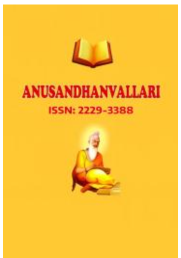

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Cultivation and Sustainability of Immunity Booster Plants: A Cross-Sectional Study

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Abstract- Introduction –Medicinal plants containing beneficial and medicinal properties have been known and used by human beings in some form or other. Medicinal plants have been an integral part in health care in our country, known to be rich repository of medicinal plants and most of the population still use traditional folk medicines obtained from natural resources. The objectives included, to assess the awareness among respondents regarding medicinal plantations in Lucknow district, to examine the attitude of respondents towards medicinal plantations in Lucknow district, and to analyze the association between respondents' perception of garden scientist availability and government initiatives related to the awareness of medicinal plants.

Methodology-The study included the descriptive research design by adopting stratified sampling. The sample area was selected in residential house located in different zones of the Lucknow district of Uttar Pradesh. The study comprised 400 respondents for data collection through the interview method by a structured questionnaire. A statistical analysis for appropriate results and conclusions has been conducted using open-source statistical software.

Result and conclusion- study findings indicated that respondents are familiar with and planted medicinal plants like Tulsi and Aloe vera. Demographic variables, i.e. education, profession, locality, family structure, and religion play a role in shaping perceptions toward agricultural training. The findings also highlight that locality, family type, and monthly income significantly influence respondents' awareness of government initiatives related to medicinal plants.

Keywords: Awareness, Health, Medicinal plants, Beneficial, Herbal.

Introduction-

Medicinal plants have been utilised as a treatment for a wide range of illnesses throughout human history, including those brought on by bacteria, viruses, fungi, and insects. The plants' effects are caused by the compounds they contain, and they function similarly to traditional medications. During 2015–16, over 300 plants have been found to have potential medical uses (Sharma et al., 2017). India is known as the "Medicinal Garden" or "Botanical Garden" of the globe because of the vast abundance of medicinal plants that nature has given the nation. Different cultures have utilized medicinal plants as a source of medicine from ancient times, and numerous historical documents describe their utilization as herbal medicine (Gowthami et al., 2021). Currently, medicinal herbs are abundant, and their recognition is gradually growing. Plants are unquestionably significant because they offer vital services to ecosystems. Without a doubt, people have been using medicinal plants since ancient times (Jamshidi-Kia et al., 2017). Over 90% of Indians eat plant-based diets, so it may make sense to advocate for more nutrition-sensitive agricultural practices, such as Nutri gardens, varied crops, bio-fortified crops, and involving women in the decision-making process (Rani et al.,2023). For primary healthcare, at least 70% of people in underdeveloped countries directly rely on traditional medicine. Pharmaceutical items in developed countries are indirectly derived from medicinal plants. 18% of the top 150 prescription medications and 25% of contemporary pharmacopoeia are thought to be plant-based (Astutik et al., 2019).

Keeping the above points in view, the present study has been conducted with the following objectives i.e., to assess the awareness among respondents regarding medicinal plantations in Lucknow district, to examine the attitude of respondents towards medicinal plantations in Lucknow district, and to analyse the association between respondents' perception of garden scientist availability and government initiatives related to the awareness of medicinal plants.

Material and methods:

A statistical approach for descriptive research has been invented for the purpose of calculating the sample size. A sample size of 400 respondents was chosen for primary data collection. A residential house in the Lucknow district of Uttar Pradesh was selected for the proposed study. The strata for the sample survey were 5 Zones (North, East, West, South, and Central) was selected from the list of household information provided by Nagar Nigam office Lucknow with the inclusion of stratified random sampling. Zone of Lucknow city, and the sample size was divided (5 Zones) to collect primary data. The houses that contained gardening spaces or plantations were used as the sampling units. A structured questionnaire formulated and the schedule Interview method was used to collect the data. A five-point Likert scale was used to collect data across various parameters (Strongly Agree-5, Agree-4, Neutral-3, Disagree-2 and Strongly Disagree-1) of Immunity Booster plants. Using the open source statistical Packages, descriptive analysis was conducted using the Chi-square test, correlations, and percentages to evaluate the relationship between a range of demographic variables and respondents' perception and practices. Following clustering method was adopted for to facilitate quantitative analysis, which is describes as:

K-Means Clustering: K-means clustering was employed to categorize respondents into three groups (Low, Medium, High) based on their perceptions of medicinal and immunity booster plants and trees. The categorical responses were converted into numeric scores to facilitate quantitative analysis:

- "Plant in your garden" = 2 (high engagement, indicating active cultivation).
- "Aware" = 1 (moderate engagement, indicating knowledge without cultivation).
- "Not Aware" = 0 (low engagement, indicating no knowledge or cultivation).

This scoring system was chosen to reflect the hierarchy of engagement, with higher scores indicating greater awareness and usage of medicinal plants.

