling layer – highlighting the unique “terroir” of the arid region, the Cham people’s cultivation heritage, and scientifically proven medicinal values. Integrated digital marketing activities include: content marketing featuring short videos showcasing the production process; origin verification marketing (QR codes enabling consumers to directly check product information); and the development of agricultural e-commerce and online search SEO.

5.4. Policy Solutions and Institutional Linkages

The cooperative-enterprise linkage model along the value chain is designed with a transparent benefit-sharing mechanism: farmers receive $\geq 50\%$ of the final retail price (instead of the current 22-27%) through legally binding purchase contracts. Cooperatives commit to controlling standards and traceability; enterprises purchase on a long-term basis and support market development. Risk-sharing mechanism: when the market fluctuates or natural disasters occur, risks are distributed fairly according to a formula predetermined in the contract. Restoring and digitizing the GEN code of Phan Rang garlic creates a long-term foundation for traceability and geographical indication. Mobilizing multi-source financing: state budget (OCOP, digital transformation, green finance), preferential credit guaranteed through cooperatives, and enterprise investment capital in exchange for priority purchase rights.

6. Implementation Roadmap and Monitoring KPI System (2026–2030) The implementation roadmap comprises three phases: Phase 1 – Foundation (Years 1–2): establishing specialized farming cooperatives, finalizing geographical indication (GI) protection dossiers, and implementing electronic farming logs and growing area identification codes; Phase 2 – Supply Chain Development (Years 2–3): signing sales linkage contracts, investing in primary processing and storage infrastructure, and boosting e-commerce; Phase 3 – Market Expansion (Years 3–5): developing deep-processed products, promoting international trade, and integrating ESG criteria into raw material sourcing standards. The monitoring KPI system is structured around a four-level M&E framework (inputs, activities, outputs, and impacts) with assessments conducted every six months (Table 5).

7. CONCLUSIONS AND RECOMMENDATIONS

7.1. Conclusions

The study has confirmed and quantified three key findings: First, Phan Rang garlic faces a severe "high quality vs. low market value" paradox; the 3.27-point gap between Criterion 3 ($TC3 = 4.67/5$ for quality) and Criterion 6 ($TC6 = 1.40/5$ for market linkages) serves as clear quantitative evidence. Farmers receive only 22–27% of the final retail price while suffering post-harvest losses of 15–25%; this is a structural supply chain issue, not a product quality problem. Second, the Pearson correlation coefficient $r(TC6 \times TC7) = +0.491$ identifies market linkages ($TC6$) as the most critical strategic lever: improving these linkages would automatically lead to price stability, representing the most effective and resource-efficient intervention point across the entire value chain. Third, the score for Criterion 8 ($TC8 = 4.93/5$ for the intention to continue farming) confirms that household social capital is the most vital asset for building

Table 5. KPI system for monitoring and evaluating the Phan Rang garlic value chain (2026–2030)

No	Index/KPI	Current status 2026	Target 2030	Monitoring agency
1	Percentage of households with formal consumption contracts (%)	< 5%	≥ 70%	HTX + DN
2	Share of the final retail price received by farmers (%)	22-27%	≥ 50%	Household economic survey
3	Post-harvest loss rate (%)	15-25%	< 8%	Cooperatives & primary processing facilities
4	Average yield (tonnes/ha/crop)	9,87	≥ 12	Regulatory agency
5	Consumption-linked Likert score (TC6)	1,40/5	≥ 4,0/5	SPSS Survey
6	Likert score for selling price stability (TC7)	1,87/5	≥ 4,0/5	SPSS Survey
7	Percentage of products with traceability and standardized packaging (%)	# 0%	≥ 80%	Market regulatory agency
8	Number of official distribution channels	3-4	≥ 8	Market survey
9	Average farm-gate purchase price (VND/kg)	40.00-60.000	≥ 90.000	Cooperative monitoring
10	Revenue from export markets	Not yet	Stable formation	Department of Industry and Trade, Customs

Source: Research team's proposal based on SPSS survey results and value chain analysis, 2026.

sustainable supply chain linkages—an asset that should be leveraged through specialized cooperative models utilizing digital data management.

The proposed integrated five-tier value chain model aims not only to boost revenue but also to achieve a strategic objective: transforming Phan Rang garlic from an undifferentiated commodity (priced at 50,000–90,000 VND/kg) into a specialty agricultural product—backed by legal protection, transparent traceability, and a recognized regional brand—with the potential to command retail prices comparable to Ly Son garlic (200,000–500,000 VND/kg) within the next five years.

