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Relationship of profile with impact of protected vegetable cultivation on growers

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Abstract
The present investigation entitled "Relationship of profile with impact of Protected Vegetable Cultivation on Growers" was conducted in Badnapur, Jalna, Bhokardan, and Jafrabad tehsils of Jalna district in the Marathwada region of Maharashtra state. An ex-post facto research design was adopted for the study. From the four selected tehsils, a total of 20 villages (five villages from each tehsil) were chosen purposively on the basis of maximum protected vegetable cultivation structures. From each village, six vegetable cultivators (three Protected Vegetable Cultivation Growers [PVCG] and three Non-Protected Vegetable Cultivation Growers [NPVCG]) were selected. Accordingly a total sample size constitute of 120 respondents (60 PVCG and 60 NPVCG). Data were collected through personal interview method using a comprehensive, pre-tested, structured interview schedule.
The primary data were analyzed using Karl Pearson's correlation coefficient (*r*) and multiple linear regression analysis. Correlation analysis indicated that eight independent variables namely education, land holding, area under PVC, experience in PVC, annual income, sources of information, trainings received, and risk orientation exhibited positive and highly significant relationships with technological impact at the 0.01 level of probability. Market orientation, perception, and knowledge were positively significant at the 0.05 level. Conversely,
age and social contact showed negative and highly significant relationships. Multiple linear regression analysis revealed a coefficient of determination (R^2) of 0.9158 with a highly significant *F*-value of 88.7478 ($p < 0.01$), indicating that 91.58 per cent of the total variation in overall impact on PVCG was collectively explained by the thirteen selected independent variables. Land holding, experience in protected vegetable cultivation, sources of information, social contact, and risk orientation were the major significant driving determinants of technological impact.

Keywords: Protected vegetable cultivation, Determinants, Profile characteristics

1. Introduction

Sustaining the majority of the Indian population, the agricultural sector remains the cornerstone of the nation's socio-economic fabric by serving as the primary source of employment. A substantial proportion of rural households rely directly or indirectly on farming and allied enterprises to secure their living. Enhancing the economic resilience of small and marginal landholders, along with landless agricultural workers, is fundamental to strengthening rural stability, securing household nutrition, and fostering balanced regional growth. Rural human capital advancement remains inextricably linked to farm progress, given that agrarian operations generate on-field work while driving interconnected support services including processing, aggregation, transport, warehousing, and farm input distribution. Consequently, agriculture functions not merely as an economic engine, but as a critical stabilizer for rural social welfare.

Farming across India followed conventional systems until the advent of the Green Revolution in the late 1960s. This transitional phase substantially elevated the yield and total output of key staples, notably wheat and paddy, primarily across canal-irrigated tracts. The introduction of high-yielding cultivars, synthetic fertilizers, expanded irrigation networks, farm mechanization, and standardized agronomic protocols spurred domestic food grain reserves and helped achieve national food autonomy. Nevertheless, the gains accruing from the Green Revolution were geographically and crop-wise skewed, leaving rainfed, dryland, and semi-arid tracts constrained by low yield realization, natural resource degradation, and volatile farm earnings. An over-reliance on cereal monocropping subsequently triggered environmental strains, including soil nutrient exhaustion, sub-surface water depletion, and diminishing returns on input investments. These structural drawbacks underscored the necessity of shifting toward a diversified, ecologically sustainable, and commercially remunerative farming model.

With the limitations of cereal-dominated production patterns becoming increasingly apparent, agricultural diversification toward high-value horticultural commodities emerged as an imperative. Horticulture has ex

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panded as a resilient and remunerative agricultural branch, providing elevated returns per unit area, generating employment, and improving nutritional security. Vegetables occupy a prominent position within this shift owing to their short vegetative cycles, high productivity thresholds, and accelerating market demand driven by demographic expansion, urban growth, purchasing power gains, and dietary transitions. Furthermore, horticultural production demands greater labor intensity than traditional field crops, offering expanded employment pathways for rural workforces.

