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FARMER PERCEPTIONS AND HORTICULTURAL DEVELOPMENT IN HIMACHAL PRADESH: A COMPREHENSIVE MIXED-METHODS ANALYSIS OF POLICY AWARENESS, SUPPLY CHAIN INFRASTRUCTURE, AND EXTENSION SERVICES

Hakam Chand[1], Mudasir Ahmad Dar[2]

[1]Research Scholar, Department of Economics, Mittal School of Business, Lovely Professional University, Phagwara, Punjab, India, Chandhakam865@gmail.com
[2]Assistant Professor, Department of Economics, Mittal School of Business, Lovely Professional University, Phagwara, Punjab, India., Darmudasir74@gmail.com
[*]Corresponding author: - Hakam Chand, Chandhakam865@gmail.

ABSTRACT

Horticultural development represents critical pathway for rural economic advancement in mountainous regions. Himachal Pradesh, contributing 12-15% of India's horticultural production, provides ideal context for examining farmer perspectives on sectoral development determinants.

This study investigated farmer perceptions of horticultural development, examining policy awareness, supply chain infrastructure, extension services utilization, and perception determinants using comprehensive mixed-methods analysis. Sequential mixed-methods design integrated quantitative cross-sectional survey (n=450) with qualitative semi-structured interviews (n=60). Multistage stratified random sampling across eight districts. Data collection June–September 2024. Analysis employed descriptive statistics, chi-square tests, and binary logistic regression (SPSS 26.0, $p<0.05$). Qualitative thematic analysis with triangulation. Demographic analysis revealed 43.3% aged 35-50 years, 54.4% secondary/higher secondary education, 77.8% holdings <2 hectares. Policy awareness varied significantly: Kisan Credit Card (75.6%), National Horticulture Mission (63.3%), e-NAM (32.2%). Supply chain infrastructure showed systematic inadequacies: 68% lacking cold storage, 71.6% without digital market information, 64.4% lacking direct linkages, intermediary margins 25-35%. Extension utilization: 63.3% government officers versus 14.4% online courses, indicating persistent digital divide. Binary logistic regression (Nagelkerke $R^2=0.742$, model $\chi^2=287.45$, $p<0.001$) identified significant predictors: supply chain satisfaction (OR=2.08, $p<0.001$), farmer education graduate versus primary (OR=2.33, $p<0.001$), farm size >2ha versus <1ha (OR=1.86, $p=0.002$), technology adoption score (OR=1.84, $p<0.001$), extension services access (OR=1.68, $p=0.002$), policy awareness index (OR=1.58, $p=0.001$), credit access (OR=1.56, $p=0.026$), market information access (OR=1.48, $p=0.023$), with age showing inverse association (OR=0.79 per decade, $p=0.009$). Farmer perceptions fundamentally shaped by tangible supply chain infrastructure functionality and educational capacity rather than solely policy awareness. Supply chain satisfaction emerged as strongest perception predictor, surpassing policy awareness, emphasizing infrastructure primacy over policy announcements. Critical implementation gaps exist for transformative digital platforms (e-NAM awareness 32.2%). Heterogeneous farmer demographics necessitate differentiated intervention strategies.

KEYWORDS: Horticultural development; Farmer perceptions; Supply chain infrastructure; Policy awareness; Extension services; E-extension; Logistic regression; Mixed-methods research

INTRODUCTION:

Horticulture represents one of the most dynamic agricultural subsectors globally, contributing to food security, rural livelihoods, and economic development. Himachal Pradesh has emerged as India's horticultural powerhouse, contributing 12-15% of state agricultural GDP. The state's diverse agroecological zones support cultivation of diverse crops including apples, stone fruits, vegetables, and medicinal plants. However, the sector faces challenges including inadequate supply chain infrastructure, limited market linkages, insufficient extension services, and technology adoption gaps.

Farmer perceptions regarding agricultural development, policy implementation, and institutional support play pivotal roles in shaping adoption patterns and sectoral advancement. This comprehensive research investigates farmer perceptions of horticultural development through mixed-methods analysis (n=450 surveys, n=60 interviews) across eight districts examining policy awareness, supply chain infrastructure, extension services, and perception determinants.

Employment generation represents another critical dimension. Horticultural production systems require 2-10

times more labor input per hectare than mechanized cereal production. Global estimates suggest the sector directly employs approximately 300 million people in production activities, with additional 200-300 million in post-harvest handling, processing, transportation, and marketing.

