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Factors Associated with Farming-Related Problems among Vegetable Farmers in Uttar Pradesh: A Cross-sectional Study

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ABSTRACT

Vegetable farming plays a critical role in rural livelihoods in India, yet farmers frequently encounter production, financial, and work-related constraints that affect sustainability. This study examines the magnitude and determinants of farming-related problems among 240 vegetable growers in Uttar Pradesh, India. Primary data were collected through structured interviews, and ordered logistic regression was employed to identify socioeconomic and work-related factors associated with problem severity. In findings, logistic regression analysis revealed that education level, number of earning members in the household, mechanisation practices, and work-related practices were significantly associated with the likelihood of experiencing higher levels of farming-related problems. Farmers with lower educational attainment and limited household earnings were more vulnerable to severe constraints. Mechanisation practices and labour dynamics also showed significant associations, highlighting structural differences in farm management capacity. The study underscores the importance of strengthening socioeconomic resilience and promoting appropriate farm-level interventions to reduce vulnerability among smallholder vegetable producers. The findings provide district-level empirical evidence to inform rural development strategies and agricultural policy in labour-intensive farming systems.

Keywords: Livelihood vulnerability; Mechanization; Northern India; Rural livelihoods; Smallholder agriculture; Socioeconomic determinants

Introduction

Vegetable cultivation plays a crucial role in the agrarian economy of Uttar Pradesh by providing higher returns per unit area, short production cycles, and substantial employment opportunities, especially for small and marginal farmers (Sonkar et al., 2020; Mishra and Ghadei, 2015). Agriculture remains the backbone of rural livelihoods in Uttar Pradesh, and vegetable cultivation is a particularly important source of income, employment, and dietary diversity for small and marginal farmers in the state (Singh et al., 2017). Uttar Pradesh is one of India's

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leading vegetable-producing states, and vegetable crops have emerged as a commercial enterprise with high returns per unit area, especially for low-income households (Kumar et al., 2024; Mishra and Ghadei, 2015). At the same time, vegetable farmers operate within a context of fragmented landholdings, constrained access to irrigation, credit, training, and markets, and considerable exposure to production and price risks (Sonkar and Ahamad, 2020).

Despite their economic importance, vegetable farmers face multiple, interlinked farming-related problems. Research across Uttar Pradesh identifies constraints such as small and fragmented holdings, high input costs, lack of timely credit, poor access to quality seed and pesticides, limited extension contact, and inadequate training in modern or scientific production technologies (Kumar et al., 2024; Pathak et al., 2024). Studies from western and eastern Uttar Pradesh show that most vegetable farmers belong to middle age groups, are largely from Other Backward Classes, have small or marginal landholdings, and fall within low to medium income categories, indicating a generally vulnerable socio-economic base (Kumar et al., 2024; Sonkar and Ahamad, 2020).

Farmers frequently report lack of government and non-government training institutions, unawareness of improved cultivation practices, and weak information flow as major barriers to efficient vegetable production (Sonkar, S., Ahamad, 2020; Kumar et al., 2024). Production and marketing constraints, including price fluctuations, non-remunerative prices, high marketing costs, inadequate storage, and transport problems, further erode profitability and make livelihoods precarious (Srivastava et al., 2025; Pathak et al., 2024).

In addition to economic and institutional constraints, the working environment exposes farmers to significant physical and health risks. Cross-sectional evidence from Uttar Pradesh shows that agricultural workers commonly experience intense physical labour, prolonged exposure to sun and heat, fatigue, and weakness, with a high proportion reporting sunstroke and other physical hazards (Ishaq & Khan, 2024). Heavy dependence on chemical pesticides, combined with low levels of training and safety awareness, creates additional health hazards and financial burdens, as many vegetable growers lack proper knowledge of safe pesticide use, access to quality inputs, and appropriate protective equipment (Mamun, A., & Goswami, 2024; Venugopal et al., 2025). External shocks such as the COVID-19 pandemic have further disrupted input supply, labour availability, marketing channels, and household food security among vegetable farmers, exacerbating pre-existing vulnerabilities (Kumar et al., 2023; Kumar et al., 2020).

