

# **Spatial Analysis of Sustainable Agricultural Diversification in Aligarh District, Uttar Pradesh: “A Village-Level Study.**

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## **Abstract**

Agricultural diversification has emerged as an important strategy for strengthening rural livelihoods, enhancing farm income, and promoting sustainable agricultural development in India. It refers to the transition from traditional subsistence agriculture to a more dynamic and diversified farming system that includes multiple crops and allied activities such as livestock rearing, dairy, poultry, horticulture, and fisheries. This transformation is influenced by factors such as technological advancement, irrigation development, infrastructure, market access, income levels, and government policies.

The present study examines the spatial patterns and determinants of agricultural diversification in villages of Aligarh district, Uttar Pradesh, with special reference to the innovation adoption index. The study is based on primary data collected during a field survey conducted in 2017–2018 across twenty-four villages selected from twelve blocks of the district. A total of 10 percent of households from each village were surveyed to analyze the relationship between agricultural diversification, innovation adoption, and socio-economic factors, including landholding size, income level, irrigation facilities, education, age composition, and electricity supply.

The findings reveal that agricultural diversification in the district is spatially uneven and strongly influenced by larger landholdings, higher income levels, better irrigation facilities, higher educational attainment, younger age groups, and reliable electricity supply. Farmers with better access to these resources are more likely to adopt innovations and engage in diversified agricultural practices. The study concludes that agricultural diversification is a crucial pathway for sustainable rural development; however, its expansion is constrained by inequalities in access to infrastructure, knowledge, and economic resources. The paper suggests policy interventions focusing on irrigation facilities, income enhancement, farmer training,

education, and promotion of allied agricultural activities to ensure balanced agricultural diversification.

## **Keywords**

Agricultural Diversification, Innovation Adoption, Rural Development, Irrigation, Socio-economic Factors, Aligarh District.

## **Introduction**

Agriculture continues to play a central role in the socio-economic structure of rural India, particularly in regions where a large proportion of the population depends directly or indirectly on farming and allied activities for their livelihood. In Aligarh district of western Uttar Pradesh, agriculture remains the dominant economic activity and serves as the foundation of rural employment and development. However, the traditional crop-based agricultural system is increasingly facing several challenges, including fragmented landholdings, uncertain monsoon patterns, fluctuating market prices, rising input costs, declining profitability, and growing pressure on land and water resources.

Under these circumstances, agricultural diversification has emerged as an important strategy for increasing farm income, reducing risk, improving resource-use efficiency, and promoting sustainable agricultural development. It refers to the transformation of a subsistence-oriented, cereal-dominated agricultural system into a more diversified and commercially viable system that includes multiple crops, high-value crops, horticulture, livestock, dairy, poultry, fisheries, and other allied activities. This process enhances resilience against climatic and economic uncertainties while also contributing to employment generation, nutritional security, and better integration with local and regional markets.

In recent years, both academic research and policy discussions have emphasized the importance of diversification in improving farm incomes and promoting sustainability in agricultural systems. At the policy level, increasing attention is being given to mixed farming systems, agro-ecological approaches, and livelihood diversification as key components of sustainable rural development.

Despite these developments, the level and nature of agricultural diversification in Aligarh district are not uniform. Significant spatial variations exist among villages and blocks due to differences in landholding size, irrigation facilities, income levels, education, electricity supply, and demographic characteristics of farmers. While some farmers have adopted improved

technologies and diversified their agricultural practices, others continue to rely on traditional farming methods with limited innovation.

The present study aims to examine the spatial patterns of agricultural diversification in Aligarh district through a village-level analysis, with a particular focus on the adoption of agricultural innovations and their socio-economic determinants. Although the primary data were collected during 2017–2018, the analysis is supported by recent literature and policy perspectives to ensure contemporary relevance. The study provides valuable insights into local-level rural transformation and identifies key factors influencing agricultural diversification in the district.

## **Literature Review**

Agricultural diversification has been widely recognized as an important indicator of agricultural modernization, rural transformation, and sustainable development. It plays a significant role in improving farm income, reducing dependence on mono-cropping, and enhancing resilience against climatic and market-related uncertainties.

