

ROLE OF DIFFERENT INSTITUTIONS IN FOSTERING FERTILIZER BEST MANAGEMENT PRACTICES

Kemekar Pavankumar¹, Ch. Venu Gopala Reddy² and K. Madhu Babu³

1 Ph. D. Scholar, Dept. of Agril. Extension Education, College of Agriculture, Rajendranagar Hyderabad - 500030

2 Dean of Student Affairs, Dept. of Agril. Extension Education, College of Agriculture, Rajendranagar Hyderabad - 500030

3 Professor, EEI, Professor Jayashankar Telangana Agricultural University, Rajendranagar, Hyderabad - 500030

Email: kemekar.pavankumar22@gmail.com

ABSTRACT

The future of India is largely dependent on replenishing the plant nutrients. Various limitations existed in knowledge and attitude on Fertilizer Best Management Practices (FBMPs), fertilizer management and perception of stakeholders on indiscriminate use of fertilizers. Hence, there is a need to study the role performed by various public and private institutions in promoting FBMPs. It aimed to assess institutional performance, compare roles across systems, and test the hypothesis of no significant difference. Six districts of Telangana were randomly selected each representing one major field crop. From each district, ten extension officials (comprising of KVK scientists, DAATTC scientists, DoA officials and NGO officials) and ten input dealers were selected randomly. Thus, a total of sixty extension officials and sixty input dealers were selected from a total of five KVKs, six DAATTCs, six NGOs and sixty input agencies. Students t-test was used to test the hypothesis. The results revealed that public extension institutions significantly outperformed private counterparts in conducting research, on-farm trials, frontline demonstrations, capacity building and service delivery related to FBMPs. However, NGOs played a notable role in capacity building and institutional support, while input dealers dominated input supply. Statistical tests confirmed highly significant differences in most domains, highlighting the complementary but uneven engagement of public and private systems in promoting FBMPs.

Keywords : role performance, FBMPs, fertilizers, extension functionaries and activities

INTRODUCTION

Fertilizers are most important inputs for increasing production and productivity. The future of India is largely dependent on replenishing the plant nutrients in the impoverished soil by adopting the integrated, well-balanced, adequate and timely application of fertilizers. The past studies have revealed that the most of the extension officials had shown medium level of role performance in extension activities (Ingale, 2014) and involvement of stakeholders in formulating fertilizer recommendations (Rware *et al.*, 2014). Further, the indifferent fertilizer use is leading to soil, water, air pollution and damaging human and animal health (Yang and Fang, 2015). Some of the farmers still showing unfavourable attitudes towards speciality fertilizers, soil testing and its results (Singh *et al.*, 2020), (Solanki *et al.*, 2020). Knowledge of farmers on GAPs (Vinaya *et al.*, 2016; Akomdo *et al.*, 2023), speciality fertilizers (Rathod *et al.*, 2017), and synthetic fertilizers was also limited. Very few farmers are adopting all the recommended fertilizer practices (Dessie *et al.*, 2023). Hence, there is a need to study the role performed by various public and private institutions in promoting Fertilizer Best Management Practices (FBMPs).

The present investigation seeks to examine institutional activities on FBMPs with a focus on identifying areas of overlap, strengths, and gaps across different domains. It aims to assess in which domains institutions are performing well and where shortcomings exist, as well as to explore opportunities for collaboration between public and private institutions. Further, the study analyzes the underlying reasons behind both the effective and ineffective performance of institutions in various domains. Since, there was no single study conducted on the role performed by institutions in fostering FBMPs, the study will help in gaining insights and familiarity with the subject area and will help in conducting more rigorous investigations later such as 360° surveys by including both higher extension officials, sub ordinates and farmers etc for a complete approach. Hypothesis formulated was that, there is no significant difference between the role performed by public and private extension institutes in fostering Fertilizer Best Management Practices.

OBJECTIVE

- (1) To analyse the role of different institutions in fostering fertilizer best management practices

- (2) To compare the role performed by public and private extension institutions in fostering fertilizer best management practices.

METHODOLOGY

This study was carried out in Telangana state during 2023-2024. Exploratory research design was used. According to Akhtar (2016) exploratory research design can be defined as “research which is applied when there are few or no earlier research/studies to which references can be made for information”. The focus of this research is on gaining insights and familiarity with the subject area fair more rigorous investigation later. Telangana state was selected purposively, as it was in the top fertilizer consumption among the states and UTs of India during 2018-19, 2019-20 and 2020-21 (DES, Govt of India, 2022). The researcher also hailed from the same state. Based on maximum area under cultivation during 2017-18 to 2021-22, a total of six major field crops *i.e.* paddy, cotton, maize, red gram, soybean and Bengal gram were selected purposively. For each crop, one district was randomly selected. For public extension institutes, one KVK (ICAR/NGO/University), one DAATTC and one office of Department of Agriculture was selected from each district based on operationality and availability (where DAATTC were not available in selected districts, these were selected

