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A comparative analysis of regional variations in profile characteristics of FPO member farmers in Telangana and Chhattisgarh

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Abstract

Farmer Producer Organizations (FPOs) have emerged as a key institutional mechanism for strengthening smallholder agriculture in India by enabling collective action, improving market access, and enhancing farmers' socio-economic outcomes. However, the effectiveness of FPOs is shaped by farmers' socio-economic, psychological, behavioural, and institutional characteristics, which often vary across regions. Understanding these variations is essential for designing context-specific interventions that enhance FPO performance and farmer empowerment. The present study aimed to analyse and compare selected socio-economic, psychological, behavioural, and institutional variables among FPO member farmers in Telangana and Chhattisgarh. Primary data were collected from 300 FPO farmers drawn from 10 purposively selected FPOs (five from each state). From each FPO, 30 member farmers were selected using a random sampling technique, resulting in a sample of 150 respondents per state. Data were gathered using a structured interview schedule and standardized measurement scales. Descriptive statistics were used to examine the distribution of farmer characteristics, while Z-test analysis was employed to test the significance of differences between the two states. The results revealed no significant differences between Telangana and Chhattisgarh with respect to age, management orientation, participation in FPO activities, satisfaction level, and cosmopoliteness. In contrast, significant differences were observed in education, farming experience, landholding, annual income, extension contact, innovativeness, risk orientation, economic orientation, information-seeking behaviour, mobile inclination, FPO membership, attitude towards FPOs, credit acquisition, training received, social participation, farmer empowerment, and perception. These findings indicate that although FPOs provide a common institutional platform, farmer attributes and institutional experiences differ considerably across regions. The study concludes that uniform policy and extension approaches may not adequately address region-specific needs of FPO farmers. Strengthening extension systems, promoting digital and mobile-based services, enhancing access to credit and training, and adopting state-specific capacity-building strategies are essential to improve farmer empowerment and institutional effectiveness. Tailored interventions aligned with regional contexts can enhance the functional performance of FPOs and contribute to inclusive and sustainable agricultural development.

Keywords: FPO, Z-test, comparative analysis, profile characteristics, member farmers

Introduction

Agricultural development in India increasingly hinges on the ability of institutions to address the complex and multidimensional constraints faced by farmers. Beyond physical resources, farmers' socio-economic conditions, psychological dispositions, behavioural patterns, and institutional linkages play a decisive role in shaping agricultural performance, technology adoption, and market participation. In recent years, policy and development discourse has shifted from viewing farmers merely as producers to recognizing them as decision-makers whose attitudes, orientations, and capacities significantly influence the success of collective and market-oriented interventions.

Farmer Producer Organizations (FPOs) represent one such institutional intervention designed to enhance farmers' collective strength and improve their engagement with input, output, and service markets (Adhikari *et al*., 2021) [1]. As member-owned and farmer-governed entities, FPOs function as platforms for collective procurement, aggregation, processing, and marketing, while also facilitating access to extension services, institutional credit, training, and technological support. Their effectiveness, however, is not determined solely by legal structure or external support but is strongly influenced by the characteristics and participation of their member farmers. Despite the rapid expansion of FPOs across India, regional variations in institutional support, socio-cultural context, and farmer profiles result in differential outcomes. Telangana and Chhattisgarh, though both agrarian states, differ markedly in terms of resource endowments, extension intensity, market exposure, and organizational maturity of farmer collectives. Understanding how farmers' socio-

economic, psychological, behavioural, and institutional characteristics vary across these two states is essential for identifying strengths, gaps, and context-specific interventions required to strengthen FPO functioning.

In this backdrop, the present study undertakes a comparative analysis of selected socio-economic, psychological, behavioural, and institutional variables among FPO farmers in Telangana and Chhattisgarh. By examining state-wise differences and similarities across these dimensions, the study seeks to generate empirical insights that can inform policy, extension strategies, and institutional design aimed at enhancing farmer participation, strengthening FPO sustainability, and promoting inclusive agricultural development.

