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Profile and Problems of Grape Growers in the Adoption of Integrated Nutrient Management Practices

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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Abstract

Integrated Nutrient Management (INM) plays a crucial role in sustaining soil fertility and improving crop productivity in grape cultivation; however, the effective adoption of INM practices by grape growers is often influenced by their socio-economic profile and various practical constraints. Therefore, the present study was undertaken to analyse the profile and problems of grape growers in the adoption of Integrated Nutrient Management practices. The study was conducted during 2023–24 in Chikkaballapura district of Karnataka

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state, particularly in Chikkaballapura and Shidlaghatta taluks. A total of 120 grape growers from 12 villages were selected through random sampling, and the data were collected using a pre-tested interview schedule. The collected data were analysed using appropriate statistical tools such as frequency, percentage, mean, and standard deviation. The results revealed that a majority of the grape growers were middle-aged (55.83%), educated up to high school (35.83%), had medium-sized families (67.50%), and possessed moderate experience in grape cultivation (55.00%). Further, a considerable proportion of farmers had low to medium knowledge regarding INM practices. The major problems faced by grape growers in adopting INM practices were lack of knowledge about recommended quantity and time of fertilizer application, and the high cost of organic manure and fertilizers. The study suggests strengthening extension programmes, improving input availability, and providing financial support to enhance the adoption of Integrated Nutrient Management practices among grape growers.

Keywords: Integrated nutrient management; grape growers; adoption; constraints; farmer profile.

1. Introduction

Agricultural growth in India, both in terms of production and productivity, is essential to ensure food and nutritional security for its rapidly increasing population. The Green Revolution marked a significant turning point in Indian agriculture by transforming the country from a food-deficit nation into a food self-sufficient one by the late 1970s. Since then, the agricultural sector has continuously expanded to meet the growing food demand. Food grain production in India has increased remarkably from about 51 million tonnes in the 1950s to more than 309.35 million tonnes during 2023–24 (Anonymous, 2024a). With the population growing at an annual rate of around 0.92 per cent, India's population is projected to reach nearly 1.5 billion by 2030, necessitating an additional production of nearly two million tonnes of food grains annually (Paroda & Praduman, 2000; Praveen & Kiran, 2025; Tarun et al., 2013). Although the country currently produces surplus quantities of major cereals such as wheat and rice, sustaining productivity while maintaining soil health has become a major challenge in the face of intensive agricultural practices.

In this context, efficient nutrient management practices have become increasingly important to sustain crop productivity and maintain soil fertility. As emphasized by Dr. M. S. Swaminathan, Indian soils are often both "thirsty" and "hungry," indicating the need for balanced water and nutrient management. Excessive dependence on chemical fertilizers over the years has led to several concerns such as soil nutrient imbalance, declining soil organic matter and environmental degradation. Therefore, sustainable agricultural production requires an integrated approach to nutrient management that combines chemical fertilizers with organic manures, crop residues, biofertilizers and green manures. Integrated Nutrient Management (INM) has emerged as a promising strategy to enhance nutrient use efficiency, maintain soil health and improve crop productivity while minimizing environmental risks.

Among horticultural crops, grapes constitute one of the most commercially important fruit crops in India due to their high economic value, export potential and wide adaptability to tropical and sub-tropical climatic conditions. Globally, grapes account for nearly 16 per cent of total fruit production. In India, the area under grape cultivation during 2023–24 was about 179.63 thousand hectares with a total production of 3904.29 thousand metric tonnes and an average productivity of 22.35 tonnes per hectare (Anonymous, 2024b). Maharashtra and Karnataka together contribute nearly 95 per cent of the total grape production in the country. Karnataka is the second largest grape-producing state with an area of about 47.12 thousand hectares and a production of 1224.67 thousand metric tonnes during 2023–24, with an average productivity of 25.31 tonnes per hectare. Major grape varieties grown in the state include Thompson Seedless, Anab-E-Shahi (Dilkush) and Bangalore Blue. Although grape cultivation in Karnataka is expanding rapidly across several districts such as those in the Nandi Valley, Cauvery Valley and Krishna Valley regions, the majority of growers continue to depend largely on chemical fertilizers, while the area under purely organic grape cultivation remains relatively limited. The increasing cost of chemical fertilizers, concerns regarding soil degradation and the need to maintain long-term soil productivity have highlighted the importance of adopting Integrated Nutrient Management practices in grape cultivation.