Recent empirical studies have highlighted the positive impact of diversification on the economic condition of farmers. For instance, Basantaray, Acharya, and Patra (2024), in their analysis of Indian agricultural households, found that crop diversification has a significant and positive effect on household income. Their study emphasizes that diversification improves farmers' economic well-being, particularly when supported by adequate infrastructure, institutional credit, and market access. It also identifies diversification as a viable pathway for achieving inclusive agricultural growth.

Similarly, Neogi and Ghosh (2022) examined crop diversification in Indian agriculture using a panel regression approach and concluded that diversification has become an important adaptive strategy in response to changing agricultural conditions. Their findings suggest that diversified farming systems contribute to income stability, risk reduction, and long-term sustainability. The study further highlights that the level of diversification varies significantly across regions, depending on factors such as irrigation availability, socio-economic conditions, and access to resources.

In addition to academic studies, recent policy discussions have also reinforced the importance of agricultural diversification. NITI Aayog (2023) has emphasized the promotion of agro-ecological approaches, mixed farming systems, and integrated agricultural practices as part of its vision for developing “clean and green villages.” Such policy initiatives reflect the growing recognition at the national level of diversification as a key strategy for achieving sustain-

able rural development and enhancing the resilience of farming systems.

Despite these important contributions, most existing studies focus on macro-level analysis at the national or state level. There remains a significant gap in micro-level, village-based studies that examine how socio-economic and infrastructural factors influence the adoption of agricultural innovations and diversification within a specific district.

The present study attempts to address this gap by providing a detailed village-level spatial analysis of agricultural diversification in Aligarh district. It specifically examines the relationship between diversification and key variables such as landholding size, income level, irrigation facilities, education, age composition, and electricity supply, thereby contributing to a more localized understanding of rural transformation and agricultural development.

### **Objectives of the Study**

1. To analyse the spatial pattern of agricultural diversification in Aligarh district at the village level.
2. To examine recent trends and developments in agricultural diversification in the study area.
3. To evaluate the role of agricultural innovations in promoting diversified farming practices.
4. To assess the relationship between landholding size and the adoption of agricultural innovations.
5. To investigate the influence of income levels on farmers' diversification behaviour.
6. To examine the impact of irrigation facilities on agricultural diversification and innovation adoption.
7. To analyze the role of educational attainment in shaping diversification practices
8. among farmers.
9. To study the effect of age composition on the adoption of diversified agricultural activities.
10. To evaluate the contribution of electricity and power supply in facilitating agricultural innovation and diversification.
11. To suggest appropriate policy measures for promoting balanced and sustainable agricultural diversification in the district.

## **Database and Methodology**

The present study is based on both primary and secondary sources of data. Primary data were collected through a field survey conducted during 2017–2018 in selected villages of Aligarh district, Uttar Pradesh. For detailed analysis, a total of twenty-four villages were selected from twelve development blocks of the district, with two villages chosen from each block. The selected villages together comprise 11,517 households with a total population of 70,013. The selection of villages was carried out using a purposive sampling technique, taking into account factors such as population size, cropping intensity, soil characteristics, and the existing level of agricultural diversification. Within each selected village, respondents were selected using a simple random sampling method.

Approximately 10 percent of households from each village were included in the survey. The head of each household, actively involved in agricultural decision-making, was interviewed to collect relevant information. Data were collected using structured questionnaires covering key variables such as landholding size, income level, irrigation facilities, educational status, age composition, electricity availability, housing condition, level of self-sufficiency, adoption of agricultural innovations, and participation in allied agricultural activities.

In addition to primary data, secondary data were obtained from various published and official sources, including Census of India (2011), Administrative Atlas of Uttar Pradesh, district statistical records, and relevant books, journals, and research reports. These sources were used to support and contextualize the primary findings.

## **Analytical Technique**

To assess the level of agricultural diversification and innovation adoption, the study employs an Adoption Index approach. Under this method, individual respondents were assigned scores based on the extent to which they adopted agricultural innovations and diversified farming practices.

