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Effect of Soybean Digital Farmer Field School on Knowledge Levels of Respondents in Maharashtra

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HIGHLIGHTS

- Digital Farmer Field School participants showed significantly higher knowledge of SOPs for soybean cultivation.
- Digital Farmer Field Schools reduce traditional barriers of age, gender, and land size by promoting experiential and group learning.
- The DFFS effectively reduces traditional socio-economic barriers to knowledge and provides expert guidance that enhances sustainable soybean farming practices.

ARTICLE INFO

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ABSTRACT

The study was conducted in 2023-2024 to assess the knowledge level of participant and non-participant farmers regarding Standard Operating Procedures (SOPs) for soybean cultivation in Ahilyanagar district, Maharashtra. An ex-post-facto research design was used, covering 150 soybean growers (75 participants and 75 non-participants) selected from fifteen villages across three talukas through multistage sampling and were assessed on their knowledge level of Standard Operating Procedures (SOPs)for soybean cultivation. Results showed that 76% of participants had high knowledge *versus* 6.67% of non-participants. Significant differences across nine key soybean cultivation aspects were confirmed by Z-tests. Higher knowledge among participants may be attributed to live expert-led sessions and collaborative group learning, fostering practical skills and experience sharing. Regression analysis identified education, scientific orientation, and techno-savviness as key predictors, while traditional socio-economic factors were less influential in participants' knowledge score on SOPs for soybean cultivation. The study highlights DFFS's potential to overcome traditional barriers, empowering farmers through enhancement in their knowledge about SOPs for soybean cultivation, ultimately promoting sustainable soybean cultivation and improved productivity.

INTRODUCTION

Soybean (*Glycine max* L.), widely recognized as the "golden bean," is one of the world's most important oilseed and pulse crops due to its considerable nutritional and economic value (Kadam et al., 2025). In India, and particularly Maharashtra, soybean occupies a central role in the agricultural economy. The crop is cultivated on nearly 3.8 million hectares in the state, providing both a vital source of dietary protein and a significant contributor to farm incomes. Despite extensive cultivation, statewide productivity remains below potential levels. Farmers face persistent challenges such as labour shortages, inadequate irrigation facilities, pest and disease infestations, limited availability of quality seeds, and restricted access to modern agronomic knowledge (Jaybhay et al., 2017). These production constraints highlight the urgent necessity for effective knowledge dissemination strategies to improve soybean cultivation and farmer livelihoods (Tiwari et al., 2023). Traditional agricultural extension systems in India have struggled to deliver

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timely and context-specific information, particularly to smallholder farmers. Within this gap, the Farmer Field School (FFS) model has emerged as a participatory, experiential approach to agricultural learning. Built on hands-on experimentation and group problem-solving, FFS enables farmers to engage directly with experts, enhance decision-making, and adopt improved practices. Empirical evidence indicates that FFS participation improves knowledge levels, accelerates the adoption of recommended practices, and results in increased yields and incomes (Amarathunga et al., 2023). Critically, FFS has also been shown to benefit marginalized groups–such as women farmers, low-literacy populations, and medium landholders–and to strengthen farmers' adaptive capacity to climate change (Jarial et al., 2024; Mdiya et al., 2024).

Nevertheless, the conventional FFS model presents noteworthy limitations. High costs per trained farmer, fiscal unsustainability at scale, and reliance on specialized expertise constrain widespread diffusion (Van et al., 2020). Moreover, its season-long, time-intensive structure poses barriers for farmers unable to attend weekly sessions (Singh et al., 2020; Maghinay & Guro, 2024). These limitations have prompted the search for alternative, technology-enabled approaches.