Over recent decades, the Indian agricultural landscape has encountered critical constraints such as land fragmentation, diminishing soil organic health, severe irrigation water scarcity, unpredictable weather anomalies, and escalating pest-pathogen pressures. Anthropogenic climate instability has aggravated production vulnerabilities through irregular monsoon distribution, elevated temperature spikes, and prolonged moisture stress. These constraints are acutely felt across semi-arid, drought-vulnerable zones like the Marathwada region in Maharashtra. In these environments, conventional open-field vegetable farming entails high production uncertainty and reduced profitability. Recurring crop damages, seasonal yield variances, and fluctuating farm-gate prices severely undermine the risk tolerance and financial stability of vegetable producers.

Under these agro-climatic pressures, protected vegetable cultivation offers an effective technological solution to alleviate structural farm-level constraints. Protected cultivation involves raising horticultural crops within fully or partially regulated micro-environments using polyhouses, shade-net facilities, greenhouses, and low or walk-in plastic tunnels. This production system empowers growers to regulate ambient micro-climates—encompassing ambient temperature, relative humidity, solar radiation, and fertigation delivery—thereby insulating the crop canopy against outdoor climatic extremes. The technology enables off-season harvesting, superior product uniformity, enhanced crop yields, minimized post-set losses, and premium price capture, directly fostering income stabilization and household livelihood security.

Maharashtra represents a leading state in the deployment of protected vegetable technologies, supported by diverse agro-ecological conditions, an established commercial horticulture base, organized marketing channels, and enabling administrative initiatives. Within Marathwada, Jalna district has established itself as the leading district in the installation and operation of protected cultivation facilities. This concentrated growth in Jalna is driven by proactive utilization of state and central assistance programs (notably NHM and Project on Climate Resilient Agriculture - PoCRA), active engagement with agricultural extension networks, expanding micro-irrigation infrastructure, direct market linkages, and an enterprising farming community. Jalna has gained recognition as a specialized center for protected horticulture—not only for commercial table vegetables such as color capsicum and cucumber, but also as an established production zone for high-value hybrid vegetable seeds (including tomato, sweet pepper, and cucumber) managed through institutional contract farming models, generating substantial farm returns and rural employment.

While protected vegetable cultivation continues to expand, systematic empirical inquiry delineating the econometric relationship between grower profile attributes and technological impact remains vital. Evaluating how grower profile characteristics influence and determine

technological impact provides critical empirical baseline data for upgrading extension delivery and agricultural policy.

In view of these considerations, the present investigation focuses strictly on the following specific

Objective:

1. To delineate the relationship of profile with impact of protected vegetable cultivation on growers.

Materials and Methods

The investigation was carried out in Jalna district of Marathwada division of Maharashtra state. The Jalna district was purposively selected as the primary locale for this research due to its prominent concentration of protected vegetable cultivation infrastructures in the region. Geographically, Jalna district spans 7,718 sq km between 19°01′ to 20°03′ N latitudes and 75°04′ to 76°04′ E longitudes with an average elevation of 516 m above mean sea level, featuring a tropical semi-arid agro-climate with an average annual precipitation of 700 to 750 mm.

The study adopted an ex-post facto research design. A multi-stage purposive sampling framework was adopted. Within Jalna district, four talukas/tehsils namely Jalna, Badnapur, Bhokardan, and Jafrabad were purposively identified due to their leading proportion of protected vegetable cultivation units. Within each tehsil, five villages exhibiting the densest concentration of protected vegetable structures were chosen, yielding an aggregate of 20 sampled villages (Ghanewadi, Gondegao, Kumbephal, Pachanwadgaon, Waghrul in Jalna tehsil; Bawane Pangri, Chanegao, Dagadwadi, Keligavhan, Tupewadi in Badnapur tehsil; Longao, Malegaon, Nalni, Rajur, Tapovan in Bhokardan tehsil; Ambewadi, Ganeshpur, Niwdunga, Pokhri, Satephal in Jafrabad tehsil). From every selected village, three protected vegetable cultivation growers (PVCG) and three non-protected vegetable cultivation growers (NPVCG) were drawn, generating a cohort of 15 PVCG and 15 NPVCG per tehsil, establishing a total sample size of 120 respondents (60 PVCG and 60 NPVCG).