However, despite the recognized importance of Integrated Nutrient Management for sustainable grape production, limited empirical information is available on the socio-economic characteristics of grape growers

and the constraints influencing the adoption of INM practices in major grape-growing regions of Karnataka**,** which restricts the development of effective extension strategies and policy interventions to promote sustainable nutrient management.

Despite the potential benefits of INM in improving soil health, nutrient use efficiency and sustainable productivity, its adoption among grape growers is often influenced by various socio-economic, technical and institutional factors. Many farmers face constraints such as inadequate knowledge of recommended nutrient management practices, high cost of organic inputs and limited access to technical guidance. Understanding the profile characteristics of grape growers and the problems they encounter in adopting INM practices is therefore essential for designing appropriate extension strategies and policy interventions. In this context, the present study was undertaken to analyse the socio-economic profile of grape growers involved in the adoption of Integrated Nutrient Management practices, identify the major problems faced by them in adopting these practices and document their suggestions to overcome the constraints, with the broader objective of promoting sustainable nutrient management and improving the long-term productivity and profitability of grape cultivation.

2. Methodology

2.1 Description of the Study Area

The present study was conducted in Chikkaballapura district of Karnataka state during the year 2023–24. The district is one of the major grape-growing regions in the state and falls under the Nandi Valley grape belt. Chikkaballapura district is known for its favourable climatic conditions and soil types suitable for grape cultivation. Among the several taluks in the district, Chikkaballapura and Shidlaghatta taluks were purposively selected for the study due to the larger area under grape cultivation and higher number of grape growers practicing nutrient management in vineyards. The district has a semi-arid climate with moderate rainfall and is characterized by red loamy soils which are suitable for horticultural crops like grapes. These favourable agro-climatic conditions have contributed to the expansion of grape cultivation in the region.

2.2 Research Design

An ex-post facto research design was adopted for the present investigation as the study aimed to analyze the existing profile characteristics of grape growers and the problems faced by them in the adoption of Integrated Nutrient Management practices. Since the variables under study had already occurred and could not be manipulated by the researcher, the ex-post facto design was considered appropriate for the study. A multistage sampling procedure was followed to select the respondents. Two taluks namely Chikkaballapura and Shidlaghatta were purposively selected. From each taluk, six villages with a higher concentration of grape growers were selected, making a total of twelve villages for the study. From each selected village, ten grape growers were selected using random sampling technique, resulting in a total sample size of 120 respondents.

2.3 Data Collection Procedures

Primary data required for the study were collected from the selected grape growers using a structured and pre-tested interview schedule. The interview schedule was designed to obtain information regarding the socio-economic profile of grape growers, their knowledge and adoption of Integrated Nutrient Management practices, and the problems encountered in adopting these practices. Before the final data collection, the interview schedule was pre-tested with a small group of respondents outside the study sample to ensure clarity and reliability of the questions. Necessary modifications were made based on the feedback obtained during the pre-testing stage. The data were collected through personal interviews with the respondents at their farms or residences to ensure accuracy and completeness of information.

2.4 Data Analysis Procedures

The collected data were carefully coded, tabulated and analyzed using appropriate statistical tools. Descriptive statistical techniques such as frequency, percentage, mean and standard deviation were used to analyze the profile characteristics of the respondents. The problems faced by the grape growers in adopting Integrated Nutrient Management practices were analyzed and ranked based on the frequency of responses. The results were presented in the form of tables and interpreted in accordance with the objectives of the study.

2.4.1 Chi-square Test: Approach and Statistical Analysis

To investigate the relationship between the chosen profile traits of grape growers and their spread across various categorical levels, the Chi-square (χ^2) test of independence was used in this study. Since the variables under investigation such as age, education, experience in grape cultivation, family size, knowledge level, cropping intensity, material possession, annual income, cosmopoliteness, economic orientation, innovativeness, risk orientation, mass media participation, extension participation, and extension contact were and extension contact were categorized into discrete classes (low, medium, and high), the Chi-square test was found to be appropriate.
For every chosen variable, the actual frequencies of respondents in various categories were recorded and contrasted with the anticipated frequencies calculated based on the supposition of independence among categories. The formula used to compute the Chi-square statistic was as follows:

$$\chi^2 = \sum \frac{(O-E)2}{E}$$

Where,

O = Observed frequency
E = Expected frequency

The expected frequencies were derived based on the marginal totals of the contingency table. The calculated χ^2 values were then compared with the corresponding tabulated values at appropriate degrees of freedom and at 5 per cent level of significance.