Methodology

The research was conducted in Telangana and Chhattisgarh between 2022 and 2024 using exploratory research design. These states were purposively selected to represent contrasting agricultural and socio-economic contexts. Telangana exemplifies strong digital adoption, institutional support, and market connectivity, while Chhattisgarh represents a region where agricultural modernization is still evolving. Studying both states provided insights that are both region-specific and broadly applicable. An initial database of active FPOs was compiled using information from SFAC, NABARD, State Agriculture Departments, and NGOs. From this, ten FPOs, five from each state, were purposively selected based on specific criteria: at least four years of operation, a minimum membership of 350 farmers, active involvement in key business activities such as aggregation, input supply, marketing, value addition, or processing, use of at least one digital or Agri-Tech tool, and established linkages with startups, KVKs, NGOs, or government agencies. From each FPO, 30 member farmers were randomly chosen, resulting in a total sample of 300 respondents, with 150 from each state.

The study included 21 independent variables i.e., age, education, farming experience, landholding, annual income, extension contact, innovativeness, risk orientation, economic orientation, information-seeking behavior, mobile inclination, management orientation, FPO membership, attitude towards FPO, credit acquisition, cosmopoliteness, training received, social participation, participation in FPO activities, level of satisfaction, and farmer empowerment. The study considered one dependent variable i.e., farmers' perception of Agri-Tech startup-FPO integration in enhancing extension advisory services.

The data was collected using interview schedule. Statistical tools like mean, frequency, percentage where used. To understand the regional variations in the profile characteristics of farmers associated with Farmer Producer Organizations (FPOs), a comparative statistical analysis was conducted between two agriculturally diverse states i.e., Telangana and Chhattisgarh. The Z-test for independent samples was employed to determine whether any statistically significant differences existed between the means of the two groups across each variable. The mathematical formula for conducting a z test is

$$Z=\frac{\bar{x}_1-\bar{x}_2}{\sqrt{\frac{s_1^2}{n_1}+\frac{s_2^2}{n_2}}}$$

Where:

$\bar{x}_1$, $\bar{x}_2$ = means of the two groups

s_1, s_2 = standard deviations of two groups

n_1, n_2 = sample size of two groups

Results and Discussion

Profile characteristics of farmers (Independent variables)

The data presented in the table 1 outlines the profile characteristics of farmer members from Telangana and Chhattisgarh, highlighting both overall and state-wise patterns. Across both states, a majority of respondents (37%) belonged to the 46-57 years age group. Telangana showed a higher concentration in this category (39.33%), whereas in Chhattisgarh, the largest proportion (35.33%) was observed in the 35-45 years age group. Similar trends were reported by Akhil (2018) [4].

With respect to educational status, high school education (9th-10th class) predominated at the overall level (25.67%). However, state-wise variations were evident, as Telangana farmers were largely educated up to the primary level (24%), while Chhattisgarh had a higher proportion of high school-educated respondents (28.67%). These findings align with those of Mahesh Babu *et al*. (2021) [18] and Velanganni (2014) [29].

Regarding farming experience, 30.67% of respondents overall possessed more than 18 years of experience, a pattern more pronounced in Telangana (36.01%). In contrast, the majority of Chhattisgarh farmers (26.01%) fell within the 8-12 years' experience category, indicating relatively shorter farming exposure. Similar findings were reported by Mahesh Babu *et al*. (2021) [18] and Dechamma *et al*. (2020) [9].

In terms of annual income, a large majority of respondents (83%) earned between ₹50,000 and ₹1.50 lakh. State-wise, most farmers in Telangana (47.34%) and Chhattisgarh (45.33%) belonged to the ₹1.00-1.50 lakh income group. These results are in conformity with the findings of Jose *et al*. (2023) [12] and Leelavathi (2017) [17].

Landholding patterns revealed that marginal farmers constituted the largest group overall (41%), particularly in Chhattisgarh (50.67%). Telangana, however, showed relatively higher proportions of marginal (31.33%) and medium landholders (26.00%). The observed trends are broadly supported by Kumud *et al*. (2016) [15], Ninama (2015) [21], and Jadhav (2018) [11].

With regard to extension contact, most respondents overall (70.33%) exhibited a medium level, with higher interaction reported in Telangana (75.33%) compared to Chhattisgarh (65.33%). Similar observations were made by Parmar (2014) [22] and Ramappa Patil (2014) [24]. Likewise, a medium level of information-seeking behaviour was predominant overall (57.00%), with comparable proportions in Telangana (58.00%) and Chhattisgarh (56.00%),

corroborating the findings of Adsul (2016) [2], Kale (2020) [13], and Nigade (2022) [20].