Primary empirical data were gathered through structured personal interviews using a pre-tested interview schedule administered face-to-face in the regional language (Marathi). Independent variables were measured using standardized scales: Supe (2007) for risk orientation, Samanta (1977) [1] for market orientation, and researcher-developed scales for sources of information, training received, social contact, perception (14-item Likert scale), and knowledge (18-item objective test).

The dependent variable, impact of protected vegetable cultivation, was operationalized as the overall percentage change brought about in the socio-economic and farming conditions of PVCG over NPVCG across five core dimensions: change in annual income (Δ_{AI}), change in employment generation (Δ_{EG}), change in land holding (Δ_{LH}), change in material possession (Δ_{MP}), and change in social status (Δ_{SS}).

To derive valid statistical inferences, tabulated data were analyzed using Karl Pearson's correlation coefficient (r), and Multiple Linear Regression analysis (R^2, F-value, and partial regression t-tests) using the model: $Y = a + b_1x_1 + b_2x_2 + ... + b_{13}x_{13} + \mu$.

Results and discuss

To delineate the relational dynamics and identify key determinants influencing the technological impact of protected vegetable cultivation, Karl Pearson's product-moment correlation analysis and multiple linear regression analysis were conducted.

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3.1 Correlation analysis between profile characteristics and impact

Table 1 presents the Karl Pearson correlation coefficients (*r*) between the thirteen selected independent variables and the overall technological impact on PVCG.

Table 1. Coefficient of Correlation Between Profile Characteristics and Impact of protected vegetable cultivation on growers

Sr. No.	Independent Variables	Correlation Coefficient ('r')	Significance Level
1.	Age	-0.3803**	Negative & Significant at 0.01 level
2.	Education	0.4915**	Positive & Significant at 0.01 level
3.	Land holding	0.4054**	Positive & Significant at 0.01 level
4.	Area under protected vegetable cultivation	0.9054**	Positive & Significant at 0.01 level
5.	Experience in protected vegetable cultivation	0.9070**	Positive & Significant at 0.01 level
6.	Annual income	0.8008**	Positive & Significant at 0.01 level
7.	Sources of information	0.3852**	Positive & Significant at 0.01 level
8.	Trainings received	0.7251**	Positive & Significant at 0.01 level
9.	Social contact	-0.5649**	Negative & Significant at 0.01 level
10.	Risk orientation	0.4756**	Positive & Significant at 0.01 level
11.	Market orientation	0.2919*	Positive & Significant at 0.05 level
12.	Perception	0.1965*	Positive & Significant at 0.05 level
13.	Knowledge	0.2245*	Positive & Significant at 0.05 level

An examination of Table 1 reveals that, all thirteen selected independent variables exhibited statistically significant relationships with the overall impact of protected vegetable cultivation. Consequently, the null hypothesis (H0) was rejected for all thirteen independent variables, and the empirical hypothesis (H1) was accepted.

Age with Impact: Age was found to have a negative and highly significant relationship (r=-0.3803**, $p < 0.01$) with impact. Younger cultivators in the study area exhibit greater entrepreneurial dynamism, technical curiosity, and willingness to take calculated risks by establishing capital-intensive polyhouses and shade net structures. Young rural agripreneurs actively adopt modern shadenet technologies, precision fertigation schedules, and digital market channels, whereas older cultivators often prefer low-risk conventional open-field farming systems. Consequently, younger growers a substantially higher socio-economic impact.

This finding is supported by Satya Prakash *et al.* (2017), Singh *et al.* (2022) [2], and Thakur *et al.* (2025) [3].

