

Direct and Indirect Effects of Farmers' Characteristics and their Knowledge about Environmental Degradation

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ABSTRACT

The present investigation was carried out in the Anand district of Gujarat. 160 farmers from four talukas were selected randomly for the study. A total of sixteen variables were studied in path analysis. The study revealed that the input utilization pattern had exerted a maximum direct positive effect and a substantial effect on farmers' knowledge of environmental degradation, and social media exposure had the maximum total indirect effect on farmers' knowledge of environmental degradation.

Keywords: Environmental degradation, Farmers, knowledge, direct-indirect effect

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Introduction

Environmental degradation in agricultural systems manifests through accelerated soil erosion, nutrient depletion, chemical contamination, and biodiversity loss, all of which undermine ecosystem resilience and long-term productivity. Synthetic fertilizer inputs, which in India exceeded 55 Mt in 2021–22, contribute to significant nitrous oxide emissions and nitrate leaching, triggering eutrophication of freshwater bodies and hypoxic “dead zones” (Ramachandra et al., 2025). Addressing these interconnected challenges requires a suite of integrated strategies such as no-till conservation, precision nutrient management, crop diversification, and residue recycling to restore soil health, reduce emissions, and improve farm-level sustainability (Verma et al., 2024). Most farmers possess awareness about bio stimulants, eco-friendly agricultural inputs that can reduce chemical use and enhance crop yields (Desai et al., 2025).

Objective

To study the direct and indirect effects of farmers’ characteristics and their knowledge of environmental degradation

Methodology

The study was carried out in the Anand district, located in central Gujarat. In Anand, 160 farmers are chosen using a step-by-step random process. First, four talukas were picked randomly, then selected four villages from each taluka, and finally picked ten farmers from each village. Data was gathered using a structured interview schedule, with interviews conducted either at the farmers’ homes or farms. Microsoft Excel (MS 365) and SPSS (version 16.0) statistical tools were applied for data analysis. The research utilized an ex-post facto (Kerlinger, 1976) research design. The collected data were examined to identify the relationship between each independent variable and the dependent variable. A variable was deemed to have a significant association if the computed value met or exceeded the critical value in statistical tests. Furthermore, the study aimed to assess both the direct and indirect effects of key independent variables on farmers’ knowledge regarding the environmental degradation, along with the nature of that influence.

The path coefficient technique, which measures the proportion of the total effect’s standard deviation caused by a specific factor, was applied by solving simultaneous equations derived from the below given method.

Estimation of Direct and Indirect Effects

The direct effect of each independent variable on the dependent variable is

obtained through **standardized regression coefficients (β)**.

$$P_{iy} = \beta_{iy}$$

Where

- P_{iy} = Direct effect (path coefficient) of X_i on Y

Regression equation:

$$Y = b_1 X_1 + b_2 X_2 + b_3 X_3 + \dots + b_n X_n + e$$

Where

- b_1, b_2, b_3 = regression coefficients
- e = residual effect

Indirect effect occurs when an independent variable affects the dependent variable **through another variable**.

Indirect effect formula:

$$\text{“Indirect effect of “ } X_i \text{ “ through “ } X_j = r_{ij} \times P_{jy}$$

Where

- r_{ij} = correlation between X_i and X_j
- P_{jy} = direct effect of X_j on Y

Total indirect effect is obtained by summing all indirect paths.

In this study, total 16 variables were considered as the independent variable affecting the dependent variable Y , which stands for environmental degradation.

Results and Discussion

Path analysis was employed across all sixteen variables to explore their causal interrelationships. This technique enabled us to separate and measure the direct impact of each variable, as well as its indirect influence mediated through other variables. The findings suggest that the relationships observed between the variables were partly direct and partly indirect. The indirect, or partial, relationships reflect the combined influence of other variables.

Therefore, it is important to examine how one variable affects another both directly and indirectly, through the impact of other variables involved in the scenario. The results of the path analysis are shown in Table 1.

Direct effect

The data in Table 1 revealed that input utilization pattern had exerted a maximum

direct positive effect on farmers' knowledge of environmental degradation (0.336), followed closely by scientific orientation (0.324), education (0.211), social participation (0.203), extension participation (0.192), risk orientation (0.175), social media exposure (0.173), annual income (0.168), innovation proneness (0.166), training received (0.160), cropping pattern (0.138), landholding (0.113), cropping intensity (0.104) and family size (0.043).

Table 1: Direct and indirect effect of farmers' characteristics and their knowledge of environmental degradation (n=160)

Sr. No.	Variables	Direct effect	Total indirect effect	Substantial indirect effect through	
				1	2
X ₁	Age	-0.263	-0.469	0.018(X ₇)	0.016(X ₅)
X ₂	Education	0.211	0.445	0.124(X ₁)	0.079(X ₃)
X ₃	Farming experience	-0.160	-0.486	0.019(X ₇)	0.015(X ₁₃)
X ₄	Family size	0.043	-0.084	0.022(X ₉)	0.022(X ₇)
X ₅	Cropping pattern	0.138	0.159	0.073(X ₆)	0.039(X ₇)
X ₆	Cropping intensity	0.104	0.068	0.096(X ₅)	0.024(X ₁₆)
X ₇	Input utilization pattern	0.336	0.130	0.048(X ₁₀)	0.044(X ₁₁)
X ₈	Social participation	0.203	0.330	0.067(X ₁₄)	0.054(X ₁₂)
X ₉	Landholding	0.113	0.307	0.077(X ₁₀)	0.069(X ₇)
X ₁₀	Annual income	0.168	0.350	0.097(X ₇)	0.052(X ₉)
X ₁₁	Extension participation	0.192	0.450	0.077(X ₇)	0.067(X ₁₄)
X ₁₂	Social media exposure	0.173	0.553	0.128(X ₁₄)	0.096(X ₁)
X ₁₃	Training received	0.160	0.390	0.069(X ₁₄)	0.069(X ₇)
X ₁₄	Scientific orientation	0.324	0.468	0.095(X ₁)	0.069(X ₁₂)
X ₁₅	Risk orientation	0.175	0.230	0.082(X ₁₄)	0.040(X ₁)
X ₁₆	Innovation proneness	0.166	0.403	0.049(X ₁)	0.047(X ₈)