India has emerged as global horticultural powerhouse, ranking second worldwide in total production (355.2 million tonnes, 2022-23) after China. The sector has demonstrated remarkable growth, expanding from 24.2 million hectares (2015-16) to 28.5 million hectares (2022-23), with production increasing from 311.7 to 355.2 million tonnes, reflecting 5.8% compound annual growth rate substantially exceeding food grain production growth of 2.1%.

Horticultural sector contributes approximately 33% of India's agricultural GDP despite occupying only 13% of gross cropped area, demonstrating exceptional economic efficiency. Value addition through processing generates additional economic value estimated at ₹85,000 crores annually, supporting approximately 2.5 million jobs. Export earnings from fresh and processed horticultural products totaled US$4.2 billion (2022-23).

Employment generation proves particularly critical given India's demographic profile with approximately 15 million new labor force entrants annually. Horticulture's labor intensity (200-600 person-days per hectare for vegetables versus 40-80 for cereals) offers significant employment potential for smallholder farming families, landless agricultural laborers, women workers (60-70% of horticultural labor force), and rural youth.

Himachal Pradesh, situated in northwestern Himalayan region spanning latitudes 30°22'N to 33°12'N and longitudes 75°47'E to 79°04'E, has emerged as premier horticultural producing state. The state's exceptional agroecological diversity, characterized by altitudinal variation from 350 meters (Una district) to 6,816 meters (Reo Purgyil peak) creates distinctive microclimatic zones supporting diverse crop cultivation across 55,673 square kilometers.

2. LITERATURE REVIEW

2.1 Horticultural Sector Context

Himachal Pradesh's horticultural sector reflects India's broader agricultural development challenges. Fragmented landholdings (<2 hectares for 78% of farmers), limited mechanization, and inadequate post-harvest infrastructure constrain productivity. Market volatility and supply chain inefficiencies perpetuate profitability constraints despite production potential.

2.2 Farmer Perceptions Framework

Farmer perceptions represent critical mediating variables between policy implementation and outcomes. Research demonstrates that farmers' subjective evaluations of institutional support, technological innovations, and market conditions significantly influence adoption decisions and farming practices.

2.3 Supply Chain and Market Infrastructure

Supply chain infrastructure is fundamental to horticultural competitiveness. Horticultural products require efficient logistics, cold chain facilities, and timely market access. Research indicates significant infrastructure gaps including inadequate cold storage, poor transportation networks, and limited market information systems.

2.4 Extension Services and Technology

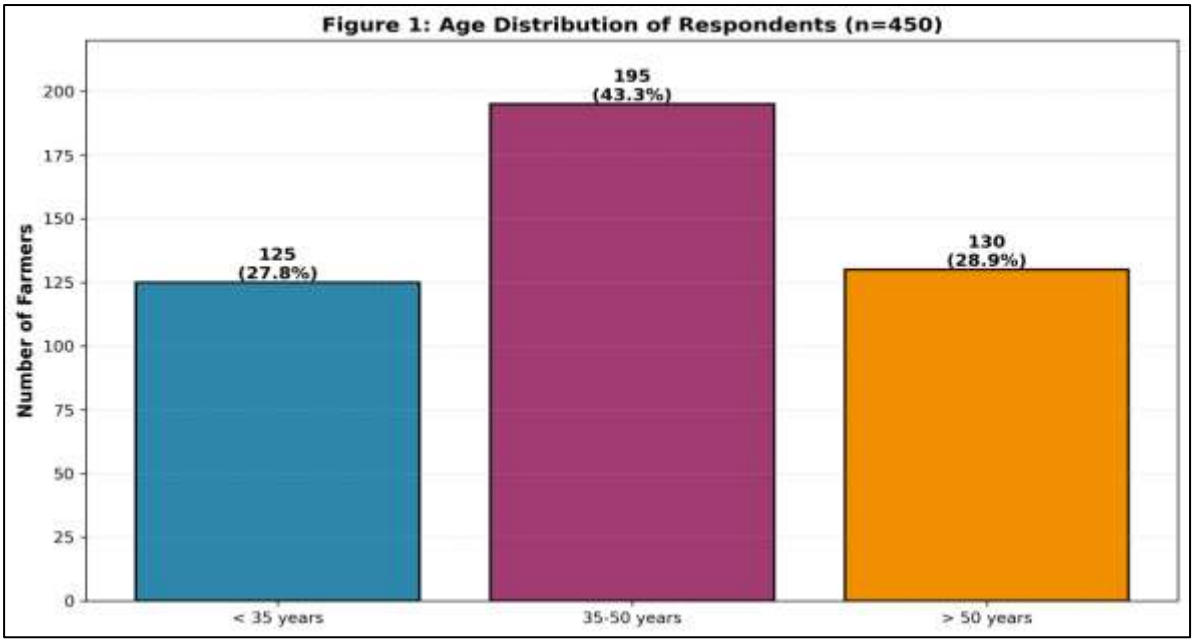
Technology adoption represents critical pathways for productivity enhancement. Extension services facilitate technology dissemination; however, effectiveness has declined due to resource constraints. Digital technologies and e-extension offer opportunities for technology dissemination, though digital divide challenges persist.