Education with Impact: Education exhibited a positive and highly significant relationship (r = 0.4915**, $p < 0.01$) with impact. Formal education equips cultivators with the necessary scientific literacy and analytical competence to understand precision crop production protocols. Educated PVCG are better positioned to calculate complex water-soluble fertilizer dosages, interpret soil and water testing reports, maintain farm accounts, and manage contractual agreements with private seed companies, maximizing overall impact.

This finding is supported by [Prakash *et al.*, (2020) [4], Iqbal *et al.*, (2021) [5] and Prakash *et al.*,
2022).

Land Holding with Impact: Land holding showed a positive and highly significant
relationship (r = 0.4054**, $p < 0.01$) with impact. Possessing a larger operational land holding provides cultivators with greater economic stability, higher creditworthiness, and the physical flexibility to allocate a portion of land for erecting protected structures while continuing traditional farming on the remaining holding, buffering growers against initial financial risks.

This finding is supported by (Pawar, 2014 [6]; Bhosale *et al.*, 2020 [7]; Sindhura *et al.*,
2022).

Area under Protected Vegetable Cultivation with Impact: Area under protected
structures showed a positive and highly significant relationship (r = 0.9054**, $p < 0.01$) with impact. In Jalna district, protected structures (polyhouses and shade nets) are extensively utilized for commercial hybrid vegetable seed production (such as tomato, capsicum, and cucumber). An increase in the area under protected structures directly scales up seed production capacity and overall farm yield, fulfilling substantial seed production quotas under corporate contract arrangements and generating higher net revenue.

This finding is supported by (Prakash *et al.*, 2020; Vishnupriyan *et al.*, 2022; Sharma *et al.*, 2023) [4, 8].

Experience in PVC with Impact: Experience in protected vegetable cultivation exhibited a positive and highly significant relationship (r = 0.9070**, $p < 0.01$) with impact. Commercial seed production is an expertise-driven enterprise requiring specialized skills in manual emasculation, controlled pollination, microclimate regulation, and pest threshold management. Accumulated operational experience over multiple seasons refines technical efficiency, reduces operational errors, and optimizes input utilization.

This finding is supported by (Prakash *et al.*, 2020 [4]; Sharma *et al.*, 2023; Thakur *et al.*,
2023).

Annual Income with Impact: Annual income had a positive and highly significant
relationship (r = 0.8008**, $p < 0.01$) with impact. PVCG in the region generate substantial annual earnings through lucrative contract farming agreements with private seed companies for hybrid seed production. In one R (Guntha) of protected area, a grower produces approximately one kilogram of hybrid tomato seed, which is procured by seed companies at pre-agreed contract rates ranging from ₹15,000 to ₹25,000 per kilogram. This assured income stream provides growers with strong reinvestment capacity to procure premium inputs and automate irrigation.

This finding is supported by (Barbade, 2014 [9]; Hasan *et al.*, 2016 [10]; Kale, 2020 [11]; Tilgame,
2021).

Sources of Information with Impact: Sources of information had a positive and highly

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significant relationship (r = 0.3852**, p < 0.01) with impact. PVCG maintain active communication linkages with diverse and credible extension sources, including KVKs, State Department of Agriculture, VNMKV, private seed company agronomists, and digital platforms (agricultural WhatsApp groups, mobile agro-apps), enabling rapid access to technical advisories and pest alerts.

This finding is supported by (Amle *et al.*, 2019 [12]; Kadam *et al.*, 2021 [13]; Sindhura *et al.*,
2022).

Trainings Received with Impact: Trainings received had a positive and highly
significant relationship (r = 0.7251**, p < 0.01) with impact. PVCG actively participate in specialized training programs organized by PoCRA, State Agriculture Department, and seed companies, gaining hands-on competence in bed preparation, soil solarization, fertigation, and pollination techniques.

This finding is supported by (Bhosale and Deshmukh, 2020; Prakash *et al.*, 2020; Waghmare *et al.*, 2023) [7, 4].