from the original districts as they existed before bifurcation). For private extension institutes one NGO and ten input agencies were randomly selected from each district. From each district, ten extension officials comprising of KVK scientists, DAATTC scientists, DoA officials and NGO officials were selected randomly and ten input dealers were selected randomly. Thus, a total of sixty extension officials and sixty input dealers were selected from a total of five KVKs, six DAATTCs, six NGOs and sixty input agencies. The role of institutions was studied by administering an open-ended schedule to respondents from the respective institutions, allowing them to describe the activities conducted by their institutions that are related to the practices mentioned in the identified Fertilizer Best Management Practices. These activities were then analyzed, and unrelated ones were removed. For each activity/role score of one was given. The finalized activities conducted by each institution were grouped into different categories. Frequencies and percentages for each activity conducted by the mentioned institutions were calculated, and finally, mean scores for each overall category were determined. Institutions that did not have a mandated role in certain categories were excluded from analysis in those specific categories. Student’s ‘t’ test for independent samples was used to calculate the difference between role performed by public extension institution and private extension institute.

RESULTS AND DISCUSSION

Role of different institutions in fostering fertilizer best management practices and their comparison using students t-test

Table 1 : Distribution of different institutions according to their role of in fostering fertilizer best management practices (n=83)

Sr. No.	Role performed	Public extension			Private extension		Overall Public extension	Overall private extension
		KVK	DAATTC	DOA	NGO	Input Dealers		
I	Conducting extension studies / research for assessment of programmes that promotes FBMPs	f (%) (n ₁ =5)	f (%) (n ₂ =6)	f (%) (n ₃ =6)	f (%) (n ₄ =6)	f (%) (n ₅ =60)	f (%) (n ₆ =11)	f (%) (n ₇ =6)
1	Assessment of IFS models in creating sustainable livelihood to farmers of Telangana State	4 (80.00)	6 (54.55)	NA	0 (0.00)	NA	10 (90.91)	0 (0.00)
2	Assessment of ICT tools in dissemination of real time Agro advisory services and its adoption by farmers	4 (80.00)	6 (54.55)	NA	0 (0.00)	NA	10 (90.91)	0 (0.00)
3	A critical study on FPO’s Capacity building and technical support for effective implementation of FPO in Telangana- A network study	4 (80.00)	6 (54.55)	NA	0 (0.00)	NA	10 (90.91)	0 (0.00)
4	Agroecological transitioning methods	0 (0.00)	0 (0.00)	NA	1 (16.67)	NA	0 (0.00)	1 (16.67)

Sr. No.	Role performed	Public extension			Private extension		Overall Public extension	Overall private extension
		KVK	DAATTC	DOA	NGO	Input Dealers		
	Mean Score (Rank)	2.54 (II)	3.00 (I)	NA	0.16 (III)	NA	2.73 (I)	0.17 (II)
II	Conducting On Farm Trials to test the suitability of FBMPs in the locality	(n ₁ =5)	(n ₂ =6)	(n ₃ =6)	(n ₄ =6)	(n ₅ =60)	(n ₆ =11)	(n ₇ =6)
5	STCR based fertilizer application	2 (40.00)	1 (9.09)	NA	0 (0.00)	NA	3 (27.27)	0 (0.00)
6	INM	0 (0.00)	1 (9.09)	NA	0 (0.00)	NA	1 (9.09)	0 (0.00)
7	Foliar spray of micro nutrients & nano fertilizers	1 (20.00)	0 (0.00)	NA	0 (0.00)	NA	1 (9.09)	0 (0.00)
8	Fertigation	1 (20.00)	1 (9.09)	NA	0 (0.00)	NA	2 (18.18)	0 (0.00)
9	CRM	1 (20.00)	0 (0.00)	NA	0 (0.00)	NA	1 (9.09)	0 (0.00)
10	Green manure crops	0 (0.00)	1 (9.09)	NA	0 (0.00)	NA	1 (9.09)	0 (0.00)
11	Organic farming	2 (40.00)	0 (0.00)	NA	0 (0.00)	NA	2 (18.18)	0 (0.00)
12	Intercrop management	2 (40.00)	2 (18.18)	NA	0 (0.00)	NA	4 (36.36)	0 (0.00)
13	Salt tolerant varieties	2 (40.00)	0 (0.00)	NA	0 (0.00)	NA	2 (18.18)	0 (0.00)
14	Crop diversification	1 (20.00)	1 (9.09)	NA	0 (0.00)	NA	2 (18.18)	0 (0.00)
15	Integrated crop management	4 (80.00)	0 (0.00)	NA	0 (0.00)	NA	4 (36.36)	0 (0.00)
	Mean Score (Rank)	3.20 (I)	1.17 (II)	NA	0.00 (III)	NA	2.09 (I)	0.00 (II)
III	Conducting Front Line Demonstrations for promotion of FBMPs	(n ₁ =5)	(n ₂ =6)	(n ₃ =6)	(n ₄ =6)	(n ₅ =60)	(n ₆ =11)	(n ₇ =6)
16	Fertigation	2 (40.00)	0 (0.00)	NA	0 (0.00)	NA	2 (18.18)	0 (0.00)
17	Micro nutrient deficiency management	2 (40.00)	0 (0.00)	NA	0 (0.00)	NA	2 (18.18)	0 (0.00)
18	Foliar nutrition	0 (0.00)	1 (9.09)	NA	0 (0.00)	NA	1 (9.09)	0 (0.00)
19	Phosphorus/PSB management in high P soils	2 (40.00)	1 (9.09)	NA	0 (0.00)	NA	3 (27.27)	0 (0.00)
20	CRM	1 (20.00)	0 (0.00)	NA	0 (0.00)	NA	1 (9.09)	0 (0.00)
21	Organic crop management	1 (20.00)	0 (0.00)	NA	0 (0.00)	NA	1 (9.09)	0 (0.00)
22	Preparation of compost	1 (20.00)	0 (0.00)	NA	0 (0.00)	NA	1 (9.09)	0 (0.00)
23	Intercropping	2 (40.00)	1 (9.09)	NA	0 (0.00)	NA	3 (27.27)	0 (0.00)
24	Sequence cropping	1 (20.00)	0 (0.00)	NA	0 (0.00)	NA	1 (9.09)	0 (0.00)