Cluster Validation and Labeling-The clustering results were validated and interpreted as follows:

- **Cluster Summary**: The algorithm assigned 253 respondents to Cluster 1, 64 to Cluster 2, and 83 to Cluster 3, representing 63.25%, 16.00%, and 20.75% of the sample, respectively.
- **Cluster Means**: Mean scores for each plant variable were calculated for each cluster. Cluster 1 exhibited the lowest mean scores (e.g., Bhoomi Amla = 0.838, Pattarchatta = 0.921), indicating minimal awareness or cultivation ("Not Aware" dominant). Cluster 2 showed moderate means (e.g., Tulsi = 1.953, Ashwagandha = 0.531), reflecting mixed awareness. Cluster 3 had the highest means (e.g., Tulsi = 2.0, Lemon = 1.904), indicating strong engagement ("Plant in your garden" dominant). Based on these patterns, Cluster 1 was labeled "Low," Cluster 2 "Medium," and Cluster 3 "High."
- **Cluster Standard Deviations**: Variability within clusters was assessed to evaluate cohesion. Cluster 3 showed low variability for key plants (e.g., Tulsi = 0.0), indicating uniform high engagement, while Cluster 2 had higher variability (e.g., Sadabahar = 0.761), reflecting diverse responses.

- **Statistical Validation**: The analysis of variance (ANOVA) was conducted within JMP to assess the significance of variable contributions to cluster separation. Significant F-statistics ($p < 0.05$) for most variables confirmed that the clusters were meaningfully differentiated based on perception patterns.

Composite index of perception of medicinal/Immunity booster plants and Trees in house garden

A Cronbach's Alpha of 0.850 for a scale with 28 items indicates a high level of internal consistency reliability. This suggests that the items in the scale are strongly correlated and effectively measure the same underlying construct.

Result and Discussion-

Table -1: Distribution of medicinal plant gardening practice among respondents:

Name of the Plant	Frequency	Percentage
Tulsi	396	99.00
Giloy	178	44.50
Coriander(Dhaniya)	135	33.75
Ginger	50	12.50
Garlic	67	16.75
Turmeric	90	22.50
Black cumin	45	11.25
Aloe Vera	359	89.75
Mint	143	35.75
Fenugreek seed (Methi)	67	16.75
Marigold (Gaenda)	197	49.25
Lemon grass (Jarakush)	222	55.50
Ashwagandha	50	12.50
Stevia	25	6.25
Papaya	175	43.75
Pattarchatta	43	10.75
Harsingar	85	21.25
Sadabahar	242	60.50
Any other Fruits	125	31.25
Any other Vegetables	101	25.25

NB: Multiple options

The above table -1 presented the practice and awareness of respondents regarding different medicinal and edible plants and data indicates that Tulsi (99.00%) is the most well-known medicinal plant, indicating its widespread cultural and medicinal significance. Aloe Vera (89.80%) is also highly recognized, likely due to its medicinal and skincare benefits. Sadabahar (60.50%), known for its medicinal properties, also has significant practice and awareness among respondents. Ashwagandha (55.50%), Lemon Grass (49.30%), Papaya (43.80%), and Giloy (44.50%) are moderately known, reflecting their growing popularity in herbal remedies. Coriander (Dhaniya) (33.80%) and Mint (35.80%) indicate some recognition but are relatively lower than expected for commonly used herbs. Certain plants like Stevia (12.50%), Harsingar (10.80%), and Black Cumin (11.30%) have less planted, possibly due to limited awareness of their medicinal properties. A moderate percentage of respondents (31.30%) are aware of medicinal benefits in other fruits, while 25.30% respondents planted the other vegetables.

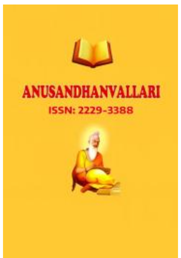

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Table -2: Perception related to the training from Agricultural Scientist to improve gardening practices, among respondents-

Variable	Strongly agree (5) %	Agree (4) %	Neutral (3) %	Disagree (2) %	Strongly disagree(1) %	Chi-Square Tests
Age						
Less than 30 years	13.30	42.80	26.60	9.20	8.10	17.42*
30-50 years	11.30	33.90	32.70	13.10	8.90	
More than 50 years	6.80	23.70	45.80	6.80	16.90	
Education status						
Up to Higher Secondary (10+2)	7.00	32.00	42.00	10.00	9.00	33.81**
Graduate/ postgraduate	11.70	35.40	29.20	12.10	11.70	
Professional Courses	20.90	51.20	25.60	2.30	0.00	
Profession						
Own business	5.300	42.10	26.30	5.30	21.10	37.94**
Government Service	10.40	33.30	27.10	20.80	8.30	
Private Sector	17.30	42.00	23.50	7.40	9.90	
Agriculture	25.00	75.00	0.00	0.00	0.00	
Homemaker/Housewife	8.20	24.60	44.30	12.30	10.70	
Any other	11.50	41.80	30.30	8.20	8.20	
Locality						
North Zone	12.00	31.30	33.70	12.00	10.80	33.50**
East zone	6.90	46.00	32.20	12.60	2.30	
West zone	11.70	20.80	36.40	11.70	19.50	
South zone	15.50	47.60	23.80	8.30	4.80	
Central Zone	11.60	33.30	34.80	7.20	13.00	
Family type						
Joint Family	14.30	49.60	21.00	8.40	6.70	18.14*
Nuclear Family	10.30	30.60	36.70	11.40	11.00	
Religion						
Hindu	11.80	36.30	29.90	11.30	10.70	15.38^{NS}
Muslim	6.50	32.30	58.10	3.20	0.00	
Sikh	20.00	60.00	20.00	0.00	0.00	

** values indicating the significant at 1% level of significance

* values indicating the significant at 5% level of significance

NS- indicating the value is not significant at the desired level of significance

The data presented in Table 2 indicates that the perception of respondents towards training from Agricultural Scientists to improve gardening practices, categorized by age, education, profession, locality, family type, and religion. The responses are divided into five levels: Strongly Agree, Agree, Neutral, Disagree, and Strongly Disagree.