Social Contact with Impact: Social contact exhibited a negative and highly significant relationship (r = -0.5649**, p < 0.01) with impact. Protected vegetable cultivation is an intensive, precision-oriented enterprise requiring continuous on-farm presence, daily technical monitoring, and strict supervision of microclimate and pollination activities. Consequently, PVCG have limited discretionary time to participate in routine local socio-political bodies (Gram Panchayat, cooperative societies). In contrast, NPVCG have more leisure time for local socializing, whereas PVCG focus on intensive farm management which directly yields higher economic outcomes.

This finding is supported by (Patel *et al.*, 2015; Gaikwad *et al.*, 2018; Singh *et al.*, 2022) [15, 14, 2].

Risk Orientation with Impact: Risk orientation had a positive and highly significant relationship (r = 0.4756**, p < 0.01) with impact. Erecting protected structures and undertaking seed production involves substantial capital outlays and production risks. Cultivators with high risk-taking propensity demonstrate greater confidence in adopting modern technology, investing in high-cost water-soluble nutrients, and committing to strict seed contract standards.

This finding is supported by (Shashidhara, 2006; Patil *et al.*, 2020; Vishnupriyan *et al.*, 2022) [17, 16, 8].

Market Orientation with Impact: Market orientation was positively and significantly correlated (r = 0.2919*, p < 0.05) with impact. PVCG actively gather market intelligence, track corporate seed procurement terms, negotiate favorable buy-back contracts, and schedule production cycles to secure premium returns.

This finding is supported by (Jadhav *et al.*, 2022 [18]; Khadse *et al.*, 2023 [19]; Thakur *et al.*,
2023).

Perception with Impact: Perception had a positive and significant relationship (r =
0.1965*, p < 0.05) with impact. A strong, positive conviction regarding the yield superiority and climate-resilience of protected structures fosters diligent unit management, leading to significant socio-economic benefits.

This finding is supported by (Sawant *et al.*, 2018; Patil *et al.*, 2020; Rajesh *et al.*, 2023) [20, 21].

Knowledge with Impact: Knowledge showed a positive and significant relationship (r = 0.2245*, p < 0.05) with impact. Comprehensive cognitive understanding of protected cultivation practices (soil solarization, seed production protocols, microclimate adjustments, fertigation compatibility) directly enhances managerial precision and prevents crop loss.

This finding is supported by (Jethi *et al.*, 2020; Kaur, 2022; Ghanghas *et al.*, 2024) [23, 24, 22].

4.2 Multiple linear regression analysis

To assess the combined explanatory power of the thirteen independent profile variables and to identify the critical determinants of technological impact on protected vegetable cultivation on growers, multiple linear regression analysis was performed. Table 2 presents the empirical results.

Table 2. Multiple Regression Analysis of profile with the impact of protected vegetable cultivation on growers.

Sr. No.	Independent Variables	Regression Coeff. (B)	Std. Error (SE)	't' Value	Significance Level
1.	Age	0.0010	0.0035	0.2810	Non-Significant (NS)
2.	Education	0.0186	0.0100	1.8697	Non-Significant (NS)
3.	Land holding (ha)	0.1135	0.0227	5.0082**	Significant (p < 0.01)
4.	Area under PVC	0.0068	0.0046	1.4775	Non-Significant (NS)
5.	Experience in PVC	0.0946	0.0211	4.4896**	Significant (p < 0.01)
6.	Annual income	3.1193	1.8878	1.6523	Non-Significant (NS)
7.	Sources of information	0.0258	0.0106	2.4345*	Significant (p < 0.05)
8.	Trainings received	0.0546	0.0753	0.7252	Non-Significant (NS)
9.	Social contact	-0.0287	0.0120	-2.3981*	Significant (p < 0.05)
10.	Risk orientation	0.0198	0.0092	2.1415*	Significant (p < 0.05)
11.	Market orientation	0.0083	0.0048	1.7328	Non-Significant (NS)
12.	Perception	0.0040	0.0136	0.2921	Non-Significant (NS)
13.	Knowledge	-0.0068	0.0105	-0.6494	Non-Significant (NS)
	R^2 = 0.9158			F = 88.7478** (p < 0.01)	