The analysis was carried out through the following steps: assigning scores to respondents according to their level of adoption of innovations and diversified activities; grouping respondents into different socio-economic and infrastructural categories; calculating average adoption index values for each category; and conducting comparative analysis across key variables such as landholding size, income level, irrigation facilities, education, age composition, and electricity supply.

The Adoption Index method was selected due to its effectiveness in quantifying the degree of innovation adoption among farmers. It facilitates comparative analysis across various socio-

economic and infrastructural variables, thereby providing a clear understanding of spatial variations in agricultural diversification at the village level.

### Study Area and Sample Villages

The study covers Aligarh district, located in western Uttar Pradesh, where agriculture forms the principal economic activity in most rural settlements. For a detailed micro-level analysis, two villages were selected from each of the twelve blocks of the district, namely Tappal, Chandaus, Khair, Jawan Sikandrabad, Lodha, Dhanipur, Gonda, Iglas, Atrauli, Bijauli, Gangiri, and Akkrabad. Thus, a total of twenty-four villages were included in the sample. These villages together represent diverse agro-ecological and socio-economic conditions and provide a suitable base for understanding the spatial variation in agricultural diversification across the district.

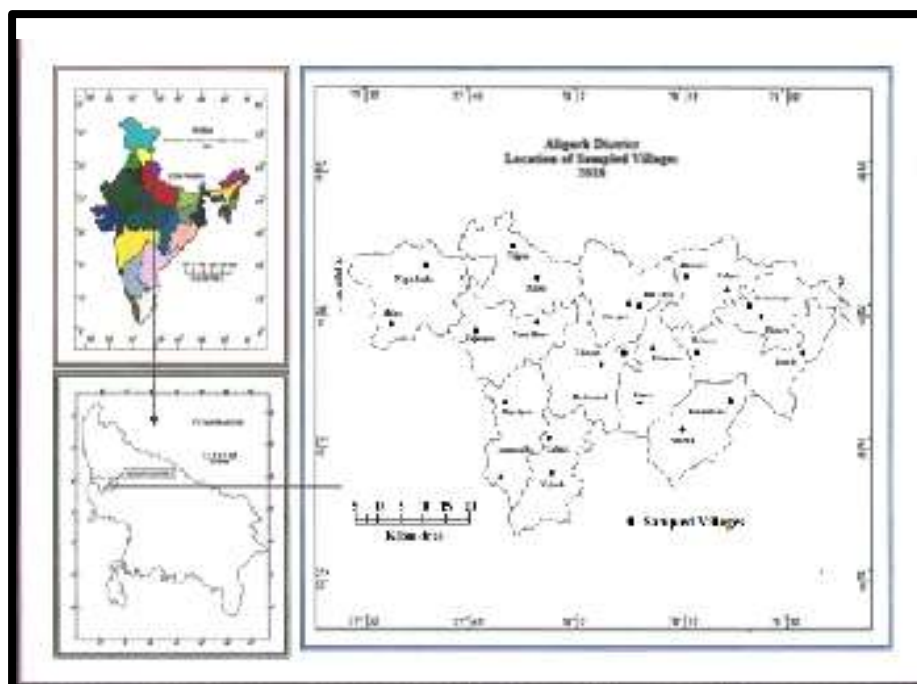


Fig.1

**Table 1: Name of Block and Selected Villages**

Block Name	Village Code	Village Name	Area (ha)	Households	Total population
Tappal	121751	Malav	1244.33	996	6301
	121712	Nagla Danda	122	63	389
Chandaus	121898	Tajpur	283.62	462	2792
	121956	Raipur	136.75	83	450
Khair	121804	Sujanpur	944.05	809	4933
	121815	Neem Khera	171.07	145	876
Jawan Si-kandrabad	122499	Talib Nagar	632.49	1264	7666
	122498	Choupur	233.85	212	1369
Lodha	122461	Talaspur ka-lan	290.23	790	4697
	122459	Nagla Bhai-beg	65.14	59	453
Dhanipur	122600	Adaun	1131.63	1096	6937
	122535	Mohanpur	124.36	90	524
Gonda	122727	Payadapur	923.07	977	5851
	122790	Amarpur Dhana	385.4	202	1144
Iglas	122865	Kajroth	562.2	779	5040
	122811	Gidauli	87.18	85	529
Atrauli	122036	Alampur Kayasthan	186.04	255	1426
	122093	Valipur	122.69	70	377
Bijauli	122209	Palimukmpur	433.37	631	4098
	122206	Bilpura	200.52	231	1380
Gangiri	122297	Jiravali	857.65	1145	6901
	122243	Babupur	228	178	1077
Akrabad	122686	Suhawali	666.1	772	4128
	122634	Govardhapur	154.13	123	675