If the calculated χ^2 value exceeded the tabulated value, the null hypothesis (H_0: no association between variables) was rejected, indicating a significant association between the categories of the variable. Conversely, if the calculated value was less than the tabulated value, the null hypothesis was accepted, indicating a non-significant association.

This statistical method allowed the research to determine if notable differences were present among the categorical distributions of grape growers regarding their profile traits. Table 1 displays the results of the Chi-square analysis, which were interpreted as significant (*) or non-significant (NS) relationships.

The application of the Chi-square test in this study is justified as it is suitable for analyzing categorical data and for testing the independence of attributes in social science and extension research.

3. Results and Discussion

3.1 Profile Characteristics of Grape Growers Adopting Integrated Nutrient Management Practices

The data in Table 1 presents the data on the profile characteristics of grape growers. It is found from the results in Table 1 that a majority of the grape growers (55.83%) belonging to the middle-age category, while 25.84 and 18.33 per cent of the grape growers belonged to the old and young age category, respectively. A greater proportion of the grape growers (35.83%) had completed high school, while 17.50, 16.67, 16.67, 5.83 and 3.33 per cent of the grape growers had completed degree, pre-university, middle school, primary school and postgraduate, respectively. Less number of grape growers were illiterate (2.50%) and could able to read and write (1.67%).

Fifty five per cent of the grape growers were having moderate experience in grape cultivation, whereas 26.67 and 18.33 per cent of the grape growers had more and less experience, respectively. A greater proportion of the grape growers were having medium size family (67.50%), while 21.67 and 10.83 per cent of the grape growers were having large and small size family, respectively. An equal proportion (38.33% each) of the grape growers had low and medium level of knowledge regarding INM practices, whereas 23.34 per cent of the grape growers had high level of knowledge regarding INM practices.

A large number of the grape growers (40.00%) belonged to high cropping intensity category, whereas 33.33 per cent and 26.67 per cent of the grape growers belonged to medium and low cropping intensity category,

respectively. A little more than two-fifth (41.67%) of the grape growers belonged to high level of material possession category, while 30.00 and 28.33 per cent of the grape growers in pooled sample belonged to medium and low level of material possession category. A little over one third (34.16%) of grape growers were in the medium annual income category, while one-third (33.33%) and 32.51 per cent of the grape growers were belonging to low and high level of annual income category, respectively.

Nearly two-fifth (39.17%) of the grape growers were having high level of cosmopoliteness, followed by medium (30.83%) and low (30.00%) level of cosmopoliteness, respectively. Almost half of the grape growers (48.33%) had high level of economic orientation, followed by 32.50 per cent of the respondents were having low level of economic orientation, and 19.17 per cent of the grape growers were having medium level of economic orientation, respectively. A little more than two-fifth (40.84%) of the grape growers were having high level of innovativeness, followed by medium (28.33%) and low (30.83%) level of innovativeness.

A substantial proportion (47.50%) of the grape growers exhibited a high level of risk orientation, while 30.83 per cent and 21.67 per cent of the respondents were categorized under medium and low levels of risk orientation, respectively. With respect to mass media participation, the largest share of respondents (35.00%) demonstrated a medium level of participation, followed by 34.17 per cent who reported high participation and 30.83 per cent who exhibited a low level of mass media participation.

A large number of the grape growers (40.00%) were belonging to low level of extension participation, followed by 35.00 and 25.00 per cent of the grape growers were belonging to high and medium level of extension participation, respectively. More than two-fifth (42.50%) of the grape growers had medium level of extension contact, while 39.17 and 18.33 per cent of the grape growers were having high and low level of extension contact, respectively.

It is observed from the results as indicated in Table 1 that, a larger proportion of grape growers were of middle-aged (55.83%), educated up to high school (35.83%), having medium size family (67.50%), moderate experience in grape cultivation (55.00%) and low level of extension participation (40.00%). The results also revealed that an equal proportion of grape growers (38.33% each) were having low and medium level of knowledge regarding INM practices. Whereas, 42.50 and 35.00 per cent of the grape growers were having medium level of extension participation and mass media participation, respectively. A large number of grape growers in pooled sample were having high level of annual income (34.16%), material possession (41.67%), cropping intensity (40.00%), cosmopoliteness (39.17%), economic orientation (48.33%), innovativeness (40.84%) and risk orientation (47.50%). Similar findings were reported by Kumar et al., (2015); Grewal et al., (2023); Samdariya et al., (2023); Rathwa & Bochalya, (2023).