Social participation among respondents was moderate, as a majority (53.00%) held membership in more than one organization. This pattern was consistent across Telangana (54.00%) and Chhattisgarh (52.00%), with around one-fifth of the respondents holding leadership positions, in line with Ninama (2015) [21].

A medium level of cosmopoliteness was observed among 62.67% of respondents overall, slightly higher in Telangana (64.67%) than Chhattisgarh (60.66%). These results are supported by Patil *et al*. (2018) [23] and Chopade *et al*. (2019) [8]. Innovativeness was also predominantly at a medium level (49.00%). Risk orientation, however, was largely high overall (53.00%), particularly in Telangana (78.00%), whereas Chhattisgarh farmers mainly exhibited a medium level of risk orientation (53.33%). These findings are consistent with those of Akkamahadevi (2016), Naik (2018) [19], Aitawade (2017) [3], and Mahesh Babu *et al*. (2021) [18].

Economic orientation was high among a majority of respondents (52.00%), with a stronger dominance observed in Telangana (62.67%), while farmers in Chhattisgarh were mostly categorized under the medium level (50.67%). Similar findings were reported by Raut (2018) [25] and Chavhan (2019) [7]. Management orientation remained predominantly at a medium level among 43.33% of respondents, with comparable proportions in Telangana (42.00%) and Chhattisgarh (44.67%), aligning with the findings of Asha (2015) [6].

In terms of mobile inclination, the majority of respondents (56.67%) exhibited a medium level, with Telangana (59.33%) and Chhattisgarh (54.00%) following similar patterns. A substantial proportion of respondents (77%) had received some form of training, with higher exposure reported in Telangana (83.33%) compared to Chhattisgarh (70.67%), supporting the findings of Singh *et al.* (2016) [27] and Kasu Divya (2017) [14].

Credit acquisition was reported by 74.33% of respondents, with relatively higher access in Chhattisgarh (78.67%) than Telangana (70%). These findings are in agreement with Lakra (2011) [16] and Singh *et al.* (2014) [28]. With respect to the duration of FPO membership, more than half of the respondents (57.33%) had been members for over four years, with a higher proportion in Telangana (60.00%) compared to Chhattisgarh (54.67%).

Participation in FPO activities was highest in training-oriented activities overall (69.50%), followed by market-oriented activities (67.33%), with Telangana consistently showing higher participation levels than Chhattisgarh. Attitudinal analysis revealed that most respondents (59.34%) exhibited a moderately favourable attitude towards FPOs, with Telangana (62.00%) slightly higher than Chhattisgarh (56.67%), corroborating the findings of Singh *et al*. (2023) [26] and Ghosh *et al*. (2025) [10].

A majority of respondents (60.67%) reported a medium level of satisfaction with their FPOs, with 58.67% in Telangana and 62.67% in Chhattisgarh. Similarly, overall empowerment levels were predominantly medium (50.00%), as reported by 49.33% of respondents in Telangana and 50.67% in Chhattisgarh, indicating moderate yet positive empowerment outcomes through FPO participation across both states.

With regards to the Perception of farmers about integration of Agri-Tech Startups with Farmer Producer Organisations, majority of respondents (62.00%) across both states exhibited a medium level of perception towards Agri-Tech startup and FPO integration, with Telangana (68.00%) slightly ahead of Chhattisgarh (56.00%).

Table 1: Distribution of respondents according to their profile characteristics

Category	Telangana (n=150)		Chhattisgarh (n=150)		Overall (n=300)	
	F	%	F	%	F	%
Independent variables						
Age						
24-34 years	51	34.00	45	30.00	96	32.00
35-45 years	40	26.67	53	35.33	93	31.00
46-57 years	59	39.33	52	34.67	111	37.00
Education						
Illiterate	0	0.00	21	14.00	21	7.00
Primary (Up to 5th class)	36	24.00	22	14.67	58	19.33
Middle (6th to 8th class)	25	16.67	33	22.00	58	19.33
High School (9th to 10th class)	34	22.67	43	28.67	77	25.67
Higher Secondary (11th to 12th class)	33	22.00	23	15.33	56	18.67
Graduate and above	22	14.66	8	5.33	30	10.00
Farming Experience						
3 to 7 years	26	17.33	38	25.33	64	21.33
8 to 12 years	35	23.33	39	26.01	74	24.67
13 to 17 years	35	23.33	35	23.33	70	23.33
Above 18 years	54	36.01	38	25.33	92	30.67
Annual income						
Up to Rs. 50,000	4	2.67	21	14.00	25	8.33
Rs. 50,001 to Rs. 1,00,000	59	39.33	51	34.00	110	40.67
Rs. 1,00,001 to Rs. 1,50,000	71	47.34	68	45.33	139	42.33
Rs. 1,50,001 to Rs. 2,00,000	12	8.00	7	4.67	19	6.33
More than Rs. 2,00,000	4	2.67	3	2.00	7	2.33
Land Holding						