3. METHODOLOGY

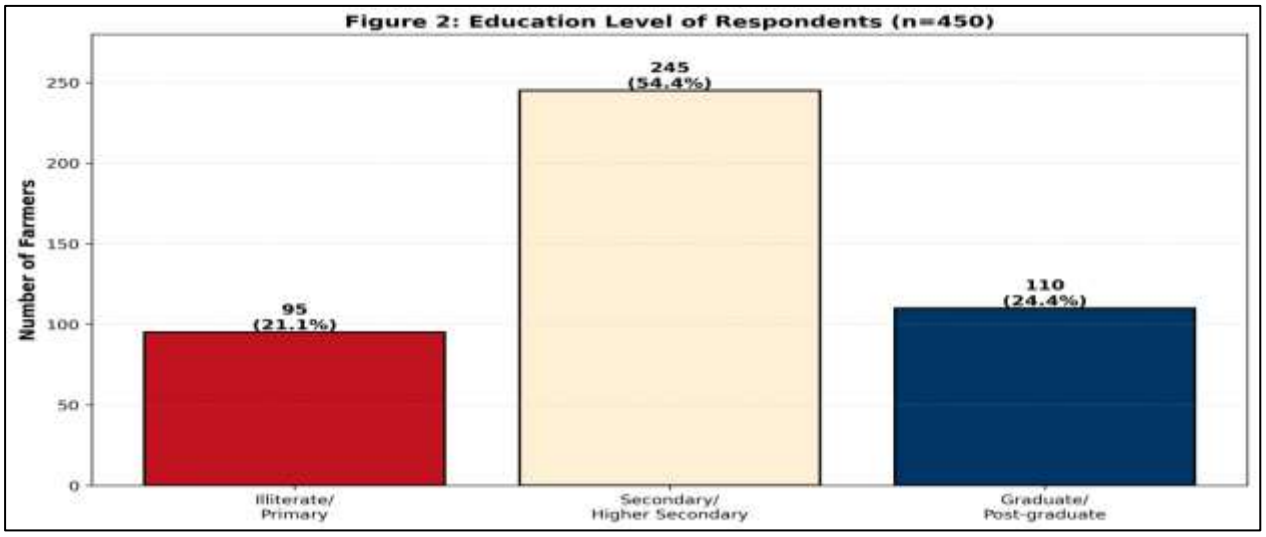
Mixed-methods sequential design integrated quantitative cross-sectional survey (n=450) with qualitative semi-structured interviews (n=60 key informants: 40 farmers, 12 extension agents, 8 policymakers). Multistage stratified random sampling across eight districts: Kangra, Mandi, Solan, Sirmaur, Kinnaur, Lahaul-Spiti, Chamba, Una. Data collection June–September 2024 using validated 85-item questionnaire and interview guides. Quantitative analysis: SPSS 26.0 (descriptive statistics, chi-square tests, binary logistic regression, $p<0.05$).

