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RESEARCH PAPER

Perception and constraints of farmers in adoption of crop intelligence systems in the state of Andhra Pradesh

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Abstract : The adoption of IoT based crop intelligence systems has been gaining momentum in modern agriculture, offering services to dry land farmers to enhance their farming practices and increase productivity. This study intend to analyze the farmers perception and constraints in adoption of IoT based crop intelligence systems in Anantapur district of Andhra Pradesh. Primary data was obtained from a random of 100 sample farmers and data obtained was analysed through mean score, rank order and Farrette's ranking techniques. The results from the study indicated that the crop intelligence systems played a crucial role in improving the planning of farm operations, crop protection particularly in irrigation alerts and disease control. The ease-of-use factor was also highly regarded. Among adopters, the lack of flexibility in operation and negative support from social networking were identified as significant barriers. For non-adopters, high initial investment cost and limited access to credit facilities were identified as the major hindrances to adopting crop intelligence systems.

Key Words : IoT, Crop intelligence systems, Dryland farmers, Perception, Constraints

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INTRODUCTION

Agriculture is a vital sector in India, providing livelihood to over 50 per cent of the population and contributing 18.80 per cent to Gross Value Added (GVA). Small-scale farming is the backbone of Indian agriculture, but it faces challenges like low productivity, limited access to credit, infrastructure and markets and decreasing land holdings. To address these challenges and improve productivity, various technological advancements and policy reforms have been introduced.Smart Agriculture (SA) has emerged as a key strategy, leveraging digital technologies like Internet of Things (IoT), drones, big data, cloud computing, and Artificial Intelligence (AI) to enable precision farming.

Smart technologies offer real-time data and analytics that empower farmers to make informed decisions regarding irrigation, fertilization, pest control and overall farm management. By optimizing resources and enhancing crop yields, digital agriculture contributes to economic, social and environmental benefits, aligning with the Sustainable Development Goals (SDGs). Adoption of IoT sensors at the field level offers advantages of providing real time information with regard to soil moisture

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levels, weather conditions and crop water requirements. IoT sensors deployed in the fields can detect the presence of pests and diseases at an early stage. One of the significant advantage of IoT in dryland farming is efficient water management.

Conversely there are several constraints in adoption of IoT based crop intelligence systems by farmers that include significant upfront costs (installation and maintenance), poor levels of internet connectivity, lower user acceptance, lack of trust, poor technical knowledge etc. Implementing IoT technologies demands a stable and robust internet connection to transmit data from sensors to the cloud for analysis and decision-making. Additionally, ongoing costs such as maintenance, data plans and upgrades must also be considered. Many dryland farming regions may have limited or unreliable internet connectivity, especially in remote areas. The lack of reliable connectivity can hinder the effectiveness of IoT solutions and pose a challenge for farmers in accessing real-time information. It is evidenced from some of the previous studies that the acceptance and adoption of farm-based technologies is determined by locations susceptible to weather extremities and many more. Anantapur district of Andhra Pradesh is one such area that is severely drought affected and more susceptible to effects of climate change. Adoption of digital technologies such as IoT based artificial intelligence systems in these areas has wider scope of impacting the agriculture towards attaining sustainability through facilitating farmers to take informed decisions at every stage of crop cycle. Hence, in this context, the study is taken up to understand the farmers perception and constraintsfor adoption and post adoption of various farm level crop intelligence systems in Anantapur district of Andhra Pradesh with the following objectives :

– To study the post adoption of farmers perception for crop intelligence systems.

– To study the constraints of adopted farmers for farm level crop intelligence systems

– To study the constraints of non- adopted farmers farm level crop intelligence systems.

Material and Methods

Anantapur district is purposively selected for the study as the district is second driest district in the country, highly susceptible to effects of climate change with more than 70 per cent of farmers dependent on agriculture (MANAGE, 2019). Agri tech startups offering farming services pertaining to IoT based farm level crop intelligence systems has been identified in Anantapur district. Initially, the study aimed to include a sample of 50 farmers. An additional 50 farmers from neighbouring areas, sharing similar characteristics in terms of irrigation sources, cropping patterns, and market conditions, were also included in the sample. In total, the study involves 100 farmers.

Statistical techniques :

Mean score :

It is the arithmetic average and the result obtained when the sum of values of the individuals in the data divided by the number of individuals in the data.

$$X=\frac{\Sigma x}{N}$$

Where,

X = Mean score

X = Sum of total score obtained by the individual

N = Total no. of respondents.

Rank order :

On the basis of the mean score, rank order was calculated. The item securing highest mean score was given first rank and the next higher second rank and so on.