Marginal (Up to 1.0 ha)	47	31.33	76	50.67	123	41.00
Small (1.0 to 2.0 ha)	32	21.33	51	34.00	83	27.67
Medium (2.0 to 3.0 ha)	39	26.00	20	13.33	59	19.66
Large (Above 4.0 ha)	32	21.33	3	2.00	35	11.67
Extension contact						
Low (8 to 11 score)	14	9.33	36	24.00	50	16.67
Medium (12 to 15 score)	113	75.33	98	65.33	211	70.33
High (Above 16 score)	23	15.33	16	10.67	39	13.00
Information seeking behaviour						
Low (38 to 45 score)	40	26.67	18	12.00	58	19.33
Medium (46 to 53 score)	87	58.00	84	56.00	171	57.00
High (Above 54 score)	23	15.33	48	32.00	71	23.67
Social Participation						
Membership in one organization	37	24.67	37	24.67	74	24.67
Membership in more than one organization	81	54.00	78	52.00	159	53.00
Holding position in an organization	32	21.33	35	23.33	67	22.33
Cosmopoliteness						
Low (11 to 15 score)	20	13.33	31	20.67	51	16.33
Medium (16 to 19 score)	97	64.67	91	60.66	188	62.67
High (Above 20 score)	33	22.00	28	18.67	61	20.33
Innovativeness						
Low (29 to 33 score)	22	14.67	29	19.33	51	17.00
Medium (34 to 38 score)	75	50.00	72	48.00	147	49.00
High (Above 39 score)	53	35.33	49	32.67	102	34.00
Risk orientation						
Low (18 to 23 score)	1	0.67	28	18.67	29	9.67
Medium (24 to 29 score)	32	21.33	80	53.33	112	37.33
High (Above 30 score)	117	78.00	42	28.00	159	53.00
Economic orientation						
Low (21 to 25 score)	4	2.67	12	8.00	16	5.33
Medium (26 to 30 score)	52	34.66	76	50.67	128	42.67
High (Above 31 score)	94	62.67	62	41.33	156	52.00
Management orientation						
Low (6 to 9 score)	48	32.00	48	32.00	96	32.00
Medium (10 to 11 score)	63	42.00	67	44.67	130	43.33
High (Above 12 score)	39	26.00	35	23.33	74	24.67
Mobile inclination						
Low (38 to 42 score)	4	2.67	60	40.00	64	21.33
Medium (43 to 47 score)	89	59.33	81	54.00	170	56.67
High (Above 48 score)	57	38.00	9	6.00	66	22.00
Training received						
Training received	125	83.33	106	70.67	231	77.00
Training not received	25	16.67	44	29.33	69	23.00
Credit Acquisition						
Acquired	105	70.00	118	78.67	223	74.33
Not acquired	45	30.00	32	21.33	77	25.67
FPO Membership:						
Member of FPO						
Yes	150	100.00	150	100.00	300	100.00
Years of Membership in FPO						
1 to 2 years	28	18.67	29	19.33	57	19.00
2 to 4 years	32	21.33	39	26.00	71	23.67
More than 4 years	90	60.00	82	54.67	172	57.33
Participation in FPO activities*						
Formations of FPO	211	70.33	178	59.33	389	64.83
Production orientation activities of FPO	196	65.33	183	61.00	379	63.17
Training orientation activities of FPO	217	72.33	200	66.67	417	69.50
Market orientation activities of FPO	211	70.33	193	64.33	404	67.33
Attitude towards FPO						
Less favourable (67 to 76 score)	32	21.33	17	11.33	49	16.33
Moderately favourable (77 to 85 score)	93	62.00	85	56.67	178	59.34
High favourable (Above 86 score)	25	16.67	48	32.00	73	24.33
Satisfaction towards FPOs						
Low (37 to 44 score)	35	23.33	32	21.33	67	22.33
Medium (45 to 51 score)	88	58.67	94	62.67	182	60.67
High (Above 52 score)	27	18.00	24	16.00	51	17.00