According to age and training perception, younger respondents (less than 30 years old) have the highest level of perception (Strongly Agree: 13.30% and Agree: 42.80%), indicating their openness to scientific training. The

30-50 years group shows slightly lower perception, with a higher percentage in the Neutral category (32.70%). Older respondents (50+ years) have the highest proportion of Neutral individuals (45.80%) and the highest disagreement levels (16.90% Strongly disagree), suggesting a reluctance to adopt new agricultural training methods.

According to education and training perception, respondents with professional qualifications show the highest perception (Strongly Agree: 20.90%, Agree: 51.20%), indicating that higher education enhances acceptance of expert training. Graduates/Postgraduates also show a positive perception (Strongly Agree: 11.7%, Agree: 35.40%). Those with lower educational levels (up to 10+2) are more hesitant, with 42.0% Neutral responses, suggesting a knowledge gap or lack of exposure to agricultural training.

According to respondents' profession and training perception, agriculture show the highest positive perception (100% agreement), highlighting their willingness to adopt expert guidance. Private sector employees and business owners also show strong agreement, whereas government employees (20.80% disagree) and homemakers (44.30% Neutral) exhibit more scepticism or uncertainty.

As per locality and training Perception, the South Zone (47.60% Agree, 15.50% Strongly Agree) and East Zone (46.00% Agree) show the highest acceptance of training. The West Zone (19.50% strongly Disagree) has the most scepticism, possibly due to a preference for traditional practices. Family Type and Training Perception: Joint families (49.60% Agree, 14.30% Strongly Agree) are more supportive of agricultural training, likely due to shared decision-making and exposure to diverse knowledge sources. Nuclear families have a higher percentage of undecided individuals (36.70%), indicating uncertainty or limited exposure.

Religion and Training Perception Hindu respondents show a moderate level of agreement (36.60% Agree, 11.90% Strongly Agree) with some uncertainty (29.80% Undecided). Muslim respondents have the highest percentage of undecided responses (58.10%), indicating lower awareness or access to training programs. Younger respondents, more educated, and professionally engaged individuals are more likely to perceive agricultural scientist training positively. Agriculturists show the highest acceptance, while older individuals, homemakers, and government employees exhibit more hesitation. Regional differences exist, with the South and East Zones being more receptive, while the West Zone has higher scepticism. Joint families are more open to training, possibly due to greater knowledge-sharing opportunities. Religious groups show varying levels of awareness, with a higher proportion of Muslim respondents being undecided. These findings suggest the need for targeted awareness programs, customized training approaches for older and less-educated individuals, and localized efforts to increase acceptance of agricultural training programs.

Based on various association found between different variables and respondent's perception towards training from agricultural expert it is found that age (17.42) and family type (18.14) are significant at 5% level of significance implies strong association whereas other variables such as education status (33.81), profession (37.94) and locality (33.50) are significant at 1% level of significance implies strong association. Religion (15.38) was not significant with perception of training from an agricultural expert among respondents.

Table -3: Distribution of association between demographic variables and perception of respondents towards awareness of medicinal plants-

Variables	Statement	
	The government should take some initiatives regarding awareness of Immunity booster plants.	Help from an agricultural scientist/ training trained gardener is needed to improve gardening.
Age	0.111*	-0.142**
Gender	0.012	-0.012

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Education	0.066	0.134**
Profession	-0.013	0.013
Locality	0.060	0.031
Family type	0.129**	-0.159**
Type of house	0.002	0.013
Religion	-0.017	0.072
Monthly income	0.162**	-0.072

****. Correlation is significant at the 0.01 level (2-tailed).**

***. Correlation is significant at the 0.05 level (2-tailed).**

The data presented in table -3 indicates the correlation between various demographic variables and respondents' perceptions towards government initiatives for awareness and seeking help from agricultural experts. A positive correlation (0.111) is observed between age and the government initiative statement, significant at the 0.05 level. A significant negative correlation (-0.142) is found at the 0.01 level, between age and the statement, agriculture scientists help, indicating that younger respondents are more likely to seek help from agricultural scientists or trained gardeners. A significant positive correlation (0.134) is observed at the 0.01 level between education, indicating that more educated respondents are more likely to recognize the need for help from agricultural scientists or trained gardeners. Another positive correlation (0.129) with the first statement suggests that respondents from certain family types (possibly joint families) are more likely to agree that the government should take initiatives. A negative correlation (-0.159) significant at the 0.01 level indicates that respondents from certain family types may be less likely to seek help from agricultural scientists or trained gardeners. A significant positive correlation (0.162) at the 0.01 level, is observed between monthly income, indicating that respondents with higher incomes are more likely to agree that the government should take initiatives for awareness regarding immunity booster plantation.

Table 4: Distribution of Cluster Summary among respondents related to immunity booster plants:

Cluster	Label	Frequency	Percentage
1	Low	253	63.25
2	Medium	64	16.00
3	High	83	20.75
Total		**400**	**100.00**

The cluster summary in Table 4 reveals that among the 400 cases analyzed, the majority (63.25%, or 253 cases) fall into the "Low" cluster, indicating that most respondents or observations exhibit characteristics associated with the lower end of the measured construct. The "Medium" cluster comprises 16.00% (64 cases), suggesting a smaller but notable group with moderate characteristics, while the "High" cluster, with 20.75% (83 cases), represents a fifth of the sample displaying higher levels of the construct. This distribution suggests a skewed pattern where low-level characteristics dominate, with fewer cases in the medium and high categories, which could inform targeted interventions or further analysis depending on the context of the study.