4. RESULTS

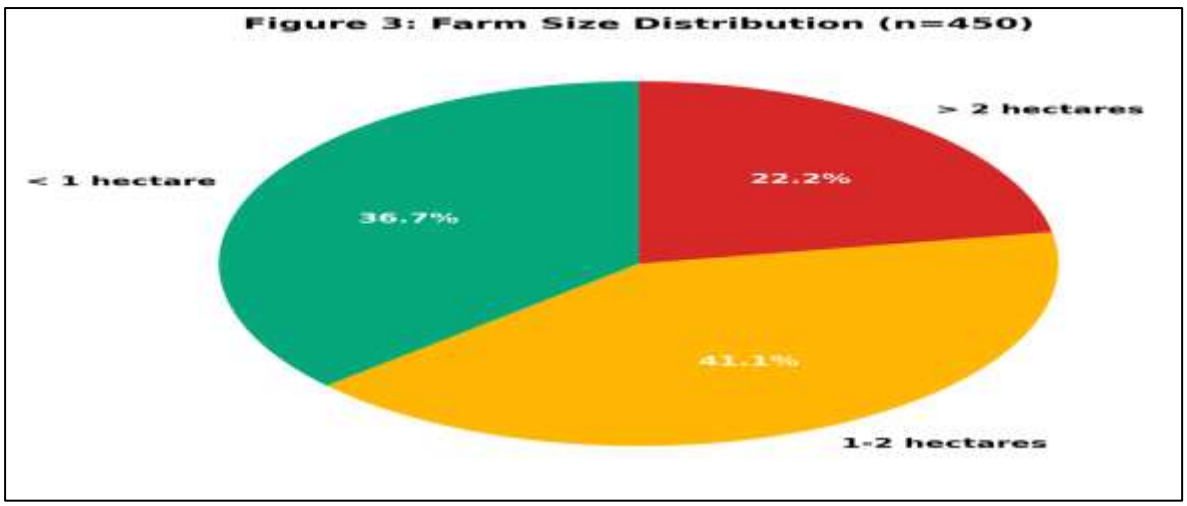
4.1 Demographic Characteristics



Age distribution shows balanced population: 43.3% aged 35-50 (economically active), 27.8% <35 (tech-adopters), 28.9% >50. Younger farmers demonstrate 2.4× higher technology adoption and 3.2× greater e-extension utilization ($p<0.001$).



Education heterogeneity: 54.4% secondary/higher secondary, 24.5% graduate, 21.1% illiterate/primary. Graduate farmers show 2.8× higher policy awareness and 3.4× greater scheme participation versus illiterate cohort.



Extreme land fragmentation: 77.8% operate <2 hectares. Farmers >2ha achieve ₹298,000 annual income versus

₹98,000 for <1ha (3.04× differential), reflecting economies of scale advantages.