Farmers empowerment						
Low (26 to 35 score)	34	22.67	39	26.00	73	24.33
Medium (36 to 45 score)	74	49.33	76	50.67	150	50.00
High (Above 46 score)	42	28.00	35	23.33	77	25.67
Dependent variable						
Perception						
Low (66 to 78 score)	16	10.67	41	27.33	57	19.00
Medium (79 to 92 score)	102	68.00	84	56.00	186	62.00
High (Above 93 score)	32	21.33	25	16.67	57	19.00

Comparative Analysis of Socio-Economic, Psychological, Behavioural, and Institutional Variables among FPO Farmers in Telangana and Chhattisgarh using Z-Test.

To understand the regional variations in the profile characteristics of farmers associated with Farmer Producer Organizations (FPOs), a comparative statistical analysis was conducted between two agriculturally diverse states i.e., Telangana and Chhattisgarh. The Z-test for independent samples was employed to determine whether any statistically significant differences existed between the means of the two groups across each variable. The following section outlines the null and alternate hypotheses formulated for this analysis, followed by the interpretation of results for each variable as shown in the table 2.

Null Hypothesis (H_0): There exists no statistically significant difference in the selected profile characteristic of farmers between Telangana and Chhattisgarh.

Alternate Hypothesis (H_1): There exists a statistically significant difference in the selected profile characteristic of farmers between Telangana and Chhattisgarh.

1. **Age:** The mean age of FPO farmers in Telangana was 40.24 years (SD = 10.11), while in Chhattisgarh it was 40.35 years (SD = 9.37). The Z-statistic (-0.095, NS) indicates no statistically significant difference between the two groups. Since the p-value exceeds the 0.05 threshold, the null hypothesis is accepted. This suggests that the age distribution of farmers is similar across both states. As age often influences experience and openness to innovation, its uniformity implies that any differences in technology adoption or FPO participation are likely influenced by other variables rather than age.
2. **Education:** The average education level of FPO farmers in Telangana was 2.87 years (SD = 1.39), while in Chhattisgarh it was 2.33 years (SD = 1.41). The Z-statistic (3.340**) indicates a statistically significant difference between the two states. Since the p-value is less than 0.05, the null hypothesis is rejected. This suggests that Telangana farmers are relatively better educated. Higher educational levels may contribute to improved information-seeking behavior, awareness about Agri-Tech solutions, and a more proactive approach toward FPO engagement and adoption of extension advisory services.
3. **Experience:** The mean farming experience in Telangana was 14.47 years (SD = 6.10) compared to 12.64 years (SD = 6.31) in Chhattisgarh. The Z-statistic (2.559*) reveals a statistically significant difference. Farmers in Telangana had an average farming experience of 14.47 years, while those in Chhattisgarh had 12.64 years. With a Z-statistic of 2.559*, the difference is statistically significant. Hence, the null hypothesis is rejected. Telangana farmers appear to have more years of experience in agriculture, which may contribute to better practical knowledge and confidence in adopting new technologies or aligning with Agri-Tech startups and FPOs. This difference in experience may influence decision-making and the pace of digital transformation.
4. **Landholding:** Farmers in Telangana reported a mean landholding size of 2.37 ha (SD = 1.14), significantly higher than Chhattisgarh's 1.67 ha (SD = 0.78). The Z-statistic (6.264***) confirms this as a statistically significant difference. Farmers in Telangana possess relatively larger landholdings, which could offer them more flexibility in trying new technologies, investing in Agri-Tech solutions, and participating in collective FPO-based initiatives. This finding suggests that landholding size may be a critical factor influencing participation in modern agricultural practices.
5. **Annual Income:** The average annual income of Telangana farmers was Rs. 1,09,333.42 (SD = Rs. 38,357.64), while that of Chhattisgarh farmers was Rs. 98,333.28 (SD = Rs. 43,076.66). The Z-statistic (4.390***) indicates a significant difference. The difference is statistically significant, and the null hypothesis is rejected. Higher income levels in Telangana may support better access to inputs, digital tools, and engagement in value-added services offered by FPOs and Agri-Tech startups. Income may thus influence farmers' ability to participate in innovative agricultural ecosystems.
6. **Extension Contact:** The extension contact mean score averaged 13.66 (SD = 3.21) in Telangana and 36.74 (SD = 3.48) in Chhattisgarh. A significant difference is evident from the Z-statistic (5.461***). This suggests that farmers in Telangana have better access to or actively seek more extension services. Stronger extension contact likely facilitates improved awareness, timely information dissemination, and higher adoption of Agri-Tech solutions through FPOs. Hence, extension contact may play a pivotal role in bridging the gap between technology providers and farmers.
7. **Innovativeness:** The innovativeness score averaged 38.83 (SD = 3.21) in Telangana and 36.74 (SD = 3.48) in Chhattisgarh. A significant difference is evident from the Z-statistic (5.461***). This significant difference indicates that Telangana farmers exhibit a greater willingness to try new ideas, practices, and technologies. Higher innovativeness can positively impact the adoption of Agri-Tech solutions and active involvement in FPO-led initiatives. This trait supports early adoption behavior, essential for scaling digital innovations in agriculture.