Digital Farmer Field Schools (DFFS) represent one such innovation. Integrating mobile applications, social media, and tablet-based learning, DFFS enhances accessibility and continuity of extension services (Witteveen et al., 2017). The rapid expansion of digital infrastructure during and after the COVID-19 pandemic has accelerated their adoption. Among the most prominent examples is the Digital *Sheti Shala* launched by the Paani Foundation in Maharashtra. Paani Foundation, founded in 2016 in Maharashtra, India, is a non-profit organization focused on sustainable water management and improving rural livelihoods. Its Satyamev Jayate Farmer Cup program encourages collective farming through *'gats'* (farmer groups) and promotes science-based agricultural and resource management practices. The program uses a competitive format with cash prizes to motivate farmers to adopt sustainable methods, improve productivity, and collaborate on bulk planning, purchasing, and sales, with participants evaluated on knowledge use, group activities, and sustainable techniques Focusing on soybean cultivation from 2021 onwards, the program combined expert-led digital sessions, participatory forums via WhatsApp, and standardized cultivation protocols. Strikingly, it attracted over 46,000 registrations, underscoring a strong farmer demand for digital extension solutions (Paani Foundation, 2022). Preliminary findings suggest substantial improvements in farmers' knowledge, productivity, and cost efficiency.

The initiative draws on Standard Operating Procedures (SOPs) for soybean cultivation curated by subject experts from State Agricultural Universities, thereby aligning scientific research with field-level practices. This bridging role not only democratizes access to technical guidance but also demonstrates the potential of digital formats to enhance sustainability in soybean farming.

METHODOLOGY

The study employed an ex-post-facto research design to investigate the knowledge levels of participant and non-participant farmers of Digital Farmer Field Schools on soybean cultivation. This design was selected because the variables under investigation had already manifested, and the researcher lacked direct control over the independent variables due to their prior occurrence and inherent non-manipulability. The research was conducted in Ahilyanagar district of Maharashtra State, covering three talukas: Ahilyanagar, Parner, and Sangamner. The study area was characterized by diverse soil types ranging from laterite to medium black soils, with an annual rainfall of 345 mm and an average temperature of 24.0°C. The cropping pattern included major Kharif crops such as bajra, groundnut, soybean, and moong, while Rabi crops comprised jowar, wheat, sugarcane, and chickpea. The selection of this district was purposive, as *Paani* Foundation had organised Digital Farmer Field Schools for farmers across 15 villages in these talukas. A multi-stage sampling procedure was implemented for respondent selection. Initially, *Ahilyanagar* district was purposively selected based on the presence of Digital Farmer Field Schools. Subsequently, three talukas were chosen from the district based on the higher number of participants of DFFS, followed by the selection of five villages from each taluka, totalling fifteen villages. From each village, 5 participants and 5 non-participants each are selected based on the DFFS participant farmers data provided by PAANI Foundation. This sampling strategy ensured balanced representation and facilitated comparative analysis between the two groups, resulting in a total sample size of 150 farmers comprising 75 participants and 75 non-participants.

To assess knowledge levels, a structured schedule was developed based on practices disseminated through the Digital Farmer Field School on soybean. The knowledge assessment was done using specifically designed knowledge test instrument. Further, to know the difference between knowledge level of participants and non-participants Digital Farmers Field School 'Z' test was applied. Relationship with socio-personal characteristics was established, and multiple regression was performed to analyse the factors affecting the knowledge level about Standard Operating Procedures (SOPs) for soybean cultivation of respondents.

RESULTS

Knowledge level of participant and non-participant farmers about SOPs for soybean cultivation

Analysis of respondents' knowledge levels on SOPs for soybean cultivation revealed pronounced differences between Digital Farmer Field School participants and non-participants, emphasizing the influence of the intervention (Table 1). Participant farmers demonstrated predominantly high knowledge levels (76.00%), with

Table 1. Distribution of respondents by knowledge level on SOPs for soybean cultivation

Knowledge level	Participant farmers (n=75) %	Non-Participant Farmers (n=75) %	Overall %
Low (below 32.02)	0.00	64.00	32.00
Medium (32.03 to 40.85)	24.00	29.33	26.67
High (above 40.86)	76.00	6.67	34.44
Total	100.00	100.00	100.00

Mean-36.44; S.D -4.42

Table 2. Aspects-wise comparison of the level of knowledge regarding important aspects of SOPs for soybean cultivation.