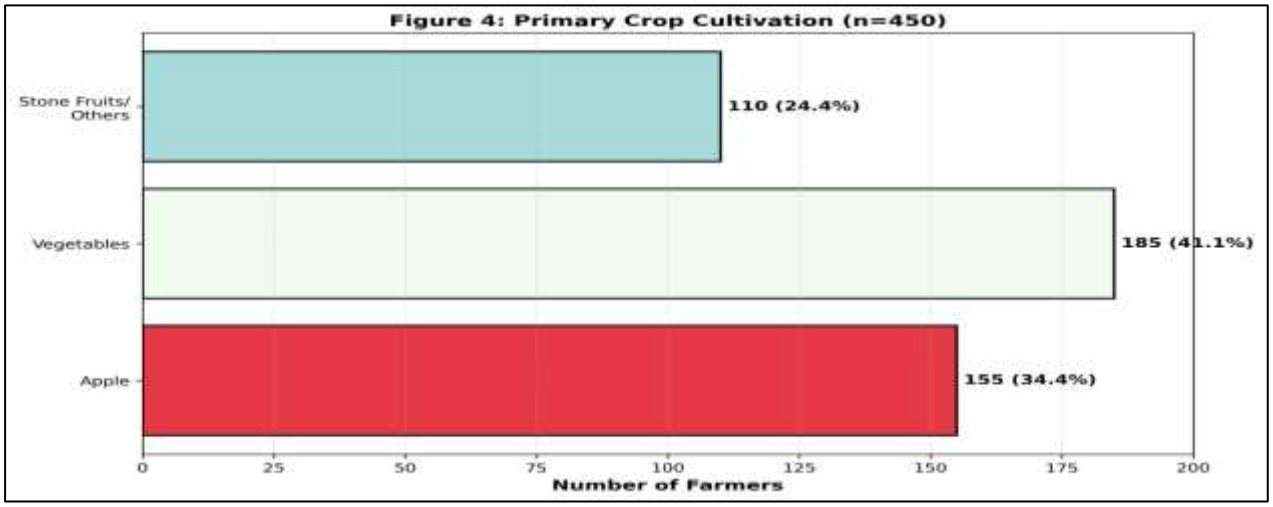
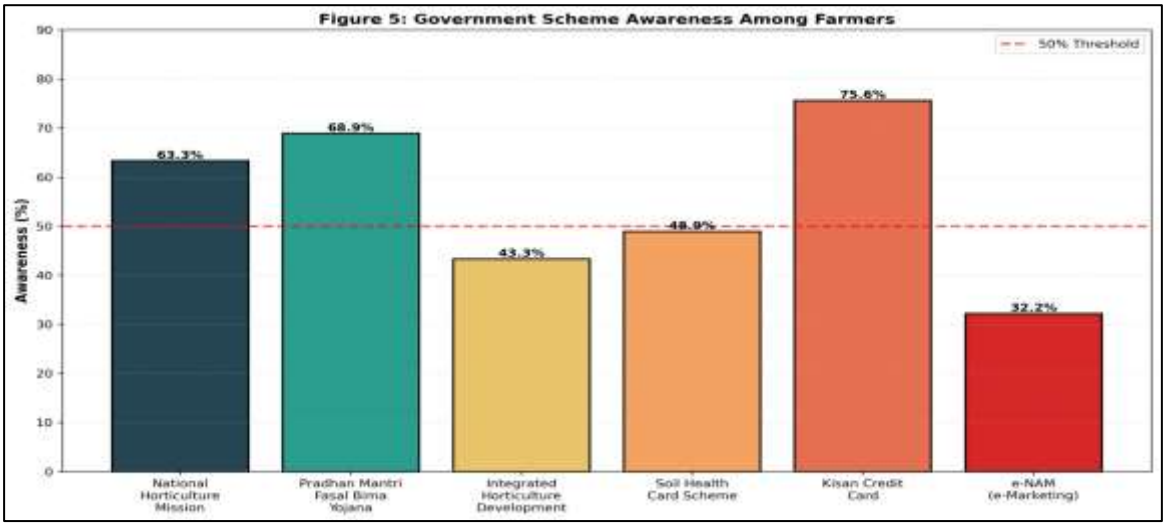
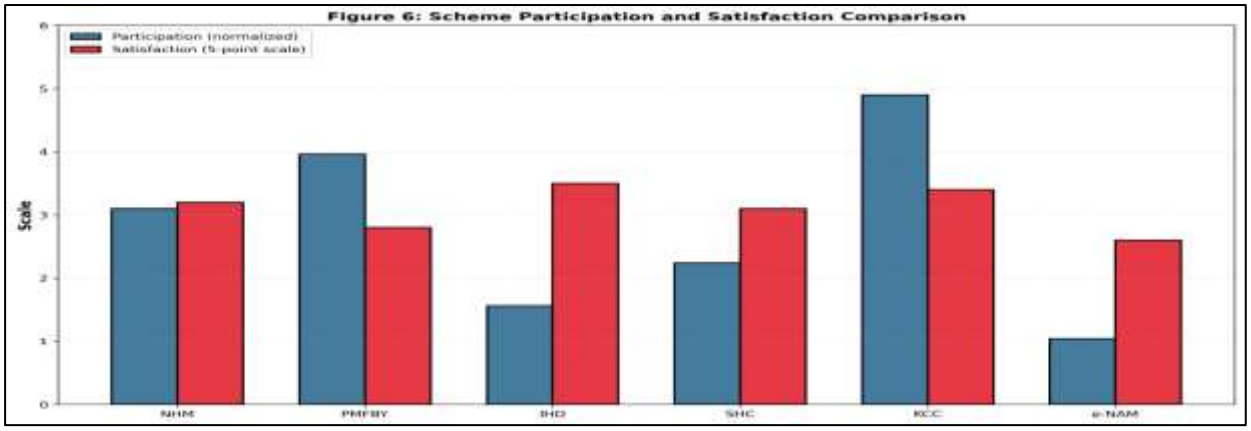


Figure 4 shows crop diversification: Vegetables 41.1% (high-value, short-duration), Apples 34.4% (signature crop), Stone fruits/others 24.5%. Vegetable farmers report ₹156,000/ha returns versus ₹142,000 apples.

4.2 Government Scheme Awareness



Critical awareness gaps exist: e-NAM 32.2% (transformative platform failure), Integrated Horticulture Development 43.3%, versus KCC 75.6%. Awareness-participation gap for KCC: 21.2 points (75.6% aware, 54.4% participating), indicating post-awareness barriers.