Garrett's ranking technique :

Garrett's ranking technique was employed to prioritize or rank the level of information sources available on constraints in adoption and non – adoption of farm level crop intelligence systems by the dry land farmers in the region of Anantapur district of Andhra Pradesh.

Garrett's formula for conveying ranks into percent is given by,

$$\text{Per cent position} = 100\times\frac{(R_{ij}-0.5)}{N_j}$$

Where,

R_{ij} = Rank given for i^{th} factor by j^{th} individual

N_j = Number of factors ranked by individual.

Results and Discussion

The experimental findings obtained from the present study have been discussed in following heads :

Perception of farmers for crop intelligence systems:

The information particulars regarding perception of sample farmers post adoption of crop intelligence systems were collected through survey method employing a well-structured schedule that comprised of 32 statements with each statement having scale agreements of strongly disagree, disagree, neutral, agree and strongly agree. A corresponding score of one, two, three, four and five were given to these agreements respectively. Later these statements were grouped into nine factors for better understanding. The nine factors are farm operations factor, crop protection factor, risk factor, ease of use factor, technical factor, organizational support factor, impact factor, cost factor and expansion factor. The total score for each statement was calculated and the mean value for each statement was obtained by dividing the total score with number of sample farmers who adopted these systems. Later these statements under each factor were ranked to identify the farmers perception post adoption of these technologies in their fields. The results obtained are presented Table 1.

A pursual of Table 1 infers that, the sample farmers who adopted crop intelligence systems in their farms perceived these systems with regard to farm operations

Table 1: Perception of crop intelligence systems adopted by sample farmers

Perception factors	Statements	Mean	Rank
Farm operations factor	Useful for better planning of farm operations	4.62	1
	Useful for timely decision making on farm operations	4.58	2
	Helped me better manage overall operations	4.50	3
	Useful for making jobs easier while taking complex decisions on farm operations	4.38	4
	Useful for better resource allocation and optimization on farm operations	4.26	5
Crop protection factor	Enhanced irrigation efficiency in the farm.	4.90	1
	Enhanced better disease control.	4.56	2
	Enhanced better pest control	4.48	3
	Enhanced better nutrition management on farm.	3.54	4
	Enhanced better weed management on farm.	3.30	5
Risk factor	Reduce risks from dry spells	3.28	1
	Reduce risks from pests	3.14	2
	Useful to reduce climate risks	3.14	3
	Reduce risks from diseases	3.04	4
Ease of use factor	Easy understanding of data alerts	5.00	1
	Ease of use interface	4.86	2
	Easy to learn and use.	4.76	3
	More and more simple as I use it	4.28	4
	Easy and a plug and play technology	4.24	5
	Very low attention and easily maintainable in farm conditions.	3.50	6
Technical factor	Need prior training from service providers	4.22	1
	Needs technical knowledge of understanding of systems.	4.06	2
	Need not have prior technical know-how of using smart phones.	1.66	3
Organization support	Improvements in device	4.60	1
	Technical support from the service providers	4.20	2
	Financial support for continuing its adoption	3.70	3
Value factor	Value for money	3.19	1
	Improvement of yield	3.08	2
Cost factor	Annual maintenance cost high	4.18	1
	Initial cost high and require financial support	4.14	2
Expansion factors	Expand to existing farms	3.22	1
	Recommend to others	3.16	2

that, these systems were highly useful for better planning of farm operations (4.62), timely decision making on farm operations (4.58), better management of overall operations(4.50), making jobs easier while taking complex decisions on farm operations (4.38) and optimization and better resource allocation (4.26).With regard to protection of crops they perceived that these systems showed better efficiency for irrigation alerts (4.9) followed with enhanced disease control (4.56) and pest control (4.48) compared to nutrition management (3.54) and weed management (3.3).The adopted farmers perception with regard to risk that, these systems helped to a better extent in providing soil moisture alerts and thus reduced the extent of dry spells (3.28) compared to other risks associated with climate (3.14), pest (3.14) and disease (3.04). With regard to ease-of-use factor, they perceived that these systems were easy to understand (5.00), easy to use (4.86), easy to learn (4.76), simple (4.28) and plug and play technology (4.24) but these systems require very high attention and difficult to maintain in farm conditions (3.5).