Source: (census of India, 2011), Administrative Atlas, Uttar Pradesh

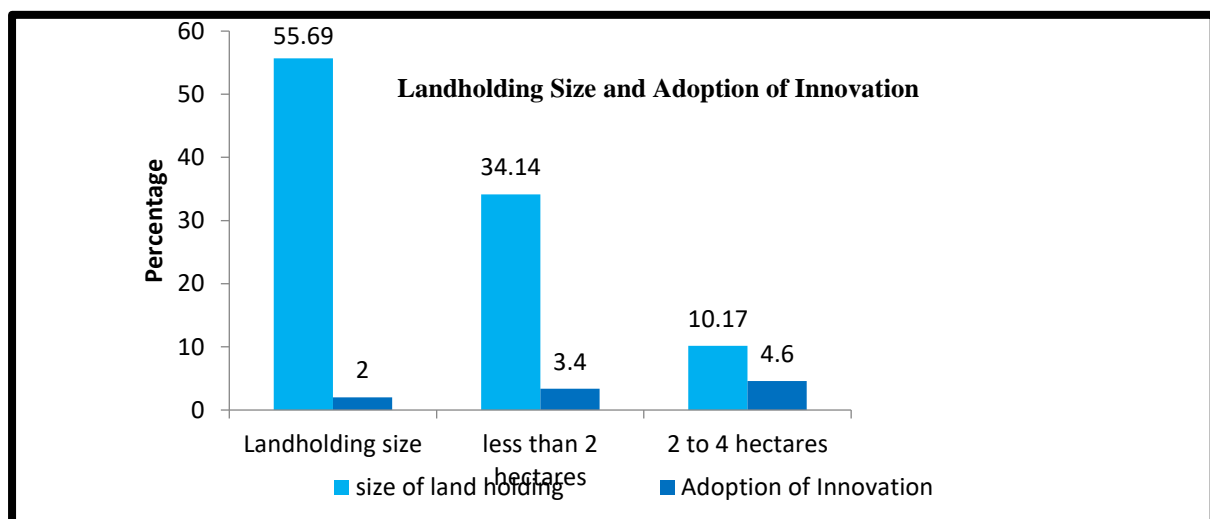
### Landholding Size and Agricultural Diversification

The size of operational landholding emerges as a critical determinant of agricultural diversification. The findings indicate a strong positive relationship between landholding size and the adoption of agricultural innovations index. Farmers with landholdings below 2 hectares constitute 55.69 percent of the sample and record a low adoption index of 2.0. In contrast, farmers with landholdings between 2 to 4 hectares (34.14 percent) show a moderate adoption index of 3.4, while those with more than 4 hectares (10.17 percent) exhibit the highest adoption index of 4.6.

**Table 2: Landholding Size and Adoption of Innovation**

Landholding size	percentage	Adoption index
less than 2 hectares	55.69	2.0
2 to 4 hectares	34.14	3.4
Above 4 hectares	10.17	4.6

Source: field survey 2018



**Fig.2**

This pattern suggests that larger landholders possess greater financial capacity, risk-bearing ability, and access to resources, enabling them to diversify into high-value crops and allied agricultural activities.