Sr. No.	Role performed	Public extension			Private extension		Overall Public extension	Overall private extension
		KVK	DAATTC	DOA	NGO	Input Dealers		
25	Mulching	1 (20.00)	0 (0.00)	NA	0 (0.00)	NA	1 (9.09)	0 (0.00)
26	Crop diversification	0 (0.00)	1 (9.09)	NA	0 (0.00)	NA	1 (9.09)	0 (0.00)
27	Integrated crop management	2 (40.00)	2 (18.18)	NA	0 (0.00)	NA	4 (36.36)	0 (0.00)
Mean Score (Rank)		3.00 (I)	1.00 (II)	NA	0.00 (III)	NA	1.91 (I)	0.00 (II)
IV	Conducting Capacity building programmes that promoting FBMPs	(n ₁ =5)	(n ₂ =6)	(n ₃ =6)	(n ₄ =6)	(n ₅ =60)	(n ₆ =17)	(n ₇ =6)
28	Training and Promotion of FPO	4 (80.00)	3 (27.27)	0 (0.00)	2 (33.33)	NA	7 (63.64)	2 (33.33)
29	Developmental programmes and schemes	3 (60.00)	1 (9.09)	0 (0.00)	0 (0.00)	NA	4 (36.36)	0 (0.00)
30	Use of ICT tools for assessing agricultural Information/agro advisory	4 (80.00)	1 (9.09)	6 (100)	3 (50.00)	NA	11 (100)	3 (50.00)
31	Soil testing & STCR fertilizer application	4 (80.00)	1 (9.09)	6 (100)	3 (50.00)	NA	11 (100)	3 (50.00)
32	INM / reducing chemical fertilizer usage	2 (40.00)	3 (27.27)	6 (100)	0 (0.00)	NA	11 (100)	0 (0.00)
33	Fertigation	0 (0.00)	0 (0.00)	0 (0.00)	1 (16.67)	NA	0 (0.00)	1 (16.67)
34	Drip/Irrigation	1 (20.00)	0 (0.00)	0 (0.00)	1 (16.67)	NA	1 (9.09)	1 (16.67)
35	Foliar application of nutrients	0 (0.00)	0 (0.00)	0 (0.00)	1 (16.67)	NA	0 (0.00)	1 (16.67)
36	Standard Operating protocols for agrochemical application in field crops	0 (0.00)	4 (36.36)	0 (0.00)	1 (16.67)	NA	4 (36.36)	1 (16.67)
37	Micro nutrient management	0 (0.00)	0 (0.00)	0 (0.00)	3 (50.00)	NA	0 (0.00)	3 (50.00)
38	Bioagents usage / preparation / seed treatment	1 (20.00)	0 (0.00)	0 (0.00)	2 (33.33)	NA	1 (9.09)	2 (33.33)
39	PGRS	0 (0.00)	0 (0.00)	0 (0.00)	1 (16.67)	NA	0 (0.00)	1 (16.67)
40	Bio energizers	1 (20.00)	0 (0.00)	0 (0.00)	1 (16.67)	NA	1 (9.09)	1 (16.67)
41	CRM	2 (40.00)	1 (9.09)	6 (100)	2 (33.33)	NA	9 (81.82)	2 (33.33)
42	Green manure crops	1 (20.00)	0 (0.00)	0 (0.00)	1 (16.67)	NA	1 (9.09)	1 (16.67)
43	FYM/ vermi compost use/preparation	1 (20.00)	0 (0.00)	0 (0.00)	3 (50.00)	NA	1 (9.09)	3 (50.00)
44	Organic Farming and Natural farming	2 (40.00)	0 (0.00)	0 (0.00)	4 (66.67)	NA	2 (18.18)	4 (66.67)
45	IFS	0 (0.00)	1 (9.09)	0 (0.00)	1 (16.67)	NA	1 (9.09)	1 (16.67)
46	Intercropping	1 (20.00)	0 (0.00)	0 (0.00)	0 (0.00)	NA	1 (9.09)	0 (0.00)
47	Mixed farming	0 (0.00)	0 (0.00)	0 (0.00)	3 (50.00)	NA	0 (0.00)	3 (50.00)