Aspects	Participant		Non-Participant		Z value
	Mean	S.D.	Mean	S.D.	
Pre-cultivation	3.74	0.46	3.16	0.93	4.90**
Seed	8.37	0.65	6.55	1.77	8.53**
Sowing	4.77	0.45	4.00	0.77	7.49**
Nutrient Management	2.78	0.44	2.36	0.65	4.69**
Water Management	4.99	0.60	3.88	1.09	4.27**
Weed Management	2.73	0.52	1.54	0.77	10.94**
Pest Management	8.12	0.78	5.29	2.39	9.73**
Disease Management	2.40	0.56	1.72	0.74	6.28**
Harvesting, Threshing and Storage	3.69	0.57	3.04	1.43	3.28**
Pooled	41.32	1.47	31.98	4.07	11.67**

**1% level of significance

the remainder exhibiting medium knowledge (24.00%) and none falling in the low category. Non-participant farmers showed an inverse pattern, with the majority clustered in low knowledge (64.00%), followed by medium (29.33%) and high (6.67%) categories. The overall sample distribution indicated 34.44% high knowledge, 26.67% medium knowledge, and 32.00% low knowledge levels.

Aspects-wise comparison of the level of knowledge

Statistical analysis using Z-test revealed significant differences between participant and non-participant farmers across all nine aspects of soybean SOPs as shown in Table 2. The calculated Z-values exceeded tabulated values at the 1% significance level for pre-cultivation, seed, sowing, nutrient management, water management, weed management, pest management, disease management, and harvesting practices. The overall Z-value (11.67) was significantly higher than the tabulated value, confirming substantial knowledge differences. Mean knowledge scores were higher for participants (41.32) compared to non-participants (31.98).

Association between profile characteristics and knowledge level of participant and non-participant farmers

Table 3 and Table 4 present correlation analysis, which showed distinct patterns for both groups. Among participant farmers, education, scientific orientation, and techno-savviness were positively significant at 1% probability level, while landholding, social media viewing behavior, and cosmopoliteness were significant at 5% level. Age, gender, area under soybean cultivation, farming experience, and annual income showed non-significant relationships. For non-participant farmers, scientific orientation was significant at 1% level, while ten variables (age, education, gender, landholding, area under soybean cultivation, farming experience, annual income, social media viewing behavior, techno-savviness, and cosmopoliteness) were significant at 5% level.

Relationship between profile characteristics and knowledge level of participant and non-participant farmers

Multiple regression analyses in Table 3 and Table 4 identify different predictors for each group. For participant farmers, scientific orientation (β=0.376), techno-savviness (β=0.345), and social media viewing behavior (β=0.292) emerged as significant positive predictors, with the model explaining 93.70% of knowledge variation (R^2=0.937). For non-participant farmers, scientific orientation (β=0.267) was significant at 1% level, while education (β=0.242), area under soybean cultivation (β=0.219), techno-savviness (β=0.224), and cosmopoliteness (β=0.168) were significant at 5% level, collectively explaining 37.40% of knowledge variation (R^2=0.374).

Table 3. Relationship between the independent variables of participants and their knowledge level

		Participant (N=75)		
		Correlation with Knowledge Level (r)	Regression Coefficient	t value
X_1	Age	-0.043	-0.052	-0.34
X_2	Education	0.608**	0.072	0.71
X_3	Gender	0.175	0.147	1.39
X_4	Land Holding	0.374*	-0.041	-0.41
X_5	Area Under Soybean Cultivation	0.113	0.087	0.86
X_6	Farming experience	0.099	0.026	0.37
X_7	Annual Income	0.156	0.107	1.12
X_8	Scientific Orientation	0.421**	0.376**	3.01
X_9	Social media viewing behaviour	0.366*	0.292**	2.49
X_{10}	Techno-savviness	0.474**	0.345**	2.87
X_{11}	Cosmopoliteness	0.313*	0.149	1.44
	R^2	0.9370		

**Significant at 0.01 level of probability; *Significant at 0.05 level of probability; Coefficient of determination (R^2) = 0.9370

Table 4. Relationship between the independent variables of non-participants and their knowledge level

		Non-Participant (N=75)		
		Correlation with Knowledge Level (r)	Regression Coefficient	t value
X_1	Age	0.142	0.121	0.57
X_2	Education	0.379*	0.242*	1.42
X_3	Gender	-0.243*	-0.127	-1.00
X_4	Land Holding	0.277*	0.134	0.64
X_5	Area Under Soybean Cultivation	0.250*	0.219*	1.24
X_6	Farming experience	0.209*	0.115	0.41
X_7	Annual Income	0.305*	0.138	0.76
X_8	Scientific Orientation	0.378**	0.267**	1.56
X_9	Social media viewing behaviour	0.264*	0.106	0.39
X_{10}	Techno-savviness	0.236*	0.224*	1.31
X_{11}	Cosmopoliteness	0.276*	0.168*	1.02
	R^2	0.3740		