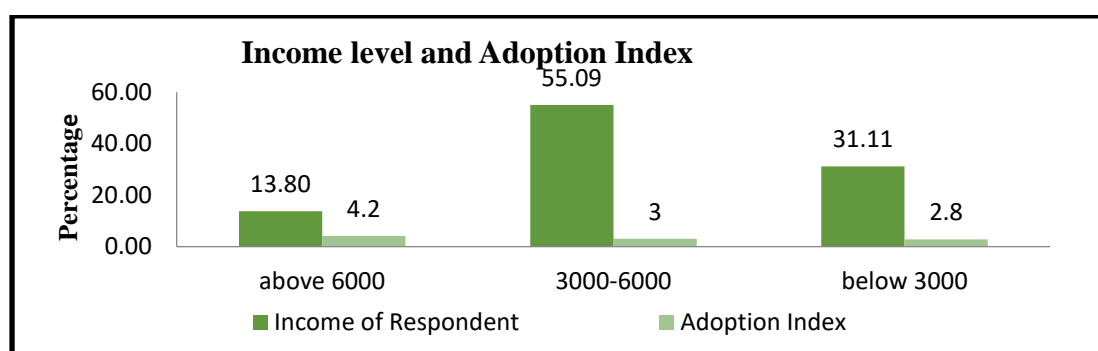
### Income Level and Agricultural Diversification

Income level is another significant factor influencing diversification. The results show a clear positive association between income and innovation adoption. Farmers earning above ₹6000 per month (13.80 percent) demonstrate the highest adoption index of 4.2. The middle-income group (₹3000–₹6000), which constitutes 55.09 percent of the respondents, records an adoption index of 3.0. In contrast, the low-income group (below ₹3000), accounting for 31.11 percent, shows a relatively lower adoption index of 2.8.

**Table 3: Income level and Innovation Adoption**

Income Level	Percentage (%)	Adoption Index
above ₹6000	13.80	4.2
₹3000–₹6000	55.09	3.0
below ₹3000	31.11	2.8

*Source: field survey 2018*



**Fig 3**

These findings indicate that higher income enhances farmers' ability to invest in modern inputs, irrigation, and allied agricultural enterprises, thereby promoting diversification.

### Irrigation Facilities and Agricultural Diversification

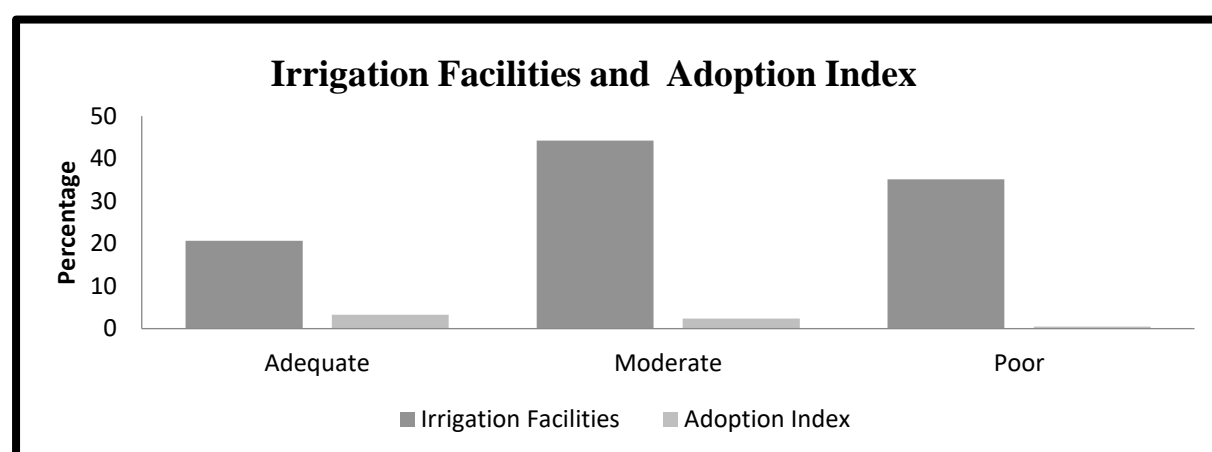
Irrigation availability plays a decisive role in shaping agricultural diversification. The study reveals that farmers with adequate irrigation facilities (20.65 percent) exhibit the highest adoption index of 3.3. Those with moderate irrigation (44.26 percent) show an adoption index

of 2.4, while farmers with poor irrigation facilities (35.10 percent) record the lowest adoption index of 0.5.