It is observed from Table 2 that the coefficient of determination (R^2) of the independent variables was 0.9158. This signifies that 91.58 per cent of the total variation in the impact of protected vegetable cultivation on growers was collectively explained by the thirteen selected independent variables. The unexplained variation of 08.42 per cent may be attributed to factors not included in the study. The computed F-value (88.7478) was highly significant at the 0.01 level of probability, establishing the robust econometric fit of the multiple regression model.

The partial regression coefficients (B) and corresponding 't' values revealed that five independent variables contributed significantly to the variation in technological impact:

Land holding (B = 0.1135, t = 5.0082**, p < 0.01): Land holding emerged as a highly significant positive determinant. Possession of larger operational acreage provides cultivators with the physical space and asset cushion to establish protected units without compromising staple food crop production.

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Experience in protected vegetable production (B = 0.0946, t = 4.4896**, $p < 0.01$): Operational experience emerged as a vital positive driver. Extensive experience equips growers with essential specialized skills in pollination, fertigation management, and microclimate adjustment, drastically reducing crop failure.

Sources of information (B = 0.0258, t = 2.4345*, $p < 0.05$): Proactive utilization of diverse information channels (KVK scientists, extension officers, seed agronomists, digital platforms) provides vital real-time problem-solving advisories.

Social contact (B=-0.0287, t=-2.3981*, $p < 0.05$): Social contact exhibited a significant negative partial regression coefficient, verifying that intensive on-farm management demands restrict routine general village socialization while concentrating farmer attention on high-value crop monitoring.

Risk orientation (B = 0.0198, t = 2.1415*, $p < 0.05$): Risk orientation was a significant positive determinant, reflecting that mental readiness to absorb financial exposure empowers growers to invest in high-tech inputs and adhere to exacting seed production standards.

These empirical findings are in close agreement with the econometric results reported by Prakash *et al.* (2020) [4], Vishnupriyan *et al.* (2022) [8], Sharma *et al.* (2023), and Thakur *et al.* (2025) [3].

Conclusion and policy implications

Conclusions

Based on the empirical findings, the following conclusions are drawn: Relational and Regression Dynamics: Eleven independent variables showed significant positive linear relationships with impact, while age (r = -0.3803**) and social contact (r = -0.5649**) exhibited significant inverse relationships. Econometrically, multiple regression analysis demonstrated that 91.58 per cent (R^2 = 0.9158, F = 88.7478**) of the total variation in impact was explained by the selected profile characteristics, with land holding (t = 5.0082**), experience in PVC (t = 4.4896**), sources of information (t = 2.4345*), social contact (t = -2.3981*), and risk orientation (t = 2.1415*) established as the critical driving determinants.

Policy implications

Mandating Structural and Crop Insurance for Natural Calamities: To protect growers against catastrophic losses from high-velocity windblasts and hailstorms that tear poly- cladding sheets and distort galvanized frameworks, the government and regulatory bodies must

introduce specialized criteria-based insurance covering both physical greenhouse structures and high-value standing crops.

Financial Continuity and Capital Subsidies: State implementing agencies under schemes like PoCRA, NHM, and MIDH should raise capital subsidy limits, streamline approval documentation, and arrange secondary maintenance grants to assist growers in replacing cladding films after their five-year operational lifespan.

Strengthening Technical Extension and Capacity Building: Agricultural universities, Krishi Vigyan Kendras, and the State Department of Agriculture must systematically provide hands-on training modules focusing on precision fertigation, manual emasculation and pollination for hybrid seed production, and biological pest management.

Market Regulation and Cold Storage Infrastructure: State Agricultural Marketing Boards should formally regulate protected produce marketing by establishing dedicated auction bays and grading standards in APMC mandis, alongside promoting taluka-level cold storage and contract farming linkages with seed companies.

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