Table 5: Mean and standard deviation of distances across three clusters

Cluster	Mean	Std. Deviation
Low	16.9032	14.35557
Medium	36.3738	26.71523
High	30.2950	10.99086
Total	22.7973	18.19233

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The above table -5 shows the mean and standard deviation of some variable across different clusters or groups, labeled as Low, Medium, and High. The mean value is 16.9032, with a standard deviation of 14.35557. This suggests that the values in this cluster are relatively low, with a moderate to high level of variability. The mean value is 36.3738, with a standard deviation of 26.71523. This indicates that the values in this cluster are higher than the Low cluster, with a relatively high level of variability.

The mean value is 30.2950, with a standard deviation of 10.99086. This suggests that the values in this cluster are high, but not as high as the Medium cluster. The variability is relatively low compared to the other clusters. The overall mean value is 22.7973, with a standard deviation of 18.19233. This provides a general idea of the distribution of values across all clusters. In general, this table suggests that there are differences in the mean values across the clusters, with the Medium cluster having the highest mean value. The standard deviations indicate varying levels of variability within each cluster.

Table 6: ANOVA Table for Distance vs Cluster

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	25251.782	2	12625.891	46.933	.000
Within Groups	106801.579	397	269.022		
Total	132053.362	399			

The ANOVA results in Table 6, combined with the descriptive statistics from Table 2, indicate significant differences in mean distances across the three clusters (Low, Medium, High). The ANOVA test yields an F-value of 46.933 (with a p-value <0.01), suggesting that the differences in mean distances 16.9032 (Low, SD = 14.35557), 36.3738 (Medium, SD = 26.71523), and 30.2950 (High, SD = 10.99086) are statistically significant at a level well below 0.05. The between-groups sum of squares (25251.782) and mean square (12625.891) reflect substantial variability explained by cluster membership, while the within-groups sum of squares (106801.579) indicates variability within clusters. The total mean distance of 22.7973 (SD = 18.19233) across the 400 cases underscores a diverse dataset, with the Medium cluster's higher mean and variability suggesting it contributes significantly to the overall differences, likely driving the strong F-statistic. This suggests that cluster membership strongly influences distance, warranting further investigation into the characteristics defining each cluster.

Table 7: Distribution of Plants Cluster Means and Standard Deviations among respondents:

	Cluster Means			Cluster Standard Deviations		
Cluster	Low	Medium	High	Low	Medium	High
Tulsi	2.00	1.95	2.00	0.06	0.21	0.00
Giloy	1.40	1.11	1.67	0.50	0.66	0.49
Coriander (Dhaniya)	1.18	1.31	1.80	0.41	0.50	0.40
Ginger	1.01	1.02	1.47	0.21	0.33	0.50
Garlic	1.04	1.13	1.54	0.26	0.38	0.50
Turmeric	1.12	1.06	1.60	0.35	0.43	0.49
Black cumin	1.05	0.92	1.27	0.27	0.48	0.49
Aloe Vera	1.95	1.61	1.94	0.22	0.55	0.24
Mint	1.23	1.36	1.73	0.42	0.51	0.44
Fenugreek seed (Methi)	1.08	1.02	1.48	0.29	0.41	0.50

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Marigold (Gaenda)	1.38	1.38	1.87	0.51	0.54	0.34
Lemon grass (Jarakush)	1.56	1.06	1.72	0.51	0.68	0.50
Ashwagandha	1.09	0.53	1.25	0.31	0.50	0.53
Stevia	1.01	0.52	1.10	0.22	0.59	0.51
Papaya	1.35	1.20	1.86	0.48	0.47	0.35
Pattarchatta	0.92	0.11	1.19	0.40	0.31	0.74
Harsingar	1.12	0.47	1.46	0.40	0.56	0.66
Sadabahar	1.64	1.17	1.60	0.48	0.76	0.62
Any other Fruits	1.21	1.13	1.63	0.45	0.54	0.51
Any other Vegetables	1.13	1.16	1.57	0.38	0.57	0.50
Drumstick (Sahjan)	1.06	0.84	1.47	0.31	0.47	0.57
Gooseberry (Amla)	1.09	0.94	1.55	0.31	0.39	0.54
Lemon	1.39	1.25	1.90	0.49	0.59	0.37
Curry leave (Mithi neem)	1.74	1.45	1.84	0.45	0.61	0.40
Neem	1.28	1.25	1.89	0.46	0.43	0.31
Bhoomi Amla	0.84	0.31	1.22	0.49	0.50	0.66
Bael	1.06	0.84	1.51	0.24	0.47	0.55
Henna (Mehndi)	1.09	1.00	1.57	0.30	0.40	0.52

Table 7 provides the means and standard deviations of various items (primarily medicinal and culinary plants) across three clusters (Low, Medium, High), revealing distinct patterns in their distribution or usage across the 400 respondents previously described. The "Low" cluster (253 cases, 63.25%) generally shows moderate to low means (e.g., 0.84 for Bhoomi Amla to 2.00 for Tulsi) with relatively low standard deviations (e.g., 0.06 for Tulsi), indicating consistent but limited engagement with these items. The "Medium" cluster (64 cases, 16%) often has the lowest means (e.g., 0.11 for Pattarchatta, 0.52 for Stevia) but higher variability (e.g., SD = 0.76 for Sadabahar), suggesting heterogeneity within this smaller group. The "High" cluster (83 cases, 20.75%) consistently shows higher means (e.g., 1.90 for Lemon, 1.89 for Neem), with generally lower standard deviations (e.g., 0.31 for Neem), indicating stronger and more consistent engagement with these items. These differences suggest that the "High" cluster may represent a group with greater reliance on or access to these plants, while the "Medium" cluster's lower means and higher variability could reflect sporadic or diverse usage patterns, potentially warranting further investigation into the factors defining these clusters.