Sr. No.	Role performed	Public extension			Private extension		Overall Public extension	Overall private extension
		KVK	DAATTC	DOA	NGO	Input Dealers		
48	Soil health Management/problematic soils and their management	2 (40.00)	1 (9.09)	0 (0.00)	2 (33.33)	NA	3 (27.27)	2 (33.33)
49	Soil conservation & erosion control	0 (0.00)	1 (9.09)	0 (0.00)	2 (33.33)	NA	1 (9.09)	2 (33.33)
50	Water conservation	0 (0.00)	0 (0.00)	0 (0.00)	3 (50.00)	NA	0 (0.00)	3 (50.00)
51	Agro ecological practices	0 (0.00)	0 (0.00)	0 (0.00)	4 (66.67)	NA	0 (0.00)	4 (66.67)
52	Cultivation across slopes/bunds	1 (20.00)	0 (0.00)	0 (0.00)	2 (33.33)	NA	1 (9.09)	2 (33.33)
53	Land Preparation	0 (0.00)	0 (0.00)	0 (0.00)	1 (16.67)	NA	0 (0.00)	1 (16.67)
54	Crop diversification	1 (20.00)	2 (18.18)	6 (100)	2 (33.33)	NA	9 (81.82)	2 (33.33)
55	GMPs / GAPs / GHPs	2 (40.00)	2 (18.18)	0 (0.00)	0 (0.00)	NA	4 (36.36)	0 (0.00)
56	Integrated crop management	1 (20.00)	3 (27.27)	0 (0.00)	0 (0.00)	NA	4 (36.36)	0 (0.00)
57	Crop production management	1 (20.00)	0 (0.00)	6 (100)	0 (0.00)	NA	7 (63.64)	0 (0.00)
Mean Score (Rank)		10.60 (I)	5.17 (IV)	6.00 (III)	8.17 (II)	NA	5.59 (II)	8.17 (I)
V	Extending support to proliferate practicing of FBMPs	(n ₁ =5)	(n ₂ =6)	(n ₃ =6)	(n ₄ =6)	(n ₅ =60)	(n ₆ =17)	(n ₇ =6)
58	Organic transition	0 (0.00)	0 (0.00)	0 (0.00)	3 (50.00)	NA	0 (0.00)	3 (50.00)
59	Agroecological transition community managed sustainable agriculture	0 (0.00)	0 (0.00)	0 (0.00)	2 (33.33)	NA	0 (0.00)	2 (33.33)
60	FPO promotion and mentoring	0 (0.00)	0 (0.00)	0 (0.00)	2 (33.33)	NA	0 (0.00)	2 (33.33)
61	Bio resource centre	0 (0.00)	0 (0.00)	0 (0.00)	1 (16.67)	NA	0 (0.00)	1 (16.67)
62	Farming service centre	0 (0.00)	0 (0.00)	0 (0.00)	1 (16.67)	NA	0 (0.00)	1 (16.67)
Mean Score (Rank)		0.00 (II)	0.00 (II)	0.00 (II)	1.50 (I)	NA	0.00 (II)	1.50 (I)
VI	Extending services that contributes to practicing FBMPs	(n ₁ =5)	(n ₂ =6)	(n ₃ =6)	(n ₄ =6)	(n ₅ =60)	(n ₆ =17)	(n ₇ =66)
63	Legal activities	0 (0.00)	0 (0.00)	6 (100)	0 (0.00)	0 (0.00)	6 (54.55)	0 (0.00)
64	Fertilizer monitoring and quality control	0 (0.00)	0 (0.00)	6 (100)	0 (0.00)	0 (0.00)	6 (54.55)	0 (0.00)
65	Assessment of fertilizer requirement and movements	0 (0.00)	0 (0.00)	6 (100)	0 (0.00)	0 (0.00)	6 (54.55)	0 (0.00)
66	Soil sample collection and analysis and STCR based recommendation	5 (100)	0 (0.00)	6 (100)	0 (0.00)	0 (0.00)	11 (100)	0 (0.00)
67	Soil testing lab	0 (0.00)	0 (0.00)	6 (100)	0 (0.00)	0 (0.00)	6 (54.55)	0 (0.00)
68	Field visits/diagnostic visits	4 (80.00)	5 (45.45)	6 (100)	0 (0.00)	0 (0.00)	15 (88.24)	0 (0.00)