While several studies have documented socio-economic profiles and broad constraints of vegetable growers in different districts of Uttar Pradesh, there is limited district-specific evidence linking farmers' characteristics and working conditions to the particular farming-related problems they face in Baghpat district. The district, dominated by intensive cash-crop and horticultural systems, presents a distinct production and market context in western Uttar Pradesh (Kumar, 2024; Sonkar and Ahamad, 2020). Understanding how socio-demographic factors, farm and resource endowments, institutional support, and work environment are associated with farming-related problems among vegetable farmers is essential for designing targeted interventions. In addition, shocks such as COVID-19, weather variability, and input

and market disruptions have further exposed vegetable farmers to production losses, food insecurity, and reduced diet quality (Kumar et al., 2023).

Within this broader context, there is a need for district-specific evidence on how farmers' socio-demographic characteristics, farm and market conditions, and work practices are associated with the farming-related problems they experience. Therefore, this cross-sectional study aims to assess the magnitude and types of problems experienced by vegetable growers and to identify the socio-economic, farm, and work-related factors associated with these problems. Insights from this study are expected to help policymakers, extension agencies, and local institutions develop context-specific strategies to improve the livelihoods, safety, and sustainability of vegetable farming in Baghpat district.

Methodology

Data Source:

The present study is based on primary data collected from vegetable farmers in the Baghpat District of Uttar Pradesh. The study was conducted in four villages-Hilwari, Idrishpur, Badka, and Kasampur Kheri-which were selected due to their significant engagement in vegetable cultivation.Using a purposive sampling technique, a total of 240 vegetable farmers were selected to ensure adequate representation of diverse demographic and farming backgrounds. Data were collected through a structured interview schedule comprising sections on demographic profile, family-related information, farming practices, and farming-related problems. The instrument was pretested to ensure reliability and validity. Field observations were also undertaken to strengthen the quality of data. Quantitative data were analyzed using descriptive statistics such as frequencies and percentages, and the results were presented using tables and figures.

Ethical Approval:

Ethical approval for the study was obtained from the Institutional Ethics Committee for Human Research (IECHR) of The Maharaja Sayajirao University of Baroda (MSU), Vadodara, vide approval letter no. IECHR/FCSc/Ph.D./10/2024/02. Informed consent was obtained from all participants prior to data collection, and confidentiality and anonymity of the respondents were strictly maintained throughout the study.

Sampling Procedure:

A purposive sampling technique was adopted for the selection of study participants. The Baghpat District of Uttar Pradesh was selected due to its high engagement in vegetable cultivation. Within the district, four villages: Hilwari, Idrishpur, Badka, and Kasampur Kheri were identified based on the concentration of vegetable farmers and accessibility for field investigation. A list of vegetable farmers was prepared in consultation with local agricultural officers, village leaders and farmer groups. Farmers who were actively engaged in vegetable cultivation for at least two year were considered eligible for inclusion in the study. From the identified list, a total of 240 vegetable farmers were selected to ensure adequate representation of different age groups, farm sizes, and farming experiences.

Based on information from agricultural officers and village leaders, approximately 18% (p = 0.18) of households were engaged in vegetable farming. The required sample size was calculated using the single population proportion formula:

$$n = \frac{Z^2\, p\, q}{d^2}$$

Where:

- $Z = 1.96$(95% confidence level)
- $p = 0.18$
- $q = 1 - p = 0.82$
- $d = 0.05$(margin of error)

$$n = \frac{(1.96)^2 \times 0.18 \times 0.82}{(0.05)^2}$$
$$n \approx 227$$

To account for a **5% non-response rate**, the adjusted sample size was calculated as:

$$n_{adj} = \frac{n}{1 - 0.05}$$
$$n_{adj} = \frac{227}{0.95}$$
$$n_{adj} \approx 239$$

Thus, the final required sample size was approximately 239 respondents, which was rounded to 240 vegetable farmers to ensure adequate representation and statistical precision.