**Table 4: Irrigation Facilities and Innovation Adoption**

Irrigation Facilities	Percentage (%)	Adoption Index
Adequate	20.65	3.3
Moderate	44.26	2.4
Poor	35.10	0.5

Source: field survey 2018



**Fig.4**

The results highlight that assured irrigation reduces dependence on monsoon rainfall and enables farmers to adopt multiple cropping patterns and diversify into high-value agricultural activities.

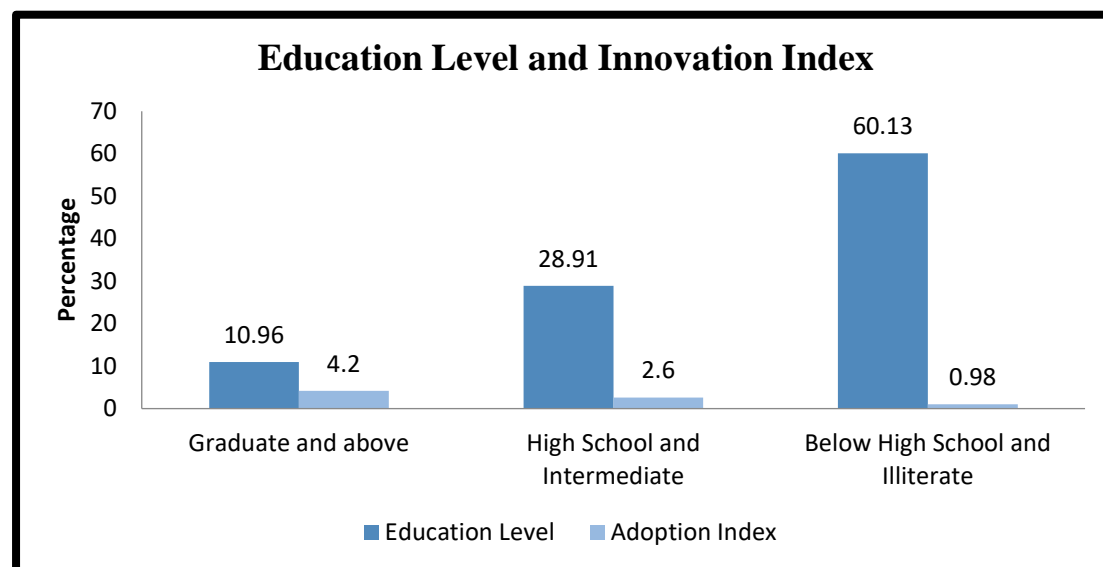
### **Education and Agricultural Diversification**

Education significantly influences the adoption of diversified agricultural practices. Farmers with graduate-level education and above (10.96 percent) show the highest innovation index of 4.2. Those with high school and intermediate education (28.91 percent) record an index of 2.6, whereas the largest group—farmers with below high school education or illiterate (60.13 percent)—exhibits the lowest index of 0.98.

**Table 5: Education Level and Innovation Index**

Education Level	Percentage(%)	Adoption Index
Graduate and above	10.96	4.2
High School and Intermediate	28.91	2.6
Below High School and Illiterate	60.13	0.98

Source: field survey 2018

**Fig 5**

This indicates that education enhances awareness, improves decision-making, and increases the likelihood of adopting modern agricultural techniques and diversified farming systems.

#### **Age Composition of Respondents and Sustainable Agricultural Diversification**

The age composition of farmers is an important factor influencing the adoption of innovations and the extent of sustainable agricultural diversification. Younger farmers are generally more energetic, more willing to take risks, and more open to experimenting with new agricultural practices and allied activities. They are more likely to diversify beyond traditional crop production and integrate activities such as livestock, poultry, fisheries, and horticulture into their farming systems.

In contrast, older farmers tend to rely more on traditional farming practices and are often less inclined to adopt new innovations. This may be attributed to lower risk-taking ability and resistance to change.