The results of chi-square revealed that there is a non-significant association among the various categories of knowledge regarding INM practices, cropping intensity, material possession, annual income, economic orientation, innovativeness, risk orientation and mass media participation of grape growers. Whereas, a significant association was observation among the various categories of age, education, experience in grape cultivation, extension participation and extension contact of grape growers.

3.2 Problems of Grape Growers in the Adoption of Integrated Nutrient Management Practices

The data in Table 2 reveals that, with respect to the application of farm yard manure, more than one-fourth (29.17%) of the grape growers had lack of knowledge about the recommended quantity of farmyard manure, while 40.00 per cent of them faced the problem of non-availability of farmyard manure. In respect to the application of vermicompost, a majority of the grape growers (80.83%) faced non-availability of vermicompost, while 19.17 per cent of the grape growers had lack of knowledge about the recommended method and time of application of vermicompost.

With respect to application of green leaf manure, a majority the grape growers (97.50%) reported the non-availability of green leaf manure as a problem for the adoption of green leaf manure in grape cultivation. The results pertaining to the application of bio-fertilizers, cent per cent (100.00%) of the grape growers had lack of knowledge about the recommended quantity of bio-fertilizers, while an equal proportion (82.50% each) of the grape growers reported the lack of knowledge on the recommended method and time of application of bio-fertilizers and non-availability of bio-fertilizers as problems.

Table 1. Profile characteristics of grape growers in the adoption of integrated nutrient management practices

(n=120)

Sl. No.	Profile characteristics	Category	Grape growers		Chi-square value
			No.	Per cent	
1.	Age	Young (< 35 years)	22	18.33	10.68*
		Middle (36 to 50 years)	67	55.83	
		Old (> 50 years)	31	25.84	
2.	Education	Illiterate	3	2.50	11.11*
		Can read and write	2	1.67	
		Primary school	7	5.83	
		Middle school	20	16.67	
		High school	43	35.83	
		PUC	20	16.67	
		Degree	21	17.50	
		Post graduate	4	3.33	
3.	Experience in grape cultivation	Less (<10.00 years)	22	18.33	10.69*
		Moderate (10 – 20 years)	66	55.00	
		More (>20 years)	32	26.67	
4.	Family size (Members per family)	Small (1-3 Members)	13	10.83	11.28*
		Medium (4-8 Members)	81	67.50	
		Large (>8 Members)	26	21.67	
5.	Knowledge regarding INM practices Mean = 19.60 SD = 3.90	Low (<17.69 score)	46	38.33	6.98NS
		Medium (17.69- 21.55 score)	46	38.33	
		High (>21.55 score)	28	23.34	
6.	Cropping intensity Mean = 188.26 SD = 18.26	Low (<179.13 score)	32	26.67	7.99NS
		Medium (179.13 –197.39 score)	40	33.33	
		High (>197.39 score)	48	40.00	
7.	Material possession Mean = 12.50 SD = 3.30	Low (<10.85 score)	34	28.33	8.99NS
		Medium (10.85 – 14.15 score)	36	30.00	
		High (>14.15 score)	50	41.67	
8.	Annual income (Rs) Mean = 985754.17 SD = 649163.32	Low (<Rs. 661172.51)	40	33.33	6.05NS
		Medium (Rs. 661172.51-Rs.1310335.83)	41	34.16	
		High (>Rs. 1310335.83)	39	32.51	
9.	Cosmopoliteness Mean = 8.03 SD =0.98	Low (<7.54 score)	36	30.00	2.11NS
		Medium (7.54 – 8.52 score)	37	30.83	
		High (>8.52 score)	47	39.17	
10.	Economic orientation Mean = 23.12 SD = 2.44	Low (<21.90 score)	39	32.50	8.90NS
		Medium (21.90 – 24.33 score)	23	19.17	
		High (>24.33 score)	58	48.33	
11.	Innovativeness Mean = 31.80 SD = 3.27	Low (<30.16 score)	37	30.83	6.66NS
		Medium (30.16 – 33.44 score)	34	28.33	
		High (>33.44 score)	49	40.84	
12.	Risk orientation Mean = 20.64 SD = 2.86	Low (<19.21 score)	26	21.67	9.08NS
		Medium (19.21 – 22.07 score)	37	30.83	
		High (>22.07 score)	57	47.50	
13.	Mass media participation Mean = 3.83 SD = 1.71	Low (<2.97 score)	37	30.83	5.69NS
		Medium (2.97 – 4.68 score)	42	35.00	
		High (>4.68 score)	41	34.17	
14.	Extension participation Mean = 5.25 SD = 3.40	Low (<3.55 score)	48	40.00	12.01*
		Medium (3.55 – 6.95 score)	30	25.00	
		High (>6.95 score)	42	35.00	