For Khanh Hoa provincial authorities: Prioritize support for finalizing registration dossiers for the “Phan Rang Garlic” geographical indication and collective trademark; invest in infrastructure for preliminary processing and storage; and strengthen market controls to combat counterfeit goods. Integrate the OCOP program, agricultural digital transformation, and green finance into the development of value chain linkages. Leverage new geographical advantages following the merger by connecting Khanh Hoa’s tourism ecosystem with distribution channels for Phan Rang garlic specialties.

For agricultural agencies: Implement standardized VietGAP procedures and electronic farm record-keeping systems; support periodic variety rejuvenation and the distribution of certified seed stock to linked production areas. Improve the content and methodology of technical training programs (a t-test result of $p = 0.573$ indicates that current training effectiveness has not yet yielded a statistically significant difference).

For enterprises and investors: Engage in long-term consumption partnerships featuring guaranteed floor prices and clear risk-sharing mechanisms; invest in semi-automated peeling/processing lines, MAP cold storage, and digital traceability systems—the three investment areas with the greatest direct impact on market expansion potential.

For cooperatives and farming households: Farmers should proactively join cooperatives, diligently maintain cultivation logs, and strictly adhere to technical protocols. Cooperatives should prioritize establishing transparent benefit-sharing mechanisms that ensure farmers receive at least 50% of the final retail price—a critical economic threshold for maintaining farmers’ long-term commitment to the value chain (with a TC8 score of 4.93/5 representing the most vital social capital to be safeguarded).

References

- [1] Akerlof, G.A. (1970). The Market for “Lemons”: Quality Uncertainty and the Market Mechanism. *Quarterly Journal of Economics*, 84(3), 488-500.
- [2] Ministry of Agriculture and Rural Development of Vietnam (2022). Summary Report on the Spice and Root/Tuber Crop Sector in 2022. Hanoi: Agricultural Publishing House.

- [3] FAO (2021). Strengthening Agricultural Value Chains: A Framework for Analysis and Action. Rome: FAO.
- [4] Ninh Thuan Provincial Science and Technology Council (2023). Acceptance Minutes for the Project: Selection and Restoration of the Phan Rang Garlic Variety. February 16, 2023. University of Agriculture and Forestry Ho Chi Minh City.
- [5] Kaplinsky, R. & Morris, M. (2003). A Handbook for Value Chain Research. Ottawa: IDRC. Nguyen Thi Lan et al. (2022). Biochemical Characteristics and Medicinal Potential of Phan Rang Garlic. Vietnam Journal of Agricultural Sciences, 20(5), 612-625.
- [6] Pham Van Hien, Bui Minh Tri, Phan Phuoc Hien (2024), Genetic analysis of seven Garlic Varieties from prominent Growing area in Southern Vietnam, Southeast Asian Journal of Science, ISSN 2286- 7724 (electronic), ISSN 2350-9910 (print) Vol.11, No.11 (2024), pp: 56-65.
- [7] Phan Phuoc Hien and IAST/VLU researchers (2026): Institute of Applied Science and Technology (IAST), Van Lang University HCMC Vietnam: Scientific Report on Results Achieved through June 2026 of the Project "Replication, Application, and Development of Restored Phan Rang Garlic Seed Production in Vinh Hai Commune, Khanh Hoa Province," Project Code: 04/2024/HD- SKHCN* .
- [8] Porter, M.E. (1985). Competitive Advantage: Creating and Sustaining Superior Performance. New York: Free Press.
- [9] Ninh Thuan Provincial Department of Agriculture and Rural Development (2023). Report No. 767/BC-SNNPTNT dated November 17, 2023: Current Status of Phan Rang Garlic Production. Phan Rang-Thap Cham.
- [10] Ninh Thuan Provincial Department of Industry and Trade (2024). Report on Distribution and Trade Promotion for Ninh Thuan's Specialty Agricultural Products. Phan Rang-Thap Cham.
- [11] Ninh Thuan Provincial People's Committee (2023). Development Plan for 12 Specialty Products of Ninh Thuan Province for the 2023-2030 Period. Phan Rang-Thap Cham.
- [12] USAID (2016). Value Chain Analysis in a Rapidly Developing Country Context. Washington DC: USAID.
- [13] VECOM (2024). Vietnam E-Business Index Report 2024: Opportunities for Specialty Agricultural Products. Hanoi.
- [14] Yamane, T. (1967). Statistics: An Introductory Analysis. 2nd ed. New York: Harper & Row.