**Significant at 0.01 level of probability; *Significant at 0.05 level of probability; Coefficient of determination (R^2) = 0.3740

DISCUSSION

The results clearly indicate that participant farmers of DFFS possess considerably higher knowledge of soybean SOPs compared to non-participants. This difference highlights the effectiveness of digital farmer field schools in knowledge enhancement. The structured training, active expert involvement, and collaborative group learning in DFFS sessions provide participants with practical insights and contextual solutions, which contribute to higher knowledge acquisition (Nitin & Indu, 2017; Rajan et al., 2021; Patel et al., 2022; Banerjee et al., 2022; Rakesh et al., 2022; Thangjam & Jha, 2025). The aspect-wise significant differences further reinforce the effectiveness of DFFS. Farmers exposed to DFFS demonstrate superiority across all domains of cultivation, particularly in areas requiring technical expertise such as pest and disease management. This suggests that digital trainingdo not merely provide basic knowledge but significantly enhance farmers' scientific understanding of complex issues (Samadder et al., 2023). The higher mean scores among participants demonstrate that digital learning environment and structured content create substantial knowledge gaps compared to traditional information access methods. The association of profile characteristics with knowledge levels also reveals important insights. Among participants, knowledge was significantly influenced by education, scientific orientation, and techno-savviness rather than traditional variables like landholding size, age, or income. This underlines the role of cognitive and technology-linked factors in successful digital farmer field school. The insignificance of demographic variables suggests that participation in DFFS reduces dependency on socio-economic status, thereby democratizing access to agricultural knowledge. The findings resonate with Samadder et al. (2023), who emphasized the transformational potential of digital platforms in overcoming structural barriers. In contrast, for non-participants, knowledge acquisition continues to be associated with a wider set of socio-economic characteristics, including education, area under soybean, and cosmopoliteness. This shows that, in the absence of structured digital interventions, access to agricultural knowledge is still governed by conventional factors such as land holding and educational background. Their lower R² value (37.40%) compared to participants (93.70%) also demonstrates weaker explanatory power of predictors, implying that traditional knowledge pathways remain fragmented and less efficient. The regression results further substantiate these patterns. For participants, the strongest predictors were scientific orientation, techno-savviness, and social media viewing behaviour, reflecting the synergy between digital learning and farmers openness to technology. The convergence of scientific orientation, techno-savviness, and social media viewing behavior among farmers demonstrates that digital training programs achieve maximum effectiveness when participants possess inherent technological readiness, thereby supporting the hypothesis that these traits create a synergistic effect in digital agricultural learning environments (Oli et al., 2025). On the other hand, non-participants rely more heavily on formal education and farm characteristics to acquire knowledge. This significant difference indicates that digital farmer field school platforms help farmers transcend structural inequalities of landholding or annual income by fostering curiosity, scientific outlook, and adaptability. Thus, the discussion highlights that DFFS act as a strong equalizing force in rural knowledge dissemination. While traditional access to knowledge remains confined to socio-economic hierarchies, digital interventions empower farmers based on learning-oriented traits, thereby promoting more inclusive, equitable, and effective knowledge distribution in soybean cultivation practices.

CONCLUSION

A clear difference in the knowledge level of participant and non-participant farmers in all nine aspects of soybean SOPs was observed. These findings show that Digital Farmer Field Schools (DFFS) have great potential to make farming knowledge accessible to all farmers. Unlike traditional methods, DFFS breaks down barriers like age, gender, land size, or income, which often limit who can get farming information. Instead, it focuses on helping farmers learning by doing, with experts guiding them and farmers learning together in groups. This way, farmers become confident in understanding and applying scientific farming techniques on their own. Ultimately, this helps improve their crop yields and makes farming more sustainable, especially for soybean cultivation.

DECLARATIONS

Ethics approval and informed consent: Informed consent was sought from the respondents regarding the study during the course of the data collection.

Conflict of interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

The authors declare that during the preparation of this work, they thoroughly reviewed, revised, and edited the content as needed. The authors take full responsibility for the final content of this publication.

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