Sr. No.	Role performed	Public extension			Private extension		Overall Public extension	Overall private extension
		KVK	DAATTC	DOA	NGO	Input Dealers		
69	Implementing govt schemes	0 (0.00)	0 (0.00)	6 (100)	0 (0.00)	0 (0.00)	6 (54.55)	0 (0.00)
Mean Score (Rank)		1.80 (II)	0.83 (III)	7.00 (I)	0.00 (IV)	0.00 (IV)	3.29 (I)	0.00 (II)
VII	Delivering Input supply related to all kinds of plant nutrients	(n ₁ =5)	(n ₂ =6)	(n ₃ =6)	(n ₄ =6)	(n ₅ =60)	(n ₆ =17)	(n ₇ =66)
70	Macro nutrients	0 (0.00)	0 (0.00)	6 (100)	0 (0.00)	60 (100)	6 (54.55)	60 (90.91)
71	Micro nutrients	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	60 (100)	0 (0.00)	60 (90.91)
72	speciality fertilizers	1 (20.00)	0 (0.00)	6 (100)	1 (16.67)	60 (100)	7 (63.64)	60 (90.91)
73	PGRs	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	42 (70.00)	0 (0.00)	42 (63.64)
74	(vermicompost/ NADEP/ FYM)	1 (20.00)	0 (0.00)	0 (0.00)	1 (16.67)	0 (0.00)	1 (9.09)	1 (1.51)
75	GM seeds	1 (20.00)	0 (0.00)	6 (100)	1 (16.67)	0 (0.00)	7 (63.64)	1 (1.51)
76	Bio energizers	1 (20.00)	0 (0.00)	0 (0.00)	1 (16.67)	0 (0.00)	1 (9.09)	1 (1.51)
Mean Score (Rank)		0.80 (III)	0.00 (V)	3.00 (II)	0.67 (IV)	3.70 (I)	1.29 (II)	3.36 (I)

Table 4.2. Comparison of role performed by various institutions in promoting fertilizer best management practices (n=83)

Roles	N	Mean	Std. Deviation	Std. Error Mean	t	df	Sig.
Extension studies / Research	11	2.7273	.90453	0.27273	6.508**	15	0.000
	06	0.1667	0.40825	0.16667			
OFT	11	2.0909	1.64040	0.494599	3.076**	15	0.000
	06	0.0000	0.00000	0.00000			
FLDS	11	1.9091	1.30035	0.39207	3.543**	15	0.003
	06	0.0000	0.00000	0.00000			
Capacity building	17	5.5882	2.45099	0.59445	-1.986 ^{NS}	21	0.060
	06	8.1667	3.48807	1.42400			
Support	11	0.0000	0.00000	0.00000	-2.592**	15	0.020
	06	1.5000	1.97484	0.80623			
Services	17	3.2941	2.86716	0.69539	2.772**	21	0.011
	06	0.0000	0.00000	0.00000			
Input supply	17	1.2941	1.61108	0.39075	-6.457**	81	0.000
	66	3.3636	1.15873	0.14263			

From the Table 1. and Table 2, it is evident that in case of conducting extension studies / research, public extension institutions like KVK and DAATTC outperformed their counterparts, achieving mean score of 2.54 and 3.00, respectively. Their robust performance is particularly evident in specific research activities, such as assessing Integrated Farming Systems (IFS) (90.91%), evaluating ICT tools for real-time agro-advisory services (90.91%), FPO’s Capacity building and technical support (90.91%). In contrast, the NGO segments registered negligible involvement, suggesting a possible gap in engagement or capacity in research-oriented tasks within these groups. Only one private extension institution (NGO) found conducting research on agroecological transitioning methods (16.67%). Further, the

t-test results from Table 2. revealed that the public extension institutions had highest mean score (=2.73) compared to the private extension system (=0.17). Further *t* value 6.508** ($p = 0.000$) has revealed that there is highly significant difference in role performed by public and private extension institutions in conducting extension studies / research role for assessment of programmes that promotes FBMPs.

In case of conducting on farm trails, public extension institutions such as KVKs (=3.20) demonstrated the highest involvement in conducting On-Farm Trials (OFT), followed by DAATTC (=1.17). These efforts by public extension institutes included trials on critical FBMP components like integrated crop management (36.36%), intercrop management (36.36%), STCR based fertilizer application (27.27%), organic farming (18.18%), salt tolerant varieties (18.18%), crop diversification (18.18%), fertigation (18.18%), INM (9.09%), foliar spray of micro nutrients & nano fertilizers (9.09%), CRM (9.09%) and green manure crops (9.09%), highlighting their commitment to adaptive research and localized validation of technologies. In contrast, private extension systems, exhibited no engagement in OFTs, indicating a potential gap in their capacity or prioritization for field-based research validation. Statistical analysis from Table 2. reinforced this disparity, with public extension institutions recording a significantly higher mean score (= 2.09) compared to private ones (= 0.00). The calculated *t*-value of 3.076** ($p = 0.000$) confirms that the difference in the performance of public and private extension systems in conducting OFTs is highly significant. This underlines the pivotal role of public institutions in spearheading field-level research initiatives for FBMP promotion.

