IOT-Based Farming Solutions for Small Farmers in Akola District: A Marketing Strategy for Improved Productivity and Market Access

DIVYA R. TALE

PG Student, Dept. of MBA, P. R. Pote Patil COE & M, Amravati, India

divyatale24@gmail.com

PROF. S. R. SHAH

Professor and H.O.D., Dept. of MBA. P. R. Pote Patil COE & M, Amravati, India

hodmba@prpotepatilengg.ac.in

Abstract

Farming is a really big deal for India's economy and way of life, especially in rural areas where lots of small farmers rely on it to earn money. In areas like Akola, these farmers face ongoing issues like crazy weather, expensive supplies, not using resources wisely, and not having the right info about the market when they need it. Because of these problems, traditional farming can be risky and not very profitable. That's where smart farming tech, powered by the Internet of Things (IoT), comes in handy. It supports farming through science by providing up-to-date info, better tracking, and smarter decision-making. This study looks at how small farmers in Akola are using IoT-based smart farming tech. It checks out how much they know about it, what difficulties they experience when trying to use it, what impact it has on their farm's output, and how marketing affects their choice to use the tech. For this research, the team gathered numbers from 34 small farmers using surveys and conversations. They analyzed the info using statistical tools to get a clearer understanding. The study shows that if used correctly, IoT farming tools can boost crop yields, improve water use, and save expenses. But many folks lack knowledge about it, struggle with computers, can't afford it, and the current promotions aren't great at spreading the word, which stops it from being widely adopted. The study gives useful suggestions for Agri-tech companies, government officials, and farm extension services to make programs that help farmers and encourage long-lasting smart farming methods. **Keywords:** Smart Farming, Small and Marginal Farmers, Internet of Things (IoT) in Agriculture, Farmer Awareness and Perception.

1. Introduction

This research digs into how Internet of Things (IoT) technology can boost farm productivity and help small farmers in Akola get their crops to market more easily. Farming drives much of India’s economy, but small and marginal farmers still run into tough problems—low yields, wild weather, rising costs, and trouble selling their produce, especially when they stick to traditional methods (Vasavi et al., 2025). Lately, all sorts of IoT gadgets have started showing up: soil moisture sensors, weather monitors, automated irrigation systems, smart pumps, and solar-powered devices. These tools make precision farming possible. With real-time data, farmers can take smarter actions and manage their resources better (Dhanaraju et al., 2022; Bhangar & Shahriyar, 2023). They’re also turning to apps for updates on soil health, crop status, local weather, land records, and government schemes. Apps like Plantix, E-Peek Pahani, Maha DBT, Mahabhumi, and E-Panchanama are getting more popular (Samal et al., 2023; Pagar et al., 2021). Still, most farmers in Akola haven’t really embraced these IoT tools yet. A few in places like Sasti and Digras BK have started, but there’s a long way to go. The main roadblocks? Not enough people know about IoT, many find these digital tools confusing, the price tags are high, and there aren’t enough training or demo facilities around (Anonymous, 2022; Vasavi et al., 2025). This study looks at how aware small farmers in Akola are about these new tools, what’s holding them back from using them, and what difference IoT actually makes on their farms. There’s also a focus on how things like farmer education, field demos, simple communication, and support from agricultural extension workers can help get more people on board (Bhangar & Shahriyar,

2023). The research zeros in on Sasti and Digras BK. On top of this, the study points out that IoT can help farmers adapt to changing weather by cutting down on wasted resources, tightening up crop management, and opening up better market access (Kingslin & Vaishnavi, 2025). Whether IoT really takes off comes down to farmers trusting the tech, being able to afford it, and seeing what it can actually do for them. The findings are clear: good marketing, regular on-the-ground support, and keeping farmers at the center of it all make a real difference. In the end, if farmers feel empowered, IoT can play a big role in making agriculture in Akola more sustainable.

2. Statement of the Problem

Farmers in Akola District deal with a lot—uncertain weather, rising costs, and unpredictable markets. Most small farmers rely on the monsoon to water their crops, but lately, the rains come late, or not at all, and temperatures keep climbing (Vasavi et al., 2025). That's just the start. They also fight soil erosion, wasteful water use, and the constant pressure to buy more seeds, fertilizer, and pesticides—all while market prices swing up and down. For small and marginal farmers, making a living off the land feels riskier and less secure every year (Dhanaraju et al., 2022).

Lately, people have been talking up Internet of Things (IoT) tech—things like soil moisture sensors, automated irrigation, weather stations right in the fields, or crop advice on your phone. The pitch is that these tools can give farmers real-time info, help them make smarter decisions, and get better results (Kingslin & Vaishnavi, 2025).

But here's the thing: not many small farmers in Akola use these tools. There's just not enough awareness, and digital skills are often low. The upfront cost of IoT devices looks steep, and there's barely any technical support or training around. Even the way these tools get marketed doesn't really connect with most farmers (Anonymous, 2022; Vasavi et al., 2025). Plus, some see IoT as too complicated or just not a fit for how they've always farmed.