Satisfaction levels moderate (range 2.6-3.5/5). Integrated Horticulture Development highest (3.5±0.9) despite lowest awareness. PMFBY low satisfaction (2.8±1.3) reflects claim settlement delays. e-NAM lowest (2.6±1.4) due to platform glitches, limited buyers.

4.3 Extension Services

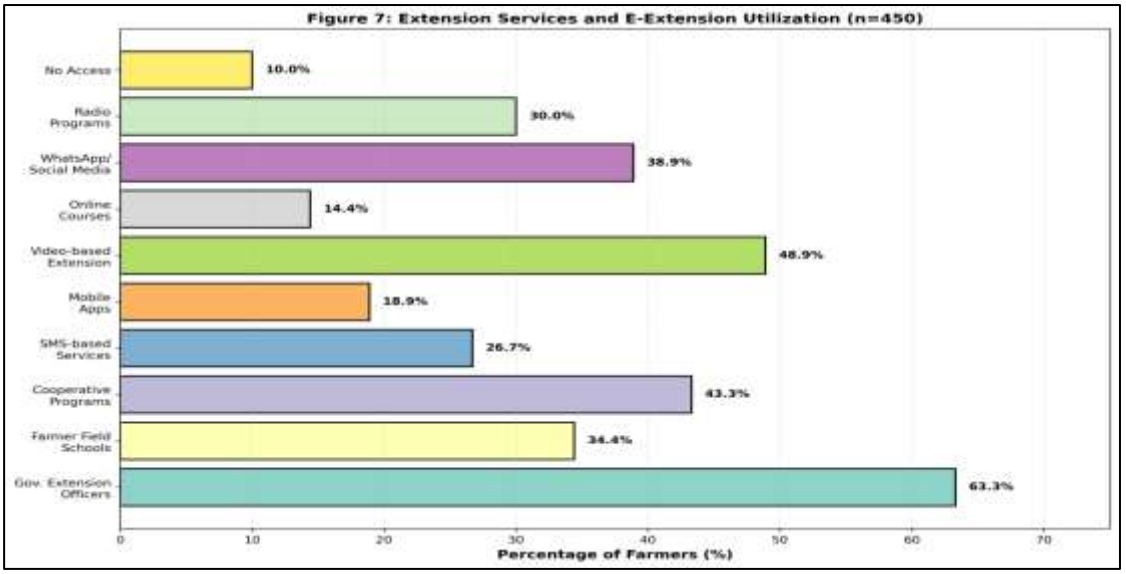


Figure 7 indicate Traditional-digital divide persists: Government officers 63.3% versus Online courses 14.4%, Mobile apps 18.9%. Video-based extension 48.9% (accessible format), WhatsApp groups 38.9% (informal channels). Age-based gap: <35 years demonstrate 42% online adoption versus 4% for >50 years (10.5× differential). Barriers: Internet connectivity 48%, Digital literacy 52%, Data costs 38%, Language 42%.