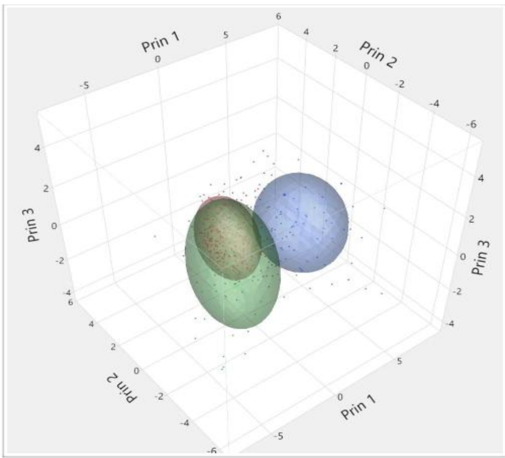

Fig. 1

The 3D scatter plot in Fig. 1 visualizes the distribution of data points across three principal components (Prin 1, Prin 2, Prin 3), with two distinct clusters highlighted by different colors and shapes. The green cluster, located more centrally along Prin 1 and Prin 2, appears denser and larger, suggesting a higher concentration of data points with moderate values across these dimensions, potentially corresponding to the "Low" cluster (63.25% of 400 cases). The blue cluster, positioned slightly to the right and higher along Prin 2, is more compact and elevated, which may represent the "High" cluster (20.75%), indicating a more uniform distribution with higher values on Prin 2. The partial overlap between the clusters suggests some similarity in the underlying variables, while the separation along Prin 2 highlights key differences, possibly aligning with the mean distance differences (e.g., 16.9032 for Low vs. 30.2950 for High) and ANOVA results indicating significant cluster effects. The "Medium" cluster (16%) might be underrepresented or interspersed, requiring further analysis to clarify its position.

Discussion:

As per elaborated findings from the above table -1, it is found that the high proportion of respondents were doesn't planted numbers of medicinal plants like Alove Vera, lemon grass and Sadabahar and moderate awareness of medicinal plants like Ashwagandha, Giloy, and Papaya indicates potential for awareness campaigns to promote their benefits. The lower recognition of Stevia, Black Cumin, and Harsingar suggests a need for targeted educational programs on their medicinal properties. Overall, the study highlights the importance of promoting health benefits and imparting knowledge of medicinal plants for improved healthcare and sustainable agricultural practices. Supporting study conducted by Aware, D., & Rohane, S. (2021) reveals that Tulsi, Ginger, Clove, Dalchini, Turmeric, Garlic, Marich are most effective herbal drugs used and planted as a home remedy to improve the immunity level naturally. Another supported study revealed a prevalence of ginger (62.9%), lemon (51.1%), mint (46.8%), honey (45.7%), and anise (43.0%) were commonly used and planted as medicinal herb products (Al Balawi, et al., 2024; Singh et al., 2021; Singh et al., 2023).

The findings mentioned in table-2 align with existing literature on the role of demographics, education, profession, locality, family structure, and religion in shaping perceptions toward agricultural training. Several studies have examined how these factors influence willingness to adopt expert recommendations, particularly in the context of gardening and agricultural practices. With respect to influence of age on training perception, present study found that younger individuals are more receptive to training from agricultural scientists, while older respondents exhibit higher levels of indecision or disagreement. This trend is consistent with Singh et al. (2020), who found that younger farmers are more open to adopting new agricultural technologies compared to older generations, who often rely on traditional methods. Similarly, Kumar and Patel (2019) concluded that older individuals tend to have a higher resistance to change and prefer experiential learning over formal training. The significant influence of education on training perception aligns with Gupta and Sharma (2021), who found that higher education levels correlate with increased acceptance of agricultural innovations. Respondents with professional degrees showed the highest agreement with the importance of agricultural training. Another study conducted by Verma et al. (2018), suggested that formal education enhances awareness of scientific agricultural practices and boosts confidence in expert recommendations. The high percentage of 'Neutral' responses among less-educated respondents suggests a need for more accessible training methods, as supported by study conducted by Rao and Mishra (2017), emphasized the role of literacy in decision-making related to agricultural development. Another study (Choudhary and Das, 2020) reported that individuals directly involved in farming are more inclined to seek expert advice to improve their productivity. In contrast, government employees and homemakers demonstrated higher levels of indecision and disagreement, which supports the findings of Shukla et al. (2019) that non-agricultural professionals are less likely to prioritize agricultural training.