Outcome and Predictors Variable

Outcome variable: The farming-related problems were assessed across six major components: soil and seed quality; pests/weed/disease management; technological challenges; water and irrigation issues; time management; and climate/weather and post-harvest issues. Each component consisted of multiple statements measured on a Five-point scale: Strongly Disagree (1), Disagree (2), Neutral (3), Agree (4), and Strongly Agree (5).

A composite score was computed by summing the responses for all items and converting the total into a percentage score. Based on the distribution of the percentage scores, the overall farming-related problem index was categorized using quantile-based cut-offs: first quantile (≤33%) as Low, second quantile (34-66%) as Medium, and third quantile (>66%) as High level of farming-related problems.

Predictor variable: The predictor variables included socioeconomic, family-related, and farming-related characteristics of the respondents. The socioeconomic variables comprised age of the respondent (21-30, 31-40, 41-50, 50-60 years), gender (male, female), marital status (married, single, widow), educational qualification (no formal education, middle school, high school, graduate), and location of present stay (rural, sub-urban). The family-related variables included type of family (nuclear, joint), household size (≤6 members, 7-10 members, >10

members), number of earning members in the family (one, two, three, four or more), whether all earning members were farmers (yes/no), whether all farming members worked on the same piece of land (yes/no), and monthly family income (Rs. 15,000-40,000; Rs. 41,000-65,000; Rs. 66,000-90,000; >Rs. 90,000). The farming-related variables included experience in growing vegetables (<10, 10-19, 20-29, ≥30 years), size of farm (1-3, 4-6, 7-9, 10-12 acres), working hours per day (3-5, 6-8, 9-11, 12-14 hours), rest during work (yes/no), method of applying pesticides and fertilizers (manually, backpack sprayers, both), frequency of application (weekly, monthly, seasonally), use of personal protective equipment (yes/no), and mode of farm work (all manual, all machines, both).

Statistical Analysis: The collected data were entered, cleaned, and analyzed using Stata version 14. Descriptive statistics such as frequencies, percentages, means, standard deviations, minimum, and maximum values were used to summarize the socio-economic characteristics of respondents and the distribution of farming-related problems. Prevalence with 95% confidence intervals (CI) was calculated for overall farming-related problems and their sub-components.To examine the determinants of farming-related problems (low, medium, high), Ordered Logistic Regression (Proportional Odds Model) was applied. Adjusted Odds Ratios (AOR) with 95% confidence intervals were reported. Model fitness was assessed using the Likelihood Ratio (LR) chi-square test, pseudo R^2, and log-likelihood values. A p-value of less than 0.05 was considered statistically significant.

The ordered logit model is expressed as:

$$\text{logit}[P(Y \leq j)] = \ln\left(\frac{P(Y \leq j)}{P(Y > j)}\right) = \alpha_j - \beta_1 X_1 - \beta_2 X_2 - \cdots - \beta_k X_k$$

Where:

- Y= Farming-related problem level (Low = 1, Medium = 2, High = 3)
- j= Category threshold (for 3 categories, j = 1, 2)
- α_j= Cut-off (threshold) parameter
- $\beta_1, \beta_2, \ldots, \beta_k$= Regression coefficients
- $X_1, X_2, \ldots, X_k$= Independent variables

Results

Descriptive Statistics of Farming-Related Problem Scores:

The table presents the mean percentage scores of overall farming-related problems and their subcomponents. The overall farming-related problem score was relatively high (Mean = 77.10, SD = 9.86), indicating a substantial burden of problems among vegetable farmers. Among the domains, Climate, Weather and Post-Harvest Issues had the highest mean score (82.22, SD = 8.02), followed closely by Pests, Weed and Disease Management (81.72, SD = 11.09), suggesting these are the most severe problem areas. Time Management (77.17) and Technological Challenges (76.70) also showed high average scores, though technological challenges exhibited the highest variability (SD = 19.68; Variance = 387.12), indicating greater differences among farmers in experiencing these issues.