For the purpose of analysis, the respondents were classified into four age groups: 18–25 years, 25–35 years, 35–50 years, and above 50 years.

**Table 6: Age Composition and Adoption Index**

Age Group	Percentage	Adoption Index
18-25	13.7	4.1
25-35	19.18	3.2
35-50	38.36	1.2
Above 50	28.77	1.5

Source: field survey 2018

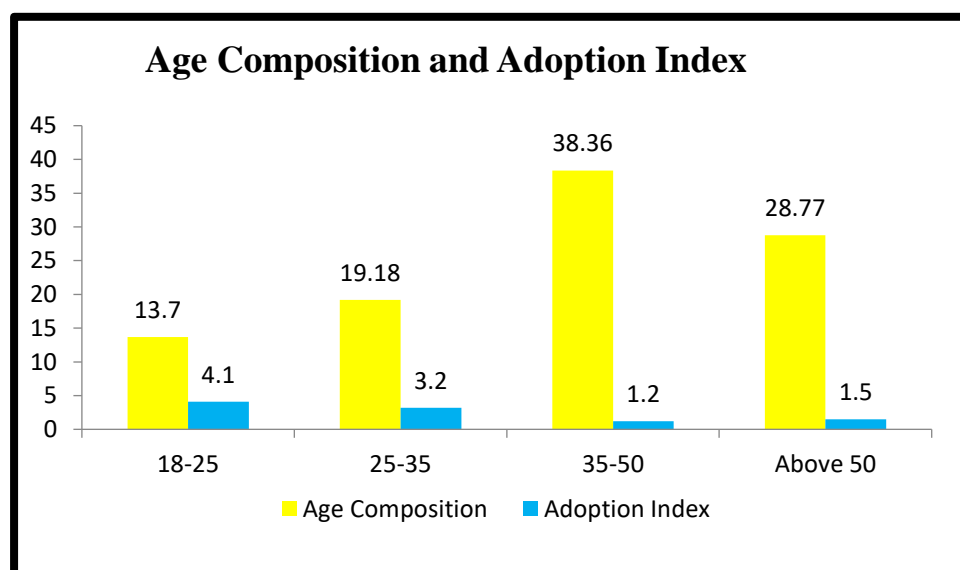
**Fig 6**

Table 6 shows that the 18–25 years age group constitutes 13.70 percent of the respondents and records the highest Adoption of Innovation Index of 4.1. The 25–35 years group accounts for 19.18 percent and shows a relatively high index of 3.2. The 35–50 years group forms the largest category with 38.36 percent, but records a lower index of 1.2. Farmers above 50 years account for 28.77 percent of the respondents and exhibit an index of 1.5.

The findings clearly indicate that younger farmers are more inclined towards innovation adoption and diversification compared to older farmers. This reflects the influence of education, exposure to new information, and changing aspirations among the younger generation.

### Results and Discussion

The analysis of field data reveals that agricultural diversification in Aligarh district is characterized by significant spatial variation, largely influenced by socio-economic and infrastructural conditions. The adoption of agricultural innovations, as measured through the adoption index, shows a consistent relationship with key variables such as landholding size, income

level, irrigation facilities, education, age composition, and electricity supply.

Landholding size emerges as a major determinant of diversification. Farmers with larger landholdings demonstrate a higher level of adoption of improved agricultural practices and diversified activities. In contrast, small and marginal farmers show relatively lower adoption levels, which may be attributed to limited financial resources, lower risk-bearing capacity, and restricted access to modern inputs. This indicates that farm size plays a crucial role in enabling diversification and technological advancement.

Income level also shows a strong positive association with agricultural diversification. Farmers belonging to higher income groups are more likely to invest in modern inputs, irrigation facilities, and allied agricultural enterprises such as dairy and horticulture. On the other hand, low-income farmers tend to depend on traditional farming practices due to financial constraints, thereby limiting their ability to diversify.