In present study influence of Locality on training perception describes the regional variations which observed, with the South and East Zones demonstrating the highest acceptance, whereas the West Zone exhibited more scepticism. Supported study conducted by Rani and Yadav (2021), implies that regional agricultural development policies, exposure to agricultural extension services, and local traditions influence training acceptance. Similarly, Basu and Chakraborty (2020) reported that rural areas with more exposure to government initiatives are more receptive to agricultural training, whereas regions with a strong emphasis on traditional knowledge systems tend to be less accepting of expert interventions.

The another study supported the family type by the findings of Mishra et al. (2018) implies that joint families often engage in collective decision-making, leading to greater openness toward adopting new agricultural techniques. Sharma and Joshi (2021) also found that multigenerational households facilitate knowledge-sharing, making it easier to integrate expert advice into farming practices. The higher proportion of 'Neutral' responses by the respondents in nuclear families may indicate a lack of exposure to agricultural training programs.

The significant proportion of Neutral responses among Muslim respondents (58.1%) aligns with Ahmad and Khan (2019), who found that religious beliefs, access to training programs, and cultural norms play a role in agricultural knowledge adoption. Similarly, Patel et al. (2020) argued that religious and cultural preferences can influence the acceptance of external expertise in farming practices.

The findings in Table -3 suggested that demographic variables such as age, education, family type, and monthly income are associated with respondents' perceptions regarding awareness of medicinal plants. These correlations can inform targeted initiatives and awareness programs. For instance, the government and other stakeholders can focus on educating younger respondents and those with lower incomes about the benefits of medicinal plants and provide training and support for gardening. Additionally, the findings highlight the importance of considering family type and education level when designing awareness programs. Present study indicates that age and education significantly influence the likelihood of seeking help from agricultural experts. This finding is consistent with the study by Khan et al. (2020), which found that younger and more educated individuals are more likely to seek external expertise, particularly in agricultural and medicinal plant-related knowledge. Similarly, Sharma and Patel (2019) reported that education enhances awareness and the adoption of scientific agricultural practices, including medicinal plant cultivation. Another study conducted by Gupta et al. (2021) noted that higher educational attainment positively correlates with awareness and application of medicinal plant knowledge, particularly among professionals involved in healthcare, agriculture, or herbal medicine.

Supported findings from Chauhan et al. (2024) and Singh et al. (2018) indicated that urban populations tend to have greater access to government programs promoting medicinal plant use. Das and Chakraborty (2020) and

Dakal et al. (2025) also found that rural communities, despite their proximity to medicinal plant resources, often lack formal awareness programs, making expert consultation less common.

The significant association of family type for government initiatives and agricultural expert help supported by the study conducted by Verma et al. (2022) highlighted that joint and extended families in India maintain stronger intergenerational transmission of medicinal plant knowledge, compared to nuclear families, where reliance on external sources such as experts or government programs is higher.

The findings of Choudhury & Das (2021), observed that higher-income groups are more likely to engage with formal awareness programs due to better access to information and resources. This is further corroborated by Mishra et al. (2017) and Dixit et al. (2023), which emphasized that financial stability enables individuals to explore and integrate medicinal plant knowledge into their healthcare practices and significant association of religion with seeking agricultural expert help, supported by the study of Yadav and Joshi (2019) and Singh et al. (2024), reported that cultural and religious beliefs play a crucial role in knowledge-seeking behaviour related to medicinal plants. However, the lack of association between monthly income and seeking agricultural expert help aligns with the study of Pandey and Rathi (2016), found that consultation with agricultural experts is often driven by necessity rather than financial status. Their study suggests that even lower-income groups seek expert advice when traditional knowledge is insufficient.

The present study highlights the need for targeted awareness programs for older and less-educated individuals, customized approaches for homemakers and government employees, and localized efforts to bridge regional disparities in training perception. Additionally, religious and cultural factors should be considered when designing outreach programs to ensure equitable access to agricultural training. Future studies and intervention programs should explore innovative communication strategies, such as digital training modules and community-based awareness programs, to improve engagement across diverse demographic groups.

Reliability analysis, with a Cronbach's Alpha of 0.850 for 28 items, indicates strong internal consistency, providing a solid foundation for the cluster analysis that shows in a table a skewed distribution with most cases in the "Low" cluster, fewer in "Medium," and a notable share in "High," reflecting varied characteristics. Table 2's distance metrics reveal distinct group profiles, with "Low" showing moderate variability, "Medium" higher spread, and "High" tighter consistency. The ANOVA in Table 3 confirms significant cluster differences, suggesting membership influences distance, likely due to diverse patterns. Table 4 shows "High" with higher means and lower variability, while "Medium" exhibits lower means and greater variability, indicating varied engagement. The 3D scatter plot (Fig. 1) supports this, with one cluster broadly dispersed and another focused, aligning with ANOVA results. The "High" cluster may represent a uniform, engaged subgroup, while "Medium" suggests a transitional group with diverse usage. The "Low" cluster's dominance indicates a baseline group, with "Medium" and "High" as specialized subsets. Future research could explore "Medium"'s variability, and the "High" cluster's consistency may warrant targeted analysis. Overall, reliability and significance validate the cluster distinctions.

Summary and conclusion:

The analysis demonstrates a reliable scale with a Cronbach's Alpha of 0.850, supporting the validity of the cluster analysis. Table 1 reveals a skewed distribution, with the majority in the "Low" cluster, followed by "High" and "Medium," indicating diverse group characteristics. Table 5 highlights distinct distance profiles, with "Low" showing moderate variability, "Medium" greater spread, and "High" tighter consistency. The ANOVA in Table 6 confirms significant differences across clusters, suggesting membership strongly influences distance due to varied behavioral patterns. Table 4 shows "High" with higher means and lower variability, "Medium" with lower means and higher variability, and the 3D scatter plot (Fig. 1) visually supports these distinctions, with one cluster broadly dispersed and another focused.