In contrast, Water and Irrigation-related problems had the lowest mean score (54.02, SD = 16.95), suggesting comparatively lower severity, although the wide standard deviation reflects considerable variation. The maximum scores reached 100% across most domains, indicating that some farmers experienced very high levels of problems, while the minimum scores reveal that no domain was completely absent among respondents. Overall, the findings indicate that climate-related factors and pest management are the most critical challenges, whereas irrigation issues, though present, are relatively less severe on average.

Table 1: Mean Scores and Distribution of Farming-Related Problems and Their Subcomponents among Vegetable Farmers (in %)

Parameter (Score in %)	Mean	Standard Deviation	Maximum	Minimum
Farming Related Problems	77.10	9.86	98.73	47.62
Soil and seed-Quality fertility and availability	76.38	14.42	100.00	25.45
Pests, Weed and Disease Management	81.72	11.09	100.00	41.25
Technological Challenges	76.70	19.68	100.00	28.00
Water and Irrigation-related problems	54.02	16.95	100.00	22.86
Time Management	77.17	14.44	100.00	32.00
Climate, Weather and Post-Harvest Issues	82.22	8.02	100.00	62.11

Prevalence of Farming related problems

The table presents the distribution of overall farming-related problems and their sub-components among vegetable farmers. Overall, 60.0% of farmers experienced a medium level of farming-related problems, while 28.3% reported a high level, and only 11.7% reported a low level. This indicates that the majority of farmers are facing moderate to severe farming challenges.

Among the sub-components, pest, weed, and disease management emerged as the most serious issue, with 65.0% reporting a high level of problems, followed closely by soil and seed quality, fertility, and availability (62.5%). Time management (54.2%) and technological challenges (51.7%) were also major concerns. In contrast, water and irrigation-related problems were comparatively less severe, with 46.7% reporting low-level problems and only 14.2% reporting high-level problems. For climate, weather, and post-harvest issues, most farmers (59.2%) reported a medium level of problems.

Table 2: Distribution of Farming-Related Problems and Their Subcomponents by Severity Level with 95% Confidence Intervals (CI) among Vegetable Farmers

Farming-related problems	Prevalence		95% of CI	
	N	%	Lower	Upper
Overall Farming Related Problems				
Low	28	11.7	8.1	16.2
Medium	144	60.0	53.7	66.0
High	68	28.3	22.9	34.3
Soil and seed -Quality fertility and availability				
Low	16	6.7	4.0	10.4
Medium	74	30.8	25.2	36.9
High	150	62.5	56.3	68.4
Pests, Weed and disease Management				
Low	10	4.2	2.2	7.3
Medium	74	30.8	25.2	36.9
High	156	65.0	58.8	70.8
Technological Challenges				
Low	36	15.0	10.9	19.9
Medium	80	33.3	27.6	39.5
High	124	51.7	45.4	57.9
Water and Irrigation related problems				
Low	112	46.7	40.4	53.0
Medium	94	39.2	33.2	45.4
High	34	14.2	10.2	19.0
Time Management				
Low	18	7.5	4.7	11.3
Medium	92	38.3	32.4	44.6

High	130	54.2	47.8	60.4
Climate, Weather and Post-Harvest Issues				
Low	42	17.5	13.1	22.7
Medium	142	59.2	52.9	65.2
High	56	23.3	18.3	29.0

The forest plot indicates that pests, weed and disease (65%) constitute the most prevalent farming-related problem, followed by soil and seed quality (62%), time management (55%), and technological challenges (52%), all of which lie significantly above the reference cut-off value. In contrast, water and irrigation (15%) and climate and post-harvest issues (25%) show comparatively lower prevalence. The overall farming-related problem (around 30%) lies near the reference threshold.