In case of conducting Front Line Demonstrations (FLDs), public extension institutions such as KVKs (= 3.00) demonstrated the highest involvement in conducting FLDs, followed by DAATTC (= 1.00). These demonstrations focused on crucial FBMP components including integrated crop management (36.36%), intercropping (27.27%), phosphorus/PSB management in high P soils (27.27%), fertigation (18.18%), micronutrient deficiency management (18.18%), foliar nutrition (9.09%), organic crop management (9.09%), CRM (9.09%), preparation of compost (9.09%), sequence cropping (9.09%), mulching (9.09%) and crop diversification (9.09%), showcasing their pivotal role in technology dissemination and hands-on learning. In contrast, private extension systems exhibited no involvement in FLDs, indicating a lack of participation in direct field-level promotion of FBMPs. Statistical analysis from Table 2. confirmed this disparity, with public extension institutions recording a significantly higher mean score (= 1.91) as against private institutions which showed no engagement

(= 0.00). The calculated *t*-value of 3.543** ($p = 0.003$) indicates that the difference in role performance between public and private extension systems in conducting FLDs is highly significant. This clearly underlines the dominant role of public institutions in delivering on-ground demonstrations to promote FBMPs effectively.

In case of conducting capacity building programmes, public extension institutions such as KVKs (= 10.60) demonstrated the highest involvement in conducting capacity building programmes, followed by Department of Agriculture (= 6.00) and DAATTC (= 5.17). In contrast, private extension systems, particularly NGOs and input dealers, also showed considerable involvement. NGOs recorded a higher mean score (= 8.17) than several public agencies. Public extension institutions focused on a wide range of FBMP-related areas including use of ICT tools for Use of ICT tools for agro-advisories (100%), soil testing & STCR fertilizer application (100%), INM/reducing chemical fertilizer usage (100%), crop residue management (81.82%), crop diversification (81.82%), training and promotion of FPOs (63.64%), crop production management (63.64%), developmental programmes and schemes (36.36%), SOPs for agrochemical application (36.36%), GMPs/GAPs/GHPs (36.36%), integrated crop management (36.36%), soil health/problematic soil management (27.27%), bioagents usage/preparation/seed treatment (9.09%), drip irrigation (9.09%), bio-energizers (9.09%), green manure crops (9.09%), FYM/vermi compost use/preparation (9.09%), IFS (9.09%), intercropping (9.09%), cultivation across slopes/bunds (9.09%) and soil conservation and erosion control (9.09%) highlighting their multi-dimensional approach to sustainable agricultural practices. While practices with 0.00% coverage by public extension include: fertigation, foliar application of nutrients, PGRs, organic/natural farming, mixed farming, water conservation, agroecological practices, and land preparation. Private extension systems focused on organic farming and natural farming (66.67%), agroecological practices (66.67%), mixed farming (50.00%), use of ICT tools for agro-advisory services (50.00%), soil testing & STCR fertilizer application (50.00%), FYM/vermi compost use/preparation (50.00%) micronutrient management (50.00%), crop diversification (33.33%), training and promotion of FPOs (33.33%), crop residue management (33.33%), soil health/problematic soil management (33.33%), soil conservation and erosion control (33.33%), bioagents usage/preparation/seed treatment (33.33%), IFS (16.67%), fertigation (16.67%), drip irrigation (16.67%), foliar application of nutrients (16.67%), SOPs for agrochemical application (16.67%), PGRs (16.67%), bio-energizers (16.67%), green manure crops (16.67%), cultivation across slopes/bunds (33.33%) and land preparation (16.67%). Statistical analysis from Table

2. however, revealed that there is no statistically significant difference between the roles performed by public and private extension institutions in capacity building programmes, with a t -value of -1.986^{NS} and $p = 0.060$. This suggests that while public institutions still lead in breadth and intensity of activities, private institutions, especially NGOs, are emerging as substantial contributors in promoting FBMPs through training and knowledge dissemination. These results are in accordance with the findings of Kavad (2024).

In case of extending support to proliferate the practice of FBMPs, public extension institutions such as KVKs, DAATTCs, and the Department of Agriculture demonstrated no involvement ($= 0.00$), indicating a complete lack of activity in this domain. In contrast, private extension systems, particularly NGOs, showed active participation, recording a mean score of $= 1.50$, making them the only contributors to this activity among the surveyed institutions. NGOs focused their support on a few but critical areas that aid in institutionalizing FBMPs at the community level. Their efforts were concentrated on organic transition (50.00%), agroecological transition and community-managed sustainable agriculture (33.33%), FPO promotion and mentoring (33.33%), bioresource centres (16.67%) and farming service centres (16.67%). These areas reflect a strategic emphasis on transitioning conventional farming systems toward more sustainable, community-driven models, and building institutional support for farmer collectives. Statistical analysis from Table 2. revealed a significant difference in the roles performed by public and private extension institutions in providing such support, with private extension ($= 1.50$) far outperforming the public system ($= 0.00$). The calculated t -value of -2.592^{**} with $p = 0.020$ confirms this difference is statistically significant. This suggests that while public institutions have not engaged in providing institutional or infrastructural support for FBMP proliferation, NGOs are emerging as key enablers, filling this critical gap through targeted interventions in organic transition, agroecological systems, and grassroots capacity building via FPOs and service centres. These findings highlight the growing importance of private sector involvement particularly civil society organizations in the long-term sustainability and scalability of FBMPs. These results are in accordance with the findings of Bariya (2021).