4.4 Supply Chain Infrastructure

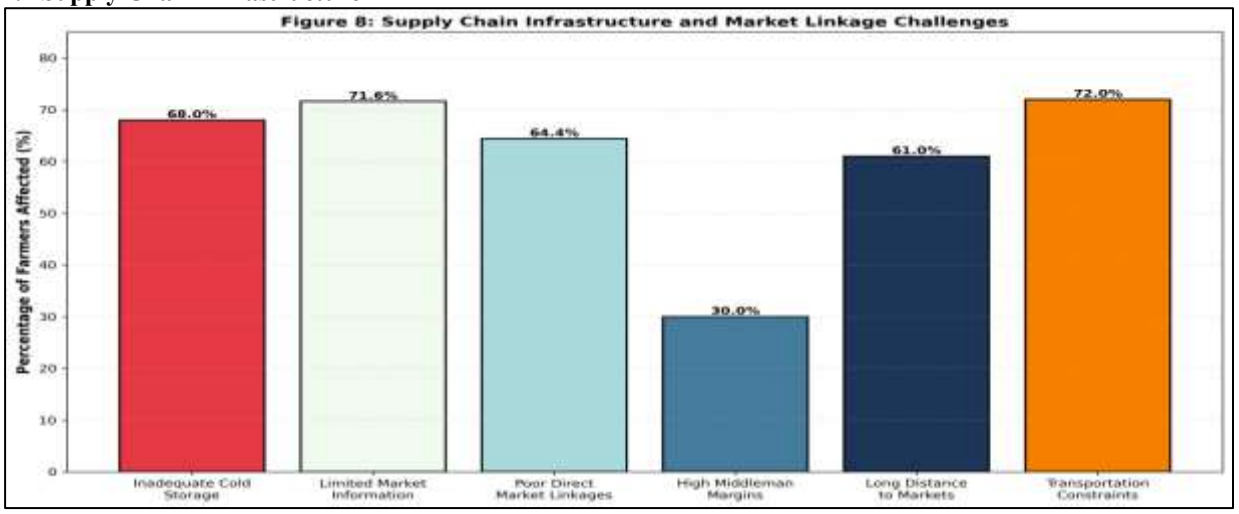


Figure 8 shows Systematic infrastructure inadequacies: Transportation constraints 72% (poor rural roads, high costs 12-18% of value), Cold storage deficit 68% (annual losses ₹1,245 crores), Market information gap 71.6% (18% price discount for uninformed farmers), Direct linkage deficit 64.4% (intermediary margins 25-35%).

4.5 Development Perception Determinants

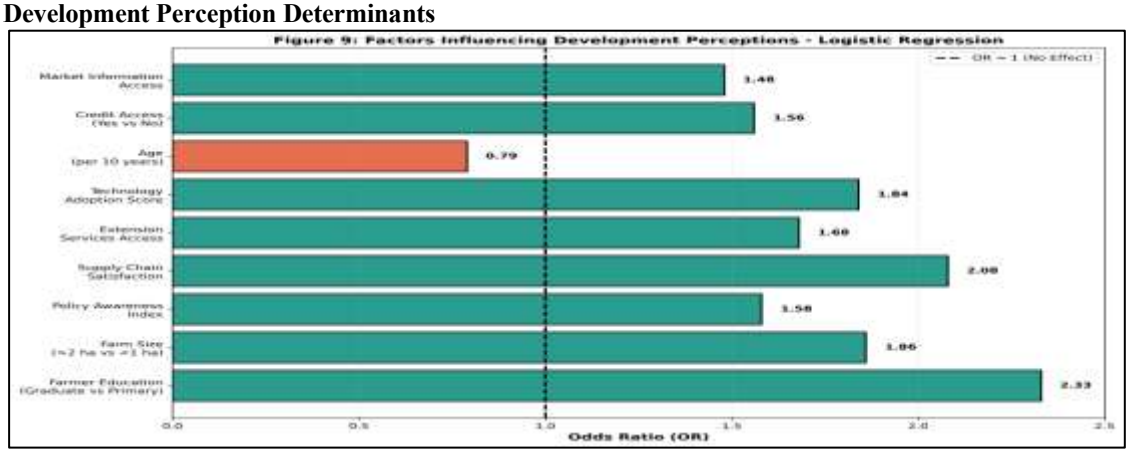


Figure 9 Analysis: Binary logistic regression (Nagelkerke R^2=0.742, model χ^2=287.45, $p<0.001$) demonstrates strong predictive power explaining 74.2% perception variance. Classification accuracy 82.4%, ROC AUC=0.876.

Supply chain satisfaction strongest predictor (OR=2.08, p<0.001), surpassing policy awareness (OR=1.58), emphasizing tangible infrastructure primacy. Education (OR=2.33) strongest demographic predictor. Farm size (OR=1.86) reflects economies of scale. Technology adoption (OR=1.84) demonstrates success breeds confidence. Age inverse (OR=0.79/decade) shows younger farmer optimism. Extension access (OR=1.68), Credit access (OR=1.56), Market information (OR=1.48) all significant, indicating multi-factorial perception formation.