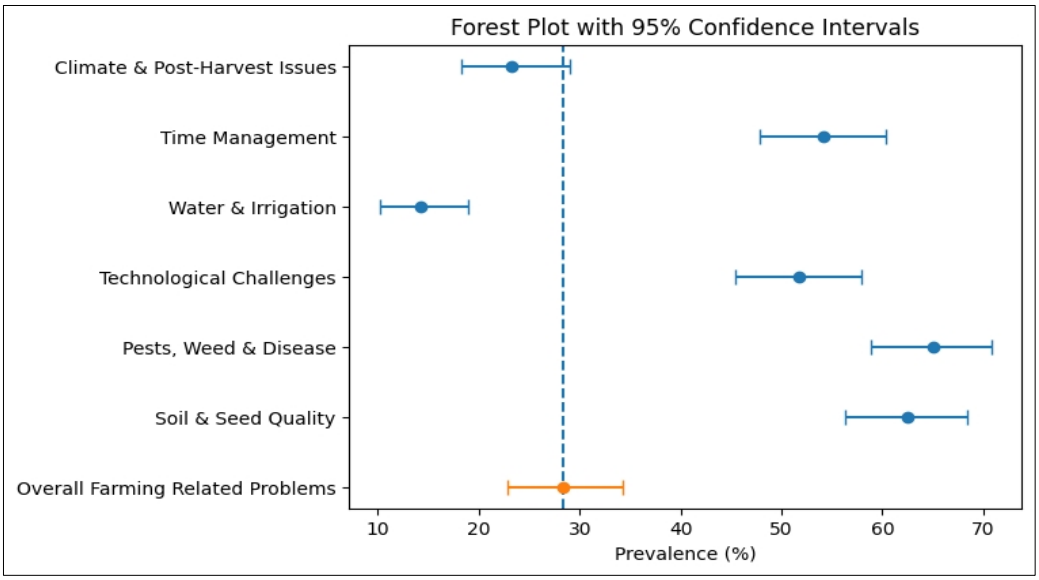

Figure 1: Forest Plot Showing High Problem Proportion Across Farming Components

Background Characteristics of the Respondents:

The study included a total of 240 vegetable farmers. The majority of respondents (33.3%) were aged 41-50 years, followed by 31-40 years (28.3%). About one-fifth (20.0%) were aged 21-30 years, while 18.3 percent were between 50-60 years.

Most respondents were male (75.8%), and nearly three-fourths (72.5%) were married. Regarding educational status, 40.0% had completed middle school, 24.2% had high school education, 20 percent had no formal education, and 15.8 percent were graduates.

A majority (61.7%) resided in rural areas. More than half (55 %) belonged to joint families, and 45.8 percent had ≤6 household members. Nearly one-third (32.1%) reported having two earning members in the family, while 31.7 percent had four or more earning members. About

half (49.2%) reported that all earning members were farmers, and 70 percent stated that all farmer members worked on the same piece of land. In terms of monthly family income, 45 percent earned between Rs. 15,000-40,000, followed by 21.7 percent earning Rs. 41,000-65,000.

Regarding farming characteristics, 32.9 percent had 20-29 years of experience in vegetable cultivation. Nearly half (45.8%) owned 4-6 acres of land, and 31.7% owned 7-9 acres. Most respondents (51.7%) worked 6-8 hours per day, and 93.3 percent reported taking rest during work.

More than half (55.0%) applied pesticides and fertilizers using both manual and backpack sprayers, and 45.8 percent applied them monthly. A concerning finding is that 64.2 percent did not use any personal protective equipment (PPE) while farming. The majority (79.2%) reported that farm work was done using both manual labor and machines.

Factors Associated with Farming-Related Problems among Vegetable Farmers:

Using ordered logistic regression, the factors associated with the level of farming-related problems (low, medium, and high) were examined. The results indicate that higher education significantly reduced the likelihood of experiencing greater farming-related problems. Compared to farmers with no formal education, those with middle school (AOR = 0.28, 95% CI: 0.09-0.86), high school (AOR = 0.19, 95% CI: 0.05-0.65), and graduate education (AOR = 0.05, 95% CI: 0.01-0.26) were less likely to report medium or high levels of problems. Widowed respondents also had lower odds of facing higher levels of problems (AOR = 0.21, 95% CI: 0.05-0.83).