Sl. No.	Profile characteristics	Category	Grape growers		Chi-square value
			No.	Per cent	
15.	Extension contact	Low (<2.03 score)	22	18.33	11.92*
	Mean = 3.80	Medium (2.03 – 5.57 score)	51	42.50	
	SD = 3.54	High (>5.57 score)	47	39.17	

With respect to the application of oil cakes, 63.33 per cent of the grape growers had lack of knowledge about the recommended quantity of oil cakes, while a majority (65.83%) of the grape growers reported the high cost of oil cakes as a problem in the adoption of integrated nutrient management practices in grape production. In respect of application of nitrogenous fertilizers, an equal proportion of the grape growers (83.33% each) had faced the problem of lack of knowledge about the recommended quantity of nitrogenous fertilizers and the high cost of nitrogenous fertilizers in adopting integrated nutrient management practices in grape gardens.

In respect of application of phosphatic fertilizers, an equal proportion of grape growers (69.17% each) had lack of knowledge about the recommended quantity of phosphatic fertilizers and the high cost of phosphatic fertilizers as problem in adopting integrated nutrient management practices in grape cultivation. With respect to the application of potash fertilizers, an equal proportion of grape growers (90.00% each) had lack of knowledge about the recommended quantity of potash fertilizers and reported the high cost of potash fertilizers as constraints, whereas, a vast majority (84.17%) of the grape growers also reported the non-availability of potash fertilizers on time as a major problem in adopting integrated nutrient management practices.

With respect to application of soil amendments, 45.83 per cent of the grape growers faced the problem of lack of knowledge on recommended quantity of gypsum. In respect of application of micronutrients, a majority of the grape growers (61.67%) had lack of knowledge about the recommended quantity of micronutrients, while 45.83 per cent of them reported the non-availability of micronutrients on time and a majority of the grape growers (53.33%) also found the high cost of micronutrients as a problem in the adoption of integrated nutrient management practices in grape cultivation. The findings are in line with the findings of Ramesh *et.al.* (2015); Shambharkar et al., (2017); Desai et al., (2018); Sanketh, et al., (2019); Mohit Sehal et al., (2023); Ananda et al., (2024).

Table 2. Problems of grape growers in the adoption of integrated nutrient management practices

(n=120)

Sl. No.	Problems*	Grape growers	
		No.	Per cent
I	Application of organic manures		
A.	Application of FYM		
1	Lack of knowledge on recommended quantity of FYM	35	29.17
2	Non-availability of farm yard manure	48	40.00
B.	Application of Vermicompost		
1	Lack of knowledge on recommended method and time of application of vermicompost	23	19.17
2	Non-availability of vermicompost	97	80.83
C.	Application of green leaf manure		
1	Non-availability of green leaf manure	117	97.50
D.	Application of bio-fertilizers		
1	Lack of knowledge on recommended quantity of bio-fertilizers	120	100.00
2	Lack of knowledge on recommended method and time of application of bio-fertilizers	99	82.50
3	Non-availability of bio-fertilizers	99	82.50
E.	Application of oil cakes (Neem, pongamia, groundnut and castor)		
1	Lack of knowledge on the recommended quantity of oil cakes	76	63.33
2	High cost of oil cakes	79	65.83
II	Application of fertilizers		
A	Application of nitrogenous fertilizers		
1	Lack of knowledge on recommended quantity of nitrogenous fertilizers	100	83.33
2	High cost of nitrogenous fertilizers	100	83.33