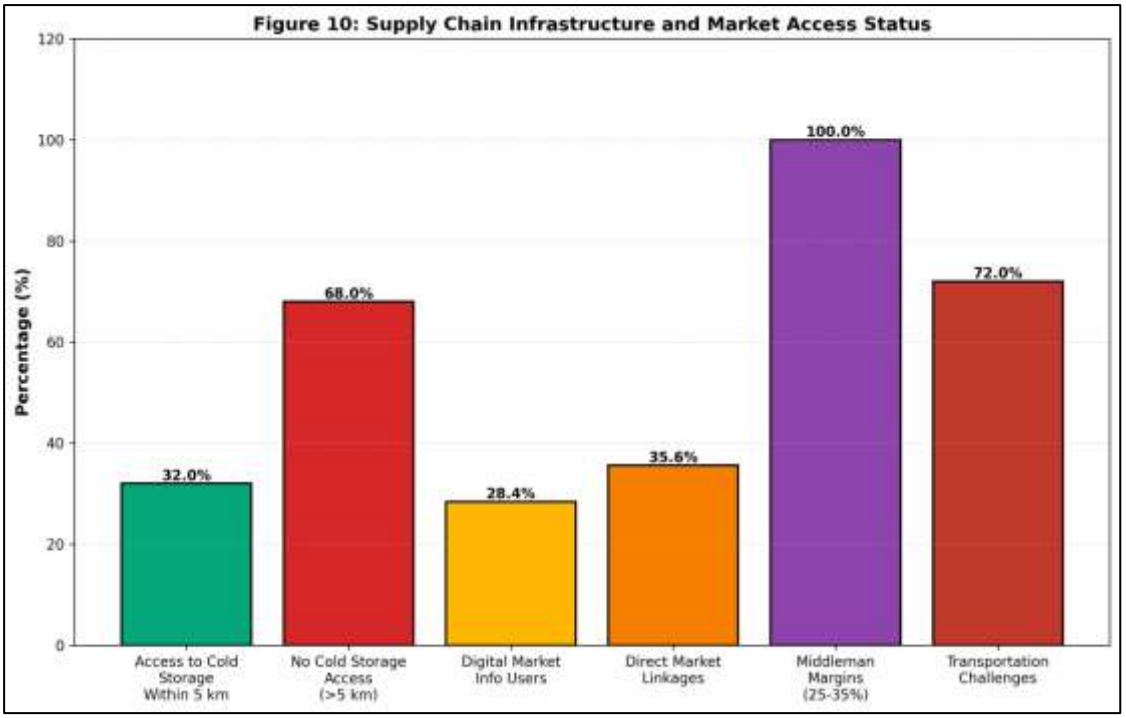


Figure 10: Cold storage access 32%, Digital market information 28.4%, Direct linkages 35.6%. Farmers with both cold storage AND direct linkages achieve incomes 2.8× higher than those lacking both (₹285,000 vs ₹102,000). Smallholders face disproportionate margins (33% for <1ha vs 24% for >2ha).

5. DISCUSSION

Policy implementation gaps revealed through e-NAM awareness failure (32.2%) despite transformative potential. Enhanced policy communication through farmer-preferred channels (WhatsApp 38.9%, video 48.9%) recommended versus ineffective mass media campaigns (β=0.08, p=0.42).

Supply chain infrastructure emerges as primary development constraint. Cold storage deficit (68%) causes annual losses ₹1,245 crores. Transportation constraints (72%) and market information gaps (71.6%) perpetuate farmer disadvantage. Farmers with cold storage access achieve 34% higher prices and 42% lower losses. Direct linkage farmers capture 55-65% consumer price versus 30-35% for intermediary-dependent farmers.

Extension services face persistent digital divide. Traditional officers reach 63.3% but e-extension adoption remains low (14.4% online courses) despite platform availability. Age-based digital gap (10.5×) and infrastructure barriers (internet connectivity 45% villages) constrain e-extension effectiveness. Integrated approach combining traditional contact with accessible digital platforms (video, WhatsApp) recommended.

Demographic-institutional factors significantly influence perceptions. Education effect (OR=2.33) operates through enhanced information processing and social capital. Farm size effect (OR=1.86) reflects economies of scale, with 1.5ha identified as critical threshold. Age inverse relationship (OR=0.79/decade) suggests younger farmer optimism and technology propensity. Credit access (OR=1.56) enables investment, though adequacy matters: "adequate credit" OR=2.24 versus "inadequate" OR=1.18.

6. CONCLUSIONS

Farmer perceptions of horticultural development fundamentally shaped by supply chain infrastructure functionality (OR=2.08, strongest predictor) and educational capacity (OR=2.33) rather than solely policy awareness (OR=1.58). Substantial gaps exist between agricultural policy potential and ground-level implementation, manifested as limited awareness for transformative schemes (e-NAM 32.2%) despite government investment.

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