Farmers from households with 7–10 members were more likely to experience higher levels of farming problems (AOR = 10.85, 95% CI: 2.87-40.98). However, having more earning members significantly reduced the likelihood of higher problem levels: 2 earning members (AOR = 0.15, 95% CI: 0.04–0.54), 3 earning members (AOR = 0.05, 95% CI: 0.01-0.28), and 4 or more earning members (AOR = 0.00, 95% CI: 0.00–0.04). When all earning members were farmers, the odds of experiencing more serious problems were also lower (AOR = 0.29, 95% CI: 0.12-0.70).

Regarding farming practices, working 6-8 hours (AOR = 0.03, 95% CI: 0.01–0.18) and 9-11 hours (AOR = 0.15, 95% CI: 0.03–0.84) per day significantly reduced the likelihood of reporting higher levels of problems compared to working 3-5 hours. Farmers who reported taking rest during work had significantly higher odds of being in a more serious problem category (AOR = 50.12, 95% CI: 7.13-352.4). Using backpack sprayers (AOR = 0.09, 95% CI: 0.01-0.75) and performing all farm work by machines (AOR = 0.07, 95% CI: 0.01-0.52) were associated with lower odds of experiencing medium or high farming-related problems.

Table 3:

Background Characteristics	AOR	Std. Err.	z	P>z	95 % of CI (LL-UL)
Socioeconomic Information					
Age of the Respondent					
21-30 Years					
31-40 Years	1.93	1.35	0.95	0.345	(0.49-7.58)
41-50 Years	1.89	1.66	0.72	0.469	(0.34-10.54)
50-60 Years	1.03	1.09	0.03	0.978	(0.13-8.18)
Gender					
Male					
Female	0.70	0.36	-0.69	0.488	(0.25-1.93)
Marital Status					
Married					
Single	4.00	3.14	1.77	0.077	(0.86-18.62)
Widow	0.21	0.15	-2.22	0.027	(0.05-0.83)
Education Qualification					
No formal education					
Middle School	0.28	0.16	-2.22	0.026	(0.09-0.86)
High School	0.19	0.12	-2.65	0.008	(0.05-0.65)
Graduate	0.05	0.04	-3.52	0.000	(0.01-0.26)
Location of present stay					
Rural					
Sub Urban	1.20	0.50	0.45	0.653	(0.54-2.7)
Family-related information					
Type of Family					
Nuclear					
Joint	0.62	0.40	-0.73	0.465	(0.17-2.22)

Background Characteristics	AOR	Std. Err.	z	P>z	95 % of CI (LL-UL)
Household Family Members					
≤ 6 Members					
7 to 10 Members	10.85	7.36	3.52	0.000	(2.87-40.98)
>10 Members	4.29	3.27	1.91	0.056	(0.96-19.11)
Earning members in the family					
One Member					
2 Members	0.15	0.10	-2.91	0.004	(0.04-0.54)
3 Members	0.05	0.04	-3.38	0.001	(0.01-0.28)
4 and More Members	0.00	0.01	-4.9	0.000	(0-0.04)
All earning members are farmers					
No					
Yes	0.29	0.13	-2.74	0.006	(0.12-0.7)
All members that are farmers are working on same piece of land					
No					
Yes	2.55	1.29	1.84	0.066	(0.94-6.89)
Your Family Monthly Income (In Rupees)					
Rs. 15,000-40,000					
Rs. 41,000-65,000	2.16	1.18	1.41	0.159	(0.74-6.31)
Rs. 66,000-90,000	0.97	0.61	-0.05	0.961	(0.28-3.35)
Rs. >90,000	1.78	1.32	0.78	0.437	(0.42-7.61)
Farming-related information					
Experience in growing vegetables					
<10 Years					
10-19 Years	1.27	0.89	0.34	0.735	(0.32-5.02)
20-29 Years	1.21	0.95	0.24	0.812	(0.26-5.66)