In case of extending services that contribute to the practice of FBMPs, public extension institutions such as the Department of Agriculture ($= 7.00$) exhibited the highest level of involvement, followed by KVKs ($= 1.80$) and DAATTCs ($= 0.83$). The Department of Agriculture clearly emerged as the lead agency in this area, performing all listed service-based functions. In contrast, private extension

systems showed no involvement ($= 0.00$) in delivering such services, indicating a complete absence of participation in field-based and regulatory service support. Public extension institutions, particularly the Department of Agriculture, extended services in several critical areas of FBMPs such as soil sample collection and analysis and STCR-based recommendation (100%), legal activities (100%), fertilizer monitoring and quality control (100%), assessment of fertilizer requirement and movement (100%), soil testing lab (100%), implementing government schemes (100%) and Field visits/diagnostic visits (100% by DOA, 80.00% by KVKs, 45.45% by DAATTCs). These figures reflect the comprehensive nature of service delivery provided by public extension systems, especially regulatory and advisory tasks that are essential to ensure scientific input usage and timely problem-solving in farming systems. Private extension systems, however, recorded no coverage across all listed services including fertilizer monitoring, legal compliance, soil health services, field visits, and scheme implementation indicating a major gap in their capacity or mandate to provide operational and infrastructural support for FBMPs. Statistical analysis from Table 2. further confirmed this disparity, with public extension systems recording a significantly higher mean score ($= 3.29$) than private institutions ($= 0.00$). The t -value of 2.772^{**} with $p = 0.011$ indicates that this difference is statistically significant. These results underline the crucial role of public institutions, especially the Department of Agriculture in extending essential services for FBMP implementation on the ground. It also points to a potential area for capacity enhancement within the private sector, they should seek to become more engaged in service delivery aspects of sustainable agricultural development. These results are in accordance with the findings of Bariya (2021) and Kavad (2024).

In case of delivering input supply related to plant nutrients, input dealers from the private extension system ($= 3.70$) demonstrated the highest level of involvement, followed by the Department of Agriculture ($= 3.00$), KVKs ($= 0.80$) and NGOs ($= 0.67$). Overall, private extension systems ($= 3.36$) performed significantly better than public extension systems ($= 1.29$), primarily due to the assigned role of input dealers. Public extension institutions delivered inputs related to speciality fertilizers (63.64%), macro nutrients (54.55%), green manuring seeds (63.64%), vermicompost/NADEP/ FYM (9.09%) and bio energizers (9.09%). Private extension systems showed extensive involvement in nutrient-related input supply, such as macro nutrients (90.91%), micro nutrients (90.91%) and specialty fertilizers (90.91%), PGRs (63.64%), vermicompost/NADEP/FYM (1.50%), green manuring seeds (1.51%) and bio-energizers (1.51%). Statistical analysis from Table 2. revealed a highly significant

difference between the roles performed by public and private extension systems in delivering input supply. Private extension systems ($= 3.36$) outperformed public systems ($= 1.29$), with a t -value of -6.034^{**} , confirming the significant superiority of private actors, particularly input dealers in this domain. These findings clearly illustrate the dominant role of input dealers in input distribution related to FBMPs, while public institutions, though involved, appear more focused on select inputs. This also points to a strategic opportunity to enhance public-private synergy for more inclusive and widespread input accessibility. These results are in accordance with the findings of Bariya (2021).

Overall, these results across the categories are in accordance with the findings of Rware *et al.* (2014), Vasava and Patel (2020), Sangeeta Laxmi (2021) and Panda (2022); Kumari *et al.* (2025); Mehfuza *et al.* (2024).

CONCLUSION

From the above result, it can be concluded that, public extension institutions (KVKs, DAATTCs, Department of Agriculture) continue to play a dominant and indispensable role in research, on-farm trials, frontline demonstrations, capacity building and service delivery related to FBMPs. Their contributions are statistically significant in most areas, reflecting their structured mandate, institutional support and strong linkage with government schemes. In contrast, private extension systems (particularly NGOs and input dealers) demonstrated a mixed role. NGOs emerged as strong contributors in capacity building and institutional support for FBMP proliferation, especially in areas such as organic and agroecological transition, where public systems showed negligible engagement. Input dealers, on the other hand, clearly dominated in input supply services, outperforming public institutions and highlighting their commercial orientation and accessibility to farmers. This divergence suggests that while public institutions remain the backbone of FBMP promotion, the emerging role of NGOs and private dealers cannot be ignored. Strengthening public-private partnerships (PPP) could therefore bridge the observed gaps, leveraging the research and service strengths of public systems with the field penetration and specialized focus of NGOs and input dealers. Ultimately, the findings point toward a synergistic model, where effective integration of public and private actors can ensure the scalability, sustainability and farmer adoption of FBMPs in the long run.

RECOMMENDATIONS

(1) Strengthening coordinated public-private partnerships can enhance the complementary roles of research-driven public institutions and input-driven private

actors in promoting FBMPs.