The adopted farmers perceived these systems with regard to technical factor that these systems need prior training from service providers (4.22), needs technical knowledge of understanding these systems (4.06) but the technical know-how of smart phone usage required for adoption (1.66). With regard to organization support factor, they perceived that these systems need improvements in terms of accurate weather alerts (4.6) and technical support from service providers (4.2) but which required financial support for continuing its adoption (3.7).The crop intelligence systems adopted farmers perceived with regard to value factor that, not that much improvement was observed in yield (3.08) and value for money (3.19) with these systems. While regard to cost factor, they perceived that these systems require financial support as the initial investment (4.14) and the annual maintenance cost was high (4.18) So, the likelihood of adoption decreases. The adopted farmers perceived that these systems with regard to expansion factor showed that, they were not interested to expand to other existing farms (3.22) and recommending to

Table 2 : Constraints in adoption of crop intelligence systems by adopted farmers

Sr.No.	Constraints	Statements	Total score	Mean score	Rank
1.	Operational flexibility	Lack of flexibility in the operation process	2615	65.37	1
2.	Networking factors	Negative support from social networking factors	2543	63.57	2
3.	Results interpretation	Difficulty of understanding the results and acting accordingly	2270	56.75	3
4.	Compatibility Issues	Lack of compatibility with the existing smartphones	2237	55.92	4
5.	Technical support	Lack of technical support from service providers	2073	51.82	5
6.	Investment cost	Higher initial investment cost for acquisition of crop intelligence systems	1687	42.17	6
7.	Recurring cost	Higher recurring cost for the services provided	1576	39.40	7
8.	Internet connectivity	Limited access to internet connectivity	999	24.97	8

Table 3: Constraints in adoption of crop intelligence systems by non - adopted farmers

Sr. No.	Constraints	Statements	Total score	Mean score	Rank
1.	Investment cost	Higher initial investment cost for acquisition of crop intelligence systems	3647	72.94	1
2.	Credit availability	Lack of access to credit facilities	3218	64.36	2
3.	Feedback	Negative feedback from existing users	2860	57.2	3
4.	Benefits	Uncertain about the benefits of adoption	2852	57.04	4
5.	Operational difficulty	Difficulty of operating and maintaining the systems	2816	56.32	5
6.	Routine operations	Not interested to shift from routine farm operations	2638	52.76	6
7.	Skill	Lack of skill in operating crop intelligence systems	2254	45.08	7
8.	Knowledge	Lack of knowledge about crop intelligence systems	2219	44.38	8
9.	Smart Phone operation	Difficulty in operating smartphones	1489	29.78	9
10.	Internet connectivity	Limited access to internet connectivity	957	19.14	10

others (3.16).

Constraints of adopted farmers for farm level crop intelligence systems :

Garrett ranking was employed to identify the constraints in adoption and non-adoption of crop intelligence systems. The results obtained are presented in below Table 2 and 3.

Table 2 reveals the primary constraints faced by adopted farmers. The top constraint was inflexibility in operation, scoring an average of 65.37. Following closely was the negative impact of social networking, with an average score of 63.57. Subsequently, the third, fourth, and fifth major constraints included difficulty in comprehending and acting upon results (mean score: 56.75), incompatibility with existing smartphones (mean score: 55.90), and a lack of technical support from service providers (mean score: 51.82).Additionally, minor constraints were identified: initial investment costs ranked sixth (mean score: 42.10), recurring service costs ranked seventh (mean score: 39.40)and access to internet connectivity ranked eighth (mean score: 24.90).

In Table 3, the primary constraints among non-adopted farmers were identified. The most significant constraint was the high initial investment cost, with an average score of 72.94. Following closely was the lack of access to credit facilities, with a mean score of 64.36.Additional major constraints among non-adopted farmers included negative feedback from existing users (mean score: 57.20), uncertainty about the benefits of adopting crop intelligence systems (mean score: 57.04), difficulty in operating and maintaining these systems (mean score: 56.32), reluctance to shift from traditional farming methods (mean score: 52.76), and a lack of technical skills to operate these systems (mean score: 45.08).Furthermore, minor constraints for non-adopted farmers encompassed limited knowledge about crop intelligence systems (mean score: 44.38), challenges in operating smartphones (mean score: 29.78), and restricted access to internet connectivity (mean score: 19.14).The findings are inline with the research findings of Krishnan *et al.* (2019), Shelar *et al.* (2021) and Naik *et al.* (2022).

Conclusion :

The sample farmers who adopted crop intelligence systems in their farms perceived that these systems were highly useful for better planning of farm operations (4.62), timely decision making on farm operations (4.58). With regard to protection of crops they perceived that these systems showed better efficiency for irrigation alerts (4.90) followed with enhanced disease control (4.56), regards to ease-of-use factor, they perceived that these systems were easy to understand (5.00), easy to use (4.86), easy to learn (4.76). with respect to organization support factor, they perceived that these systems required improvements in terms of accurate weather alerts (4.60). The Garrett ranking results indicated that lack of flexibility in operation (65.37) and negative support from social networking (63.57) were the two major constraints in adoption of crop intelligence systems by the adopted farmers. While high initial investment cost (72.94) and lack of access to credit facilities (64.36) were the two major constraints in adoption of crop intelligence systems by the non-adopted farmers.

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