Background Characteristics	AOR	Std. Err.	z	P>z	95 % of CI (LL-UL)
30 and more years	0.57	0.50	-0.65	0.519	(0.1-3.13)
Size of farm					
1-3 Acre					
4-6 Acre	1.03	0.54	0.05	0.962	(0.36-2.9)
7-9 Acre	1.64	1.02	0.8	0.426	(0.48-5.56)
10-12 Acre	2.12	2.04	0.78	0.436	(0.32-13.98)
Working hours per day					
3-5 Hours					
6-8 Hours	0.03	0.03	-3.85	0.000	(0.01-0.18)
9-11 Hours	0.15	0.13	-2.16	0.031	(0.03-0.84)
12-14 Hours	0.47	0.56	-0.64	0.524	(0.05-4.77)
Do you take rests in between work					
No					
Yes	50.12	49.87	3.93	0.000	(7.13-352.4)
How do you apply pesticides and fertilizers in your field					
Manually					
Backpack sprayers	0.09	0.10	-2.23	0.026	(0.01-0.75)
Both in combination	0.14	0.14	-1.88	0.06	(0.02-1.09)
How frequently you apply pesticides and fertilizers					
Weekly					
Monthly	1.96	1.41	0.94	0.35	(0.48-8.05)
Seasonally	1.02	0.72	0.02	0.982	(0.25-4.11)
Do you use any Personal Protective Equipment or any other safety measures while farming?					

Background Characteristics	AOR	Std. Err.	z	P>z	95 % of CI (LL-UL)
No					
Yes	0.56	0.26	-1.23	0.22	(0.23-1.41)
Work done on your farm is by					
All Manually					
All by machines	0.07	0.07	-2.59	0.01	(0.01-0.52)
Both	4.65	3.91	1.83	0.068	(0.89-24.16)
Model Fitness					
Cut 1: Low and Medium	-5.97				
Cut 2: Medium and High	-0.66				
Number of Observations (N)	240				
LR chi2(38)	163				
Prob > chi2	0				
Pseudo R2	0.3713				
Log likelihood	-137.97134				

Discussion:

Vegetable cultivation plays an important economic role in Uttar Pradesh, especially for small and marginal farmers (Sonkar et al., 2020; Mishra & Ghadei, 2015; Singh et al., 2017). However, despite its commercial potential, farmers operate under multiple structural constraints, including fragmented landholdings, high input costs, and market uncertainties (Sonkar & Ahamad, 2020; Kumar et al., 2024). The present study from Baghpat district provides district-level evidence on the magnitude and determinants of farming-related problems.

The findings show that 60 per cent of farmers experienced a medium level of farming-related problems, while 28 per cent reported high levels, indicating that nearly one-third of farmers face severe challenges. Among sub-components, pest, weed, and disease management (65%) and soil and seed quality issues (63%) were the most prevalent high-level problems. These findings align with earlier studies in Uttar Pradesh highlighting poor access to quality inputs, high pesticide dependence, and inadequate technical guidance (Kumar et al., 2024; Pathak et al., 2024). The heavy burden of pest-related problems also supports evidence of unsafe pesticide use and limited safety awareness among vegetable growers (Mamun & Goswami, 2024; Venugopal et al., 2025). Additionally, the study indicates that technological challenges

and time management issues were also substantial. Previous research indicates limited extension services and weak training systems as major barriers to adopting improved technologies (Sonkar & Ahamad, 2020). In the present study, mechanisation significantly reduced higher problem levels. Farmers using backpack sprayers had lower odds, and those relying fully on machines had reduced odds of experiencing severe problems, emphasising the protective role of technology adoption. Studies from other developing regions also highlight that access to farm mechanisation reduces labour constraints and improves farm efficiency among smallholders (Simtowe et al., 2021).