Table 2: Comparative Analysis of Socio-Economic, Psychological, Behavioural, and Institutional Variables among FPO Farmers in Telangana and Chhattisgarh (Z-Test Results)

S. No	Variables	Telangana (n=150)		Chhattisgarh (n=150)		Z-statistic	Decision	Interpretation
		Mean	S. D	Mean	S. D			
1.	Age	40.24	10.11	40.35	9.37	-0.095 NS	Accept H_0	No significant difference
2.	Education	2.87	1.39	2.33	1.41	3.340 **	Reject H_0	Significant difference
3.	Experience	14.47	6.10	12.64	6.31	2.559 *	Reject H_0	Significant difference
4.	Landholding	2.37	1.14	1.67	0.78	6.264 ***	Reject H_0	Significant difference
5.	Annual Income	109333.42	38357.64	98333.28	43076.66	4.390 ***	Reject H_0	Significant difference
6.	Extension Contact	13.66	1.83	12.75	1.60	4.524 ***	Reject H_0	Significant difference
7.	Innovativeness	38.83	3.21	36.74	3.48	5.461 ***	Reject H_0	Significant difference
8.	Risk Orientation	31.46	2.61	30.31	3.33	3.341 **	Reject H_0	Significant difference
9.	Economic Orientation	31.26	2.66	29.93	3.03	4.027 ***	Reject H_0	Significant difference
10.	Information Seek Behaviour	49.33	4.17	51.10	4.71	-2.262 *	Reject H_0	Significant difference
11.	Mobile Inclination	48.34	3.26	46.83	2.44	4.658 ***	Reject H_0	Significant difference
12.	Management Orientation	10.26	1.68	10.27	1.60	-0.035 NS	Accept H_0	No significant difference
13.	FPO Membership	9.56	1.68	8.73	1.56	4.428 ***	Reject H_0	Significant difference
14.	Attitude of Farmers Towards FPO	80.88	5.15	85.75	5.09	-8.269 ***	Reject H_0	Significant difference
15.	Credit Acquisition	3.33	2.28	3.85	2.11	-2.026 *	Reject H_0	Significant difference
16.	Cosmopoliteness	17.85	2.29	17.54	2.29	1.126 NS	Accept H_0	No significant difference
17.	Training Received	0.83	0.37	0.71	0.46	2.500 *	Reject H_0	Significant difference
18.	Social Participation	1.97	0.68	1.99	0.70	6.481 ***	Reject H_0	Significant difference
19.	Participation In FPO Activities	4.23	1.91	4.07	1.85	0.832 NS	Accept H_0	No significant difference
20.	Satisfaction Level of Farmers	47.21	3.66	47.50	4.10	-0.638 NS	Accept H_0	No significant difference
21.	Farmers Empowerment	40.77	6.54	50.23	3.08	-16.020 ***	Reject H_0	Significant difference
22.	Perception	87.36	6.91	84.03	7.58	3.972***	Reject H_0	Significant difference

* Significant at the 0.05% probability level, **Significant at the 0.01% probability level, *** Significant at the 0.1% probability level, S.D = Standard Deviation