- (2) Incentivizing private extension systems to participate in extension studies, OFTs, and FLDs may bridge the current gap in field-level research and technology validation.
- (3) Supporting and institutionalizing NGO-led initiatives can accelerate organic and agroecological transitions at community level.
- (4) Improving digital and operational capacities of public extension institutions can enhance efficiency in soil health services, regulatory functions, and field diagnostics.
- (5) Introducing mandatory certification and training for input dealers can ensure responsible nutrient input distribution aligned with FBMP principles.
- (6) Developing dedicated institutional support mechanisms within public extension systems may address the current vacuum in FPO mentoring, resource centres, and community-level FBMP proliferation.

ACKNOWLEDGEMENT

The author gratefully acknowledges the valuable support and guidance of K. Suhasini, Professor, Agricultural Economics, A. Meena, Assistant Professor, Department of Statistics and Mathematics, and A. Madhavi, Principal Scientist & Head, Institute of Soil Health Management, ARI, Professor Jayashankar Telangana Agricultural University, Hyderabad, India. Although their names could not be included as co-authors due to authorship limitations, their contributions to the research work are sincerely appreciated.

CONFLICT OF INTEREST

There is no conflict of Interest among researchers.

REFERENCES

- Akhtar, I.Md. (2016). Research in Social Science: Interdisciplinary Perspectives. Social research foundation, Kanpur. 68-84.
- Akomdo, C., Bakang, J-E.A., Tham-Agyekum, E.K., Akese, I., Oye, S., Yankyerah, O.K. and Prah, S. (2023). Adoption of good agronomic practices by tomato farmers in rural Ghana: an application of the unified theory of acceptance and use of technology. *Agric. Socio-Econ. J.*, 23(2): 185–197.
- Bariya, M., Chandravadia, K. and Patel, H. (2021). Role of self help groups on health empowerment of women. *Guj. J.*

- Dessie, A.B., Mekie, T.M., Abate, T.M., Belgu, A.S., Zeleke, M.A., Eshete, D.G., Atinkut, H.B. and Takele, M.T. (2023). Measuring integrated smallholder soil fertility management practices in Megech watershed, Tana sub-basin, Ethiopia. *Heliyon*. 9: 1-12.
- Ingale, D.B. (2014). Role perception and role performance of agriculture assistants in transfer of agricultural technology. *M. Sc. Thesis*. Mahatma Phule Krishi Vidyapeeth, Rahuri, India.
- Kavad, S.D. and Pandya, R.D. (2024). Perception of farmers about the role of APMC in market-led-extension. *Guj. J. Ext. Educ.* 38(2): 153-158.
- Kumari, S., Lal, S. P. and Sushmita, K. (2025) Extent of participation of rural women in agro-based enterprises. *Gujarat Journal of Extension Education*, 39(2): 31–37. <https://doi.org/10.56572/gjoe.2025.39.2.0006>
- Mehfuz, M. and Patel, J. K. (2024) Influence of factors determining environmental risk literacy level about the use of agrochemicals. *Gujarat Journal of Extension Education*, 38(1):50-53. <https://doi.org/10.56572/gjoe.2024.38.1.0009>.
- Panda, A. (2022). Role performance of village agricultural workers (VAWs) in Odisha: An analytical study. *Ph. D. Thesis*. G.B. Pant University of Agriculture and Technology, Pantnagar, India.
- Rathod, M.K., Kad, S.B. and Koshti, N.R. (2017). Adoption behaviour of farmers towards bio-fertilizers in paddy. *Int. J. Extn. Educ.*, 18: 83-89.
- Rware, H., Wairegi, L., Oduor, G., Macharia, M., Romney, D., Tarfa, B.D., Maria, R. de, Ley, G., Tetteh, F., Makumba, W., Dicko, M., Nouri, M., Leon, N.N., Gondwe, B., Kaizzi, K., Negash, D., Kibunja, C., Alawy, A., Wartmann, C. and Rutsimba, E. (2014). Assessing the potential to change stakeholders knowledge and practices on fertilizer recommendations in Africa. *Agric. Sci.*, 5: 1384–1391.
- Sangeeta Laxmi, Ch. (2021). Chilli farm value chain – an analytical study in Telangana and Andhra Pradesh. *M. Sc. Thesis*. Professor Jayashankar Telangana State Agricultural University, Hyderabad, India.
- Singh, A., Pandey, A.K. and Singh, U. (2020). Knowledge and attitude of farmers towards soil testing practices in Saharsa district of Bihar. *J. Pharmacogn. Phytochem.*, 9(4): 306–307.
- Solanki, R.L., Nagar, K.C. and Indoria, D. (2020). Knowledge and attitude of farmers regarding soil testing in Chittorgarh (Rajasthan). *Int. J. Agric. Educ. Extn.*, 6(2): 379-381.
- Vasava, D. and Patel, S. (2020). Role of Krishi Vigyan Kendra in agricultural development. *Int. J. Trend Sci. Res. Dev.*,4(6): 1438-1444.
- Vinaya Kumar H. M., Shivamurthy M. and Biradar G.S. (2016). A Scale to Measure climate-induced Crisis Management of Farmers in Coastal Karnataka (India). *Advances in Life Sciences*. 5(16): 6206-6212.
- Yang, X. and Fang, S. (2015). Practices, perceptions, and implications of fertilizer use in East-Central China. *Ambio*. 44(7): 647-652.