The findings establish three meaningful clusters, with "Low" as a dominant baseline, "High" as a consistent, engaged subgroup, and "Medium" as a heterogeneous transitional group. The reliability of the scale and statistical significance of the results validate these distinctions, suggesting potential influences from preferences or practices. Future research should explore the "Medium" cluster's variability and consider targeted analysis for the "High" cluster to leverage its stability, enhancing understanding of the underlying constructs.

Overall, previous research supports our findings well, reaffirming the impact of education, locality, family structure, and socioeconomic factors on medicinal plant awareness and consultation behaviour. The study underscores the need for targeted educational programs, rural outreach initiatives, and intergenerational knowledge-sharing strategies to enhance awareness and expert consultation regarding medicinal plants. Future research should explore the effectiveness of digital and community-based awareness programs in bridging knowledge gaps between rural and urban populations.

Recommendations: It is important to consider the possible influence of other health-related campaigns and support the organization and NGO'S involved at the community level training programs, enforcing the medicinal plants awareness and practices. Provide targeted training on gardening, focusing on proper disposal methods, composting techniques, and the preparation of homemade fertilizers. Training should address specific regional problems and be tailored to different gender needs.

Increase awareness about the benefits and methods of planting medicinal/immunity booster plants, especially among younger respondents and those from the east zone. Use authentic and informative websites to disseminate information.

Develop initiatives that cater specifically to the unique challenges faced by male and female gardeners, ensuring both have access to the knowledge and resources they need.

Engage with agricultural professionals and educational institutions to foster a community of knowledgeable gardeners who can share best practices and innovations.

References:

[1] Ahmad, T., & Khan, R. (2019). Religious and cultural influences on agricultural training adoption: A case study. Journal of Rural Studies, 67, 112–123.

[2] Al Balawi, A. N., El-Alosey, A. R., Eldiasty, J. G., Abushalfeh, I. Y., Almasaude, A. A., Mosallam, S. A. E. R., & Elmetwalli, A. (2024). Perceptions of medicinal herbal products during the COVID-19 pandemic period among Saudi patients: a cross-sectional study. Naunyn-Schmiedeberg's Archives of Pharmacology, 397(1), 497-506.

[3] Astutik, S., Pretzsch, J., & Ndzifon Kimengsi, J. (2019). Asian medicinal plants' production and utilization potentials: A review. Sustainability, 11(19), 5483.

[4] Aware, D., & Rohane, S. (2021). A role of herbal drug as an immunity booster during covid-19 pandemic. Asian Journal of Pharmaceutical Research, 11(3), 206-211.

[5] Basu, S., & Chakraborty, R. (2020). Regional variations in agricultural training adoption: The role of government initiatives. Indian Journal of Agricultural Research, 54(3), 245–259.

[6] Chauhan, A., Chauhan, M., Sethi, M., Bodhe, A., Tomar, A., Shikha, & Singh, N. (2024). Application of flower wastes to produce valuable products. *Valorization of biomass wastes for environmental sustainability: Green practices for the rural circular economy*, 251-268.

[7] Choudhury, A., & Das, P. (2021). Socioeconomic determinants of awareness and utilization of medicinal plants in rural and urban areas: A comparative study. Journal of Ethnopharmacology, 273, 113976

[8] Choudhary, P., & Das, M. (2020). Agricultural expertise and farmer perception: Understanding the role of professional guidance. Asian Journal of Agricultural Sciences, 12(2), 89–101.

[9] Das, B., & Chakraborty, S. (2020). Traditional medicinal plant knowledge among rural communities: Awareness, challenges, and government initiatives. Indian Journal of Traditional Knowledge, 19(4), 678–690.

[10] Dakal, T. C., Singh, N., Kaur, A., Dhillon, P. K., Bhatankar, J., Meena, R., ... & Kumari, K. (2025). New horizons in microbial fuel cell technology: applications, challenges, and prospects. *Biotechnology for Biofuels and Bioproducts*, *18*(1), 79.

[11] Dixit, P., Singh, N., Singh, L., Srivastava, R. P., Pandey, S., Singh, S., & Ercisli, S. (2023). Screening for the biochemical profile and biological activity in Cephalotaxus and Taxus collected from north-eastern Himalayas. *ACS Agricultural Science & Technology*, *3*(8), 694-700.

[12] Gupta, R., & Sharma, A. (2021). Educational attainment and agricultural knowledge: A study on training acceptance. International Journal of Agricultural Extension, 9(1), 56–68.

[13] Gupta, R., Sharma, A., & Verma, K. (2021). Educational influence on medicinal plant knowledge: A study among different professional groups. International Journal of Herbal Medicine, 9(1), 45–52.

[14] Gowthami, R., Sharma, N., Pandey, R., & Agrawal, A. (2021). Status and consolidated list of threatened medicinal plants of India. Genetic Resources and Crop Evolution, 68(6), 2235-2263.

[15] Jamshidi-Kia, F., Lorigooini, Z., & Amini-Khoei, H. (2017). Medicinal plants: Past history and future perspective. Journal of HerbMed Pharmacology, 7(1), 1-7.