The availability of irrigation facilities significantly influences diversification patterns. Farmers with assured irrigation are better positioned to adopt multiple cropping systems and high-value agricultural activities. In contrast, those dependent on uncertain rainfall conditions exhibit lower levels of diversification. This highlights the importance of irrigation infrastructure in reducing production risk and enhancing agricultural productivity.

Education is another key factor affecting the adoption of diversified farming practices. Farmers with higher educational attainment display greater awareness, better decision-making ability, and a higher tendency to adopt innovative agricultural techniques. Conversely, lower levels of education are associated with reduced adoption of modern practices and continued reliance on conventional methods.

The age composition of farmers also plays a significant role in shaping diversification behaviour. Younger farmers are generally more open to experimentation, more willing to take risks, and more receptive to new technologies and practices. In contrast, older farmers tend to follow traditional approaches and are less inclined towards diversification. This generational difference reflects variations in adaptability and exposure to new information.

Electricity and power supply are found to be important infrastructural factors influencing agricultural diversification. Reliable electricity facilitates irrigation, mechanization, storage, and processing activities, thereby encouraging the adoption of diversified and market-oriented farming systems. Farmers with inadequate or no access to electricity face constraints in adopting such practices.

Overall, the findings indicate that agricultural diversification in the study area is not uniform but varies according to the availability of resources and infrastructure. Farmers with better

access to land, income, education, irrigation, and electricity are more likely to adopt diversified agricultural practices, while resource-poor farmers remain dependent on traditional systems. This uneven pattern suggests the need for targeted interventions to promote inclusive and balanced agricultural development.

### **Overall Interpretation**

Overall, the results demonstrate that agricultural diversification in Aligarh district is not uniform but varies significantly across different socio-economic and infrastructural conditions. The adoption of agricultural innovation is strongly influenced by access to resources such as land, income, irrigation, education, and electricity.

The findings highlight that farmers with better resource availability are more likely to adopt diversified and market-oriented agricultural practices, whereas resource-poor farmers remain dependent on traditional subsistence farming. This uneven pattern underscores the need for targeted policy interventions to ensure inclusive and balanced agricultural development.

### **Conclusion**

The present study demonstrates that agricultural diversification in Aligarh district plays a significant role in improving rural livelihoods, enhancing farm income, and promoting sustainable agricultural development. The findings indicate that diversification is not limited to changes in cropping patterns but represents a broader transformation involving the adoption of innovative practices and the integration of allied agricultural activities such as dairy, livestock, horticulture, and poultry.

The analysis clearly shows that the level of agricultural diversification varies considerably across the study area and is strongly influenced by a combination of socio-economic and infrastructural factors. Variables such as landholding size, income level, irrigation facilities, education, age composition, and electricity supply significantly affect the adoption of diversified farming practices.

Among these factors, access to irrigation, educational attainment, and reliable electricity supply emerge as particularly important in facilitating agricultural innovation and diversification. Farmers with better access to these resources are more likely to adopt improved and market-oriented agricultural practices, whereas small and resource-constrained farmers tend to rely on traditional methods with limited diversification.

The study also highlights the role of younger farmers in promoting agricultural innovation, as they are more open to adopting new techniques and diversified activities. In contrast, older

farmers show relatively lower levels of adoption, reflecting differences in risk-taking behaviour and adaptability.

Overall, the study establishes that while agricultural diversification holds significant potential for rural development, its benefits are not evenly distributed. Addressing these disparities is essential to ensure inclusive and sustainable agricultural growth in the district.

### **Policy Implications**

Based on the findings of the study, the following policy measures are suggested to promote balanced and sustainable agricultural diversification:

Strengthening irrigation infrastructure to reduce dependence on monsoon rainfall and support multiple cropping systems

Enhancing access to affordable credit and financial support, especially for small and marginal farmers

Promoting farmer education and training programs to improve awareness and adoption of modern agricultural practices

Ensuring reliable and continuous electricity supply to support irrigation, mechanization, and post-harvest activities

Encouraging the development of allied agricultural sectors such as dairy, poultry, and horticulture to diversify income sources

Improving market access, storage facilities, and rural infrastructure to support the commercialization of agriculture.

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