Education emerged as a strong protective factor. Compared to farmers with no formal education, those with middle school, high school, and graduate education were significantly less likely to report higher problem levels. This is consistent with previous findings reported among smallholder farmers in developing countries that education enhances awareness, access to information, and adoption of scientific practices (Jean et al., 2023; Ruzzante et al., 2021; Kumar et al., 2024; Sonkar & Ahamad, 2020).

Household economic structure also influenced vulnerability. Farmers from households with 7–10 members had higher odds of severe problems, whereas having multiple earning members significantly reduced risk. This suggests that diversified household income buffers against production and market shocks, consistent with reports of price volatility and marketing constraints in Uttar Pradesh (Srivastava et al., 2025; Pathak et al., 2024).

Interestingly, water and irrigation problems were comparatively less severe, with only 14% reporting high levels. This may reflect better irrigation access in western Uttar Pradesh than in other regions, although broader studies still identify irrigation as a structural constraint (Sonkar & Ahamad, 2020).

Work-related practices also showed significant associations. Farmers who reported taking rest during work had substantially higher adjusted odds of experiencing severe farming-related problems. However, the very high adjusted odds observed for rest during work may reflect reverse causality, whereby farmers experiencing greater physical strain or production-related challenges are more likely to take breaks, rather than rest itself increasing problem severity. Given the cross-sectional nature of the study, causal direction cannot be established and this association should be interpreted with caution.

Overall, the study demonstrates that farming-related problems in Baghpat are multidimensional and strongly associated with education, household labour structure, mechanisation, and work practices. The findings reinforce existing evidence while providing district-specific insights. Strengthening extension services, improving access to quality inputs, promoting mechanisation, ensuring safe pesticide practices, and enhancing farmer education are critical for improving resilience and sustainability in vegetable farming systems.

Limitations

This study has certain limitations. First, the cross-sectional design limits causal inference between socioeconomic characteristics and farming-related problems. Second, the findings rely on self-reported responses, which may be subject to recall and reporting bias. Third, the

study was conducted in a single district of Uttar Pradesh, which may restrict the generalizability of the findings to regions with different agro-ecological and institutional conditions. Despite these limitations, the study provides important district-level empirical insights into the determinants of farming-related vulnerability in labour-intensive vegetable production systems.

Conclusion

Vegetable cultivation plays a vital role in sustaining rural livelihoods in Baghpat district, yet the findings of this study reveal that farmers continue to face substantial farming-related challenges. The majority of respondents experienced either medium or high levels of overall farming-related problems, indicating that vegetable production remains a demanding and risk-prone activity. Among the different components, pest, weed, and disease management, and soil and seed quality issues emerged as the most critical concerns. Time management and technological challenges also affected a large proportion of farmers. In contrast, water and irrigation-related problems were relatively less severe, suggesting comparatively better irrigation access in the study area. The ordered logistic regression analysis highlighted the importance of socio-economic and work-related factors in shaping farmers' experiences. Higher educational attainment significantly reduced the likelihood of facing severe farming-related problems, underscoring the protective role of knowledge and awareness in adopting improved practices. Similarly, households with multiple earning members were less likely to experience higher levels of problems, reflecting the role of economic stability and labor sharing in reducing farming stress. Mechanisation and the use of backpack sprayers were also associated with lower odds of severe problems, indicating that access to appropriate technology can mitigate production-related constraints. Overall, the study emphasizes that farming-related problems are multidimensional, influenced not only by agronomic factors but also by household structure, education, and work practices. Addressing these challenges requires integrated interventions, including strengthening extension services, promoting farmer education and training, encouraging safe and mechanised farming practices, and improving access to quality inputs. District-specific policy measures tailored to the socio-economic context of Baghpat are essential to enhance productivity, reduce vulnerability, and ensure the long-term sustainability of vegetable cultivation. Although the study is based on a district in northern India, the findings have broader relevance for smallholder farming systems in developing countries facing similar socioeconomic and technological constraints.

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