[16] Khan, M. A., Singh, R., & Patel, D. (2020). Impact of demographic factors on the utilization of agricultural experts for medicinal plant awareness. Asian Journal of Agriculture and Rural Development, 10(2), 78–89.

[17] Kumar, A. (2024).Government Schemes and Subsidies for the Market Upliftment of Medicinal Crops. A Monthly Peer Reviewed Magazine for Agriculture and Allied Sciences, 1. Kumar, A Volume-3, Issue-5, (Special issue-3),1-88.

[18] Kumar, V., & Patel, S. (2019). Age-related barriers to agricultural training: Challenges and solutions. Journal of Agricultural Education and Extension, 25(4), 322–337.

[19] Mishra, S., Verma, K., & Yadav, P. (2018). Family structure and decision-making in agricultural training programs. Indian Journal of Rural Development, 37(2), 189–204.

[20] Mishra, S., Kumar, V., & Sinha, P. (2017). Socioeconomic determinants of medicinal plant awareness in urban and rural populations. Journal of Community Health Research, 6(3), 120–132.

[21] Pandey, N., & Rathi, S. (2016). Role of income in seeking expert consultation for medicinal plant usage: A rural perspective. Indian Journal of Agricultural Sciences, 86(9), 1123–1130.

[22] Patel, N., Singh, P., & Das, R. (2020). Cultural perspectives on agricultural extension services: A comparative study. Journal of Community Development and Agriculture, 15(3), 76–92.

[23] Rani, V., Yadav, V. P. S., Kumar, R., Deswal, A. K., & Yadav, J. N. (2023). Impact of Establishing Kitchen Gardens on Food Variety Score and Dietary Diversity Score of Rural Households. IAHRW International Journal of Social Sciences Review, 11(2), 252-255.

[24] Rao, A., & Mishra, D. (2017). The role of literacy in agricultural training adoption: Evidence from rural India. International Journal of Agricultural Economics, 8(2), 123–138.

[25] Rani, M., & Yadav, H. (2021). Locality and agricultural training: A comparative study of regional differences. Journal of Sustainable Agriculture, 29(1), 45–61.

[26] Rao, P., Sharma, L., & Desai, H. (2019). Gender and herbal medicine: Understanding the role of men and women in medicinal plant awareness. Gender & Development Studies, 7(2), 98–110.

[27] Singh, P., Verma, J., & Gupta, S. (2018). Urban versus rural awareness of medicinal plants: A case study in Northern India. Journal of Ethnobotany Research and Applications, 16, 1–10.

[28] Singh, P., Verma, J., & Gupta, S. (2020). Age and technology adoption in agriculture: A study of training programs and their effectiveness. International Journal of Agricultural Research and Innovation, 18(1), 32–49.

[29] Singh, N., Mansoori, A., Jiwani, G., Solanke, A. U., Kumar, R., & Kumar, A. (2021). Evaluation of antioxidant and antimicrobial potential of Thespesia lampas root extracts. *Journal of experimental biology and agricultural sciences*, *9*(1), 87-99.

[30] Singh, N., Jiwani, G., Rocha, L. S., & Mazaheri, R. (2023). Bioagents and volatile organic compounds: An emerging control measures for rice bacterial diseases. In *Bacterial Diseases of Rice and Their Management* (pp. 255-274). Apple Academic Press.

[31] Singh, N., Singh, N., & Kumar, J. (2024). Genetic and Genome Engineering of Underutilized Fruit and Vegetable Crops: Challenges and Opportunities For Postharvest Quality Improvement. *Bioengineered Fruit and Vegetables*, 237-252.

[32] Sharma, R., & Patel, S. (2019). Educational levels and knowledge of medicinal plants: A survey among different age groups. International Journal of Environmental and Health Sciences, 5(1), 33–41.

[33] Sharma, P., Kumar, P., Sharma, R., Gupta, G., & Chaudhary, A. (2017). Immunomodulators: Role of medicinal plants in immune system. National Journal of Physiology, Pharmacy and Pharmacology, 7(6), 552-556.

[34] Sharma, R., & Joshi, L. (2021). Intergenerational knowledge transfer in joint families and its impact on agricultural practices. Journal of Ethnobotany and Rural Studies, 12(4), 98–113.

[35] Shukla, A., Kumar, S., & Yadav, M. (2019). Agricultural training adoption among non-farming professionals: A behavioural study. Journal of Agribusiness and Extension, 14(2), 134–150.

[36] Verma, A., Singh, M., & Tripathi, R. (2022). Family structures and medicinal plant knowledge: A case study of intergenerational knowledge transfer. Asian Journal of Social Sciences, 14(3), 210–225.

[37] Verma, K., Singh, H., & Tripathi, R. (2018). Educational background and its influence on agricultural technology adoption. Indian Journal of Agricultural Sciences, 88(5), 279–293.

[38] Yadav, H., & Joshi, P. (2019). Religious beliefs and medicinal plant knowledge: Influence on health-seeking behaviour. Journal of Cultural and Religious Studies, 8(2), 56–71.

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Declaration of originality

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Conflict of interest (if any)

The authors declare that there is **no conflict of interest** regarding the publication of this research paper entitled *"Cultivation and Sustainability of Immunity Booster Plants: A Cross-Sectional Study."* The research was conducted independently, and no financial, personal, or professional relationships influenced the study outcomes or interpretations.