Conversely, variables with negative direct effects include age (-0.263) exerted the maximum negative effect on farmers' knowledge of environmental degradation and farming experience (-0.160), indicating that as farmers grow older or gain more experience, their direct impact on the dependent variable decreases. Understanding these ongoing influences is essential for designing extension and training programs targeted effectively to different farmer demographics.

It can be inferred that the input utilization pattern had exerted the maximum positive direct effect on knowledge of environmental degradation followed by scientific orientation, education, social participation, extension participation, risk orientation, social media exposure, annual income, innovation proneness and training received, deferred gratification cropping pattern, landholding, cropping intensity and family size.

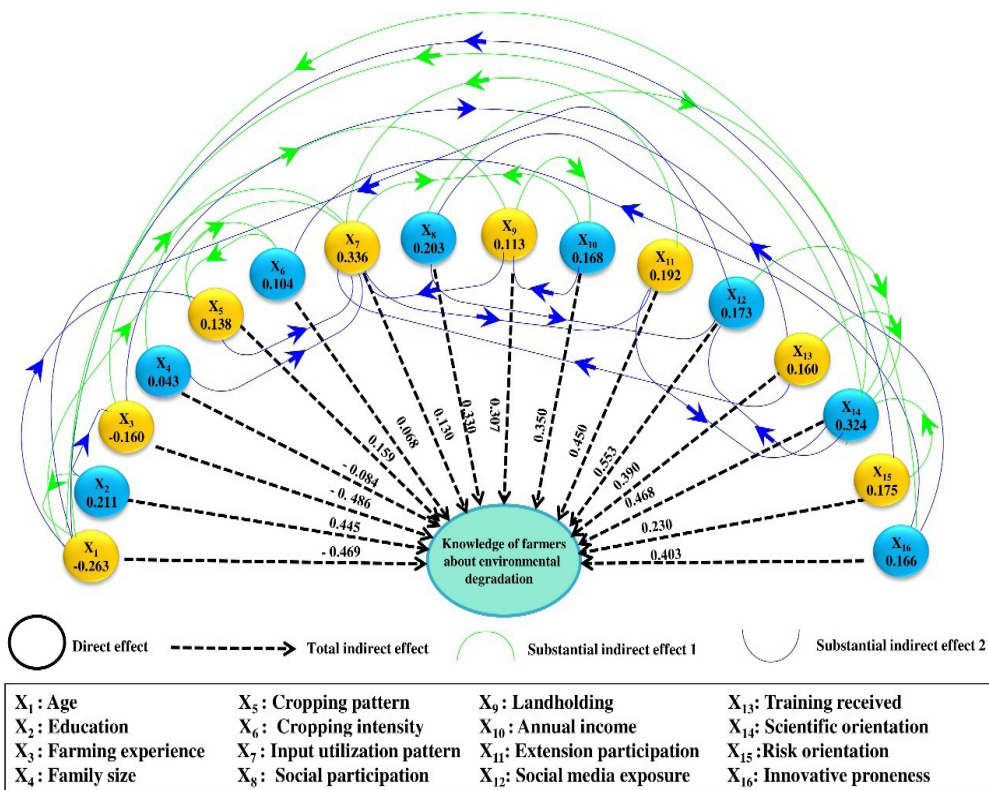


Fig.: Direct and indirect effect of farmers' characteristics and their knowledge of environmental degradation

Total indirect effect

So far, the total indirect effect is concerned; fourteen variables had a positive total indirect effect on knowledge of environmental degradation. Further, it can be observed that social media exposure had the maximum total indirect effect (0.553), followed by scientific orientation (0.468), extension participation (0.450), education (0.445), innovation proneness (0.403), training received (0.390), annual income (0.350), social participation (0.330), landholding (0.307), risk orientation (0.230), cropping pattern (0.159), input utilization pattern (0.130), cropping intensity (0.068), whereas the highest negative indirect effect was exerted by family size (-0.084), age (-0.469), and farming experience (-0.486).

Substantial indirect effect

Data further revealed that out of 32 substantial indirect effects, eight each routed through input utilization pattern, five each routed through scientific orientation and age, two each routed through cropping pattern, landholding, annual income and social media exposure, one through farming experience, cropping intensity, social participation, extension participation, training received innovation proneness and deferred gratification.

Concluding the findings, it can be said that the input utilization pattern exerted the highest direct effect and substantial effect and social media exposure exerted the maximum total indirect effect on the farmers' knowledge of environmental degradation.

Conclusion

The path analysis showed that the input utilization pattern had the highest direct positive effect on farmers' knowledge of environmental degradation (0.336), while scientific orientation (0.324 direct, 0.468 indirect) and education (0.211 direct, 0.445 indirect) significantly influenced knowledge. Age (-0.263 direct, -0.469 indirect) and farming experience (-0.160 direct, -0.486 indirect) exhibited negative effects. While social media exposure had the maximum total indirect effect (0.553). These results emphasize the key roles of input utilization and social media exposure in enhancing environmental knowledge among farmers, suggesting that focusing on these factors could effectively improve awareness and promote sustainable practices.

Conflict of Interest

The authors declare no conflicts of interest related to the research presented in this article.

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