Sl. No.	Problems*	Grape growers	
		No.	Per cent
B	Application of phosphatic fertilizers		
1	Lack of knowledge on recommended quantity of phosphatic fertilizers	83	69.17
2	High cost of phosphatic fertilizers	83	69.17
C	Application of potash fertilizers		
1	Lack of knowledge on the recommended quantity of potash fertilizers	108	90.00
2	Non-availability of potash fertilizers on time	101	84.17
3	High cost of potash fertilizers	108	90.00
III	Application of soil amendments and micronutrients		
A.	Application of gypsum		
1	Lack of knowledge on recommended quantity of gypsum	55	45.83
B.	Application of micronutrients		
1	Lack of knowledge on the recommended quantity of micronutrients	74	61.67
2	Non-availability of required quantity of micronutrients on time	55	45.83
3	High cost of micronutrients	64	53.33

*****-*Multiple response*

3.3 Suggestions of Grape Growers to Overcome the Problems in the Adoption of Integrated Nutrient Management Practices

The findings with respect to the suggestions offered by grape growers to overcome the problems faced in the adoption of integrated nutrient management practices are presented in Table 3. Cent per cent of the grape growers (100.00%) expressed the need for technical guidance on the recommended quantity of bio-fertilizers, while 63.33 per cent of them expressed the need for technical guidance on the recommended quantity of oil cakes, to overcome the problems faced in adoption of integrated nutrient management practices. Regarding the timely availability of organic manures, a vast majority (97.50%) of the grape growers in emphasized the need for ensuring the timely availability of green leaf manure, bio-fertilizers (82.50%), vermicompost (80.83%) and FYM (40.00%). As high as 65.83 per cent of the grape growers in suggested for providing subsidies on oil cakes. In the case of inorganic fertilizers, a vast majority of the grape growers (90.00%) required technical guidance on the recommended quantity of NPK fertilizers and a greater majority (80.83%) of them suggested to provide subsidies on NPK fertilizers to overcome the problems faced in adoption of integrated nutrient management practices.

In respect to soil amendments and micronutrients, a majority (61.67%) of the grape growers expressed the need for technical guidance on the recommended quantity of micronutrient mixture, while 53.33 per cent of the grape growers suggested the government to provide subsidies on micronutrient mixture. An equal proportion (45.83% each) of the grape growers expressed the need for providing technical guidance on the recommended quantity of gypsum and timely availability of micronutrient mixture to overcome the problems faced in the adoption of integrated nutrient management practices in grape cultivation. Similar findings were reported by Hanumant (2017); Desai et al., (2018).

Table 3. Suggestions of grape growers to overcome the problems faced in the adoption of integrated nutrient management practices

(n=120)

Sl. No.	Suggestions	Grape growers	
		No.	Per cent
I	Application of organic manures		
A.	Technical guidance required on recommended quantity of:		
1.	Bio-fertilizers	120	100.00
2.	Oil cakes	76	63.33
B.	Ensuring timely availability of:		
1.	FYM	48	40.00
2.	Vermicompost	97	80.83
3.	Green leaf manure	117	97.50
4.	Bio-fertilizer	99	82.50
C.	Providing subsidies on:		

Sl. No.	Suggestions	Grape growers	
		No.	Per cent
1.	Oil cakes	79	65.83
II	Application of inorganic manure (fertilizers)		
A.	Technical guidance required on recommended quantity of:		
1.	NPK fertilizers	108	90.00
B.	Providing subsidies on:		
1.	NPK fertilizers		80.83
III	Application of soil amendments and micronutrient mixture		
A.	Technical guidance required on recommended quantity of:		
1.	Gypsum	55	45.83
2.	Micronutrient mixture	74	61.67
B.	Ensuring timely availability of:		
1.	Micronutrient mixture	55	45.83
C.	Providing subsidies on:		
1.	Micronutrient mixture	64	53.33

4. Conclusion

The research demonstrated that most grape farmers exhibited moderate degrees of socio-economic and psychological traits, including risk orientation and engagement with mass media, which significantly impact the acceptance of Integrated Nutrient Management (INM) practices. Although the advantages of INM are acknowledged, grape producers faced multiple challenges in its implementation, especially insufficient understanding of fertilizer recommendations, elevated costs of organic materials, and restricted access to prompt technical support. The respondents highlighted the necessity for enhanced extension support via training programs, prompt access to quality inputs, and financial aid in the shape of subsidies. Tackling these challenges would boost the implementation of INM practices, consequently enhancing soil fertility, maintaining grape yields, and encouraging environmentally friendly viticulture.

Consent

As per international standards or university standards, respondents' written consent has been collected and preserved by the author(s).

Disclaimer (Artificial Intelligence)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

Competing Interests

Authors have declared that no competing interests exist.

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