8. **Risk Orientation:** Telangana farmers had a mean risk orientation score of 31.46 (SD = 2.61), while Chhattisgarh farmers scored 30.31 (SD = 3.33). The Z-statistic (3.341**) shows a significant difference. Telangana farmers appear more open to taking calculated risks, which is critical in adopting new technologies or experimenting with startup-led solutions. Higher risk orientation may foster entrepreneurship and proactive participation in FPO activities that demand innovation and adaptability.
9. **Economic Orientation:** The economic orientation score was higher in Telangana (mean = 31.26, SD = 2.66) than in Chhattisgarh (mean = 29.93, SD = 3.03), with a Z-statistic (4.027***). Telangana farmers showed a greater inclination toward profitability and income enhancement through agriculture. This orientation likely influences their motivation to associate with FPOs and adopt Agri-Tech tools aimed at improving productivity and efficiency. Economic orientation acts as a strong behavioural determinant in innovation adoption and market-driven farming.
10. **Information Seeking Behaviour:** Farmers in Chhattisgarh had a higher information-seeking score (mean = 51.10, SD = 4.71) than those in Telangana (mean = 49.33, SD = 4.17). The Z-statistic (-2.262*) confirms a significant difference. Interestingly, Chhattisgarh farmers are more active in seeking information, possibly due to limited access, prompting them to explore diverse sources. This proactive behaviour can influence technology adoption positively if supported with accessible digital platforms and responsive extension services. Information-seeking is a vital component in farmer readiness for Agri-Tech-FPO collaboration.
11. **Mobile Inclination:** Telangana farmers scored higher in mobile inclination (mean = 48.34, SD = 3.26) than those in Chhattisgarh (mean = 46.83, SD = 2.44), with a significant Z-statistic (4.658***). This indicates a strong and statistically significant difference in mobile usage preference. A higher mobile inclination reflects greater digital readiness, enabling Telangana farmers to access Agri-Tech applications, advisory services, and FPO-related information more effectively. This readiness supports the integration of mobile-based platforms for precision agriculture, decision support, and market linkage systems.
12. **Management Orientation:** Management orientation scores were nearly identical in both Telangana (mean = 10.26, SD = 1.68) and Chhattisgarh (mean = 10.27, SD = 1.60), with a Z-statistic of -0.035 (NS), suggests that there is no significant difference between the two states. Hence, the null hypothesis is accepted. This implies that farmers across both regions display a similar level of planning, decision-making, and resource allocation abilities. While management orientation is essential for adopting structured approaches to farming, it does not appear to vary regionally in this study, suggesting uniformity in operational discipline.
13. **FPO Membership:** Telangana farmers had a higher FPO membership score (mean = 9.56, SD = 1.68) compared to Chhattisgarh (mean = 8.73, SD = 1.56), and the Z-statistic (4.428***) reveal a statistically significant difference. This suggests stronger involvement of Telangana farmers in Farmer Producer Organizations. Higher membership could translate to greater exposure to collective bargaining, shared services, and Agri-Tech interventions delivered through FPO platforms. FPO membership plays a crucial role in

enabling institutional access and building trust in startup-FPO partnerships for extension advisory services.

14. **Attitude of Farmers Towards FPO:** Chhattisgarh farmers exhibited a more favorable attitude toward FPOs (mean = 85.75, SD = 5.09) compared to Telangana (mean = 80.88, SD = 5.15). The Z-statistic (-8.269***) confirms a significant difference. The negative Z-score indicates that Chhattisgarh farmers hold more favorable perceptions of FPOs. This suggests a stronger belief in the effectiveness and benefits of FPOs, possibly due to successful local models or better communication of FPO services. Such positive attitudes can be leveraged to deepen Agri-Tech-FPO integration for inclusive and scalable extension systems.
15. **Credit Acquisition:** Credit acquisition scores were slightly higher in Chhattisgarh (mean = 3.85, SD = 2.11) than in Telangana (mean = 3.33, SD = 2.28). The Z-statistic (-2.026*) indicating a statistically significant difference. This suggests that farmers in Chhattisgarh are more active or successful in obtaining credit facilities. Access to credit is crucial for investing in Agri-Tech solutions and participating in FPO-driven initiatives. Improved financial inclusion may empower farmers to adopt risk-bearing innovations, enhancing the ecosystem for startup engagement.
16. **Cosmopoliteness:** Cosmopoliteness scores were similar across states, Telangana (mean = 17.85, SD = 2.29) and Chhattisgarh (mean = 17.54, SD = 2.29), with a Z-statistic of 1.126 (NS), showing no significant difference. As the p-value exceeds 0.05, the difference is not statistically significant. This suggests that farmers in both states have a similar degree of openness to external ideas, practices, and exposure to broader social networks. While Cosmopoliteness can influence technology adoption and external collaboration, in this case, it does not appear to be a differentiating factor in Agri-Tech and FPO integration.
17. **Training Received:** Training scores were higher in Telangana (mean = 0.83, SD = 0.37) than in Chhattisgarh (mean = 0.71, SD = 0.46). The Z-statistic (2.500*) shows a significant difference. This shows that Telangana farmers have received more training programs or capacity-building initiatives. Training enhances technical competence and readiness to adopt Agri-Tech innovations and engage with FPO activities. The result highlights the importance of structured training interventions in increasing farmer confidence and participation in digital and institutional platforms.
18. **Social Participation:** Social participation scores were nearly the same in both states: Telangana (mean = 1.97, SD = 0.68) and Chhattisgarh (mean = 1.99, SD = 0.70). Yet, the Z-statistic (6.481***) indicates a significant difference. This statistically significant difference suggests that farmers in Telangana are more involved in community organizations, groups, or collective activities. Strong social participation may facilitate peer learning, trust-building, and quicker dissemination of information related to Agri-Tech startups and FPO initiatives. It strengthens community-driven adoption of innovations and collective decision-making.
19. **Participation in FPO Activities:** The mean participation in FPO activities was 4.23 (SD = 1.91) in Telangana and 4.07 (SD = 1.85) in Chhattisgarh. The Z-statistic (0.832, NS) shows no significant difference. This implies that participation levels in FPO-led activities are similar across both states. Despite regional differences in other variables, the engagement of farmers in FPO functions appears relatively uniform, reflecting a common interest and involvement in institutional agricultural mechanisms.
20. **Satisfaction Level of Farmers:** The average satisfaction score was 47.21 (S.D =3.66) in Telangana and 47.50 (S.D = 4.10) in Chhattisgarh. The Z-statistic (-0.638NS) indicate no significant difference between the two groups. Hence, farmers across both states report similar levels of satisfaction with agricultural services, FPO performance, or advisory mechanisms. This suggests a baseline of contentment with available systems, but also implies that any intervention to enhance farmer satisfaction may need to focus more on value addition, efficiency, and innovation rather than state-specific structural reforms.
21. **Farmers Empowerment:** Empowerment scores were significantly higher in Chhattisgarh (50.23, SD = 3.08) than in Telangana (mean = 40.77, SD = 6.54), with a strong Z-statistic (mean =-16.020, $p < 0.001$). This highly significant result suggests that farmers in Chhattisgarh feel more empowered in terms of decision-making, access to resources, and influence over agricultural activities. Higher empowerment levels may enhance farmers' capacity to engage with Agri-Tech startups and actively participate in FPOs. Strengthening empowerment is critical for building resilient, participatory, and innovation-driven rural communities.
22. **Perception:** The mean perception score toward Agri-Tech Startup-FPO integration was significantly higher in Telangana (87.36) compared to Chhattisgarh (84.03). The Z-statistic of 3.972 and p-value < 0.001 confirm this as a statistically significant difference. Telangana farmers hold a more positive perception of the potential and relevance of such integration in improving agricultural advisory and support services. Favorable perception is a key precursor to adoption, and this result highlights the readiness of Telangana farmers to embrace digital innovations and institutional collaboration for better agricultural outcomes.

Conclusion

The study highlights that while Farmer Producer Organizations provide a common institutional platform, the socio-economic, psychological, behavioural, and institutional characteristics of member farmers vary significantly between Telangana and Chhattisgarh. The Z-test analysis across 22 variables revealed that out of 22, 17 variables showed a significant difference between farmers of Telangana and Chhattisgarh. These differences suggest that FPO performance and farmer outcomes are strongly influenced by regional contexts rather than uniform institutional structures. The study underscores the need for state-specific capacity-building strategies focusing on

strengthening extension contact, enhancing innovativeness, promoting risk-taking ability, and improving digital and mobile-based engagement, particularly in relatively lagging regions. Tailored training programmes, improved access to institutional credit, and targeted support for leadership and empowerment within FPOs are essential to enhance farmer participation and institutional effectiveness. Policymakers and implementing agencies should adopt differentiated intervention approaches to ensure that FPOs function as inclusive, resilient, and farmer-centric institutions across diverse agro-economic settings.

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Conflict of Interest
The authors of the paper declare no conflict of interest

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