So, it's important to dig into how small farmers in Akola actually see these new technologies, what's stopping them from trying IoT, and whether better training or farmer-first marketing could change their minds. If we don't tackle these barriers, it's hard to see how small farmers will get access to affordable, practical tools that could make their farms more productive and their income more stable for the long haul.

3. Review of Literature

Wireless technology in Agriculture is allowing Farmers to increase Productivity and allow them to adopt an Automated Farming & Data-Driven Agriculture method to overcome issues faced due to Climate Change and Water Scarcity.

Sayyad Liyakat (2024) described that IoT Smart Water Pumps enable Farmers to irrigate with Precision, thus increasing Crop Health while conserving Water; however, this requires a decent Internet Connection along with adequate Training for Farmers.

Yunus & Zainal (2023) described how Farmers can use IoT Security Systems to keep their Farms Secure through their Smartphones & reduce the Cost & Effort of Maintaining Security Systems.

Samal et al. (2023) explained that AI Applications, such as Plantix, assist Farmers in quickly identifying Crop Diseases, but the success of these Applications is dependent on their Precision, Smartphone Capability, and Training on their use in Local Communities. **Anonymous (2022)** indicated that Educated Farmers have the greatest access to Information & therefore, are most likely to adopt IoT Tools when they have been supported by Simple Training & Peer Learning.

Pagar et al. (2021) indicated that Mobile-Based Marketing Applications facilitate the Connection between Farmers and their Buyers and/or Product/Service Providers, which results in increased Income and reduced Intermediaries.

Salman & Lam (2020) created a cost-effective, solar-powered IoT Irrigation System for Farmers, enabling them to Automate their Irrigation Process with Efficiency.

4. Objectives of the Study

1. To assess the level of awareness and understanding of IoT-based farming technologies among small farmers in Akola district

2. To identify the challenges faced by farmers in implementing smart farming technologies effectively

3. To analyse the impact of IoT-based farming solutions on the productivity of small farmers in Akola district

5. Research Hypotheses

This research examines whether the use of Internet of Things (IoT) devices such as Smart Sensors and Automated Irrigation systems has had a positive impact on increasing both productivity and the efficiency of smallholder farmers located in Akola City, and uses Data Analysis techniques to evaluate this hypothesis.

H_1: IoT-based farming solutions have a significant positive impact on the agricultural productivity of small farmers in Akola district.

6. Research Methodology

6.1 Research Design

Research Methodology The purpose of this study will be to develop an extensive, quantifiable framework that details how smallholder farmers within the Akola district are presently using IoT-based agricultural technology and methods. This includes evaluating smallholder farmers' understanding of IoT-based technologies; determining their current levels of adoption and frequency of use; identifying what types of IoT-based tools (e.g., sensor-based irrigation and remote monitoring), if any, are currently being utilized; analyzing the challenges faced by smallholder farmers related to the adoption and usage of IoT tools (including but not limited to barriers to government assistance, availability of digital communications, and the lack of knowledge concerning this technology); and how the availability of government assistance, access to reliable digital communications, and/or inadequate levels of information and knowledge have assisted (or impeded) smallholder farmers from successfully adopting IoT technology. This quantitative research will utilize a structured questionnaire for collection of data that can be subsequently analyzed on a statistical basis to better demonstrate patterns related to IoT use and agricultural productivity.

6.2 Sources of Data

To ensure objective and credible results, the study relied on both primary and secondary sources of data. Primary data were collected through surveys, interviews, and direct observations of smallholder farmers and agricultural extention officials, as well as through indirect communication with this population via focus group discussions about their knowledge, experience, and perceptions of the impact that IOT has had on their businesses and operations. Meanwhile, the use of secondary data confirmed and supported the findings of this research.

6.3 Sample Design

- **Sample Universe:** All smallholder farmers in Akola District actively engaged in agriculture.
- **Sample Population:** Small irrigated farmers from Sasti and Digras Bk villages aware of or using IoT technologies/agricultural apps for farm management.
- **Sample Unit:** Individual small irrigated farmers from these villages who adopt IoT-enabled tools like smart water pumps and crop monitoring apps.
- **Sampling Frame:** Official lists of small irrigated farmers from agricultural officers, local cooperatives, and village panchayat records.
- **Sample Size:** Data collected from 34 respondents across both Sasti and Digras Bk villages combined, representing diverse landholdings, genders, and age groups.
- **Sampling Technique:** Stratified random sampling by farm size, crop types, and IoT access to capture village diversity.

6.4 Tools for Collecting Data

The research consists of primary data collected through standard questionnaires sent out to smallholder farmers in Sasti and Digras Bk to find out what they use IoT tools for, how useful they are, and what problems the farmers experience with IoT tools. Interviews with agricultural officials were also carried out along with field observation to gain the insight of professionals and confirm what actually happens in farming.

6.5 Statistical Analysis Technique

Once the data is collected, the appropriate statistical methods will be determined to analyze the data and achieve the purpose of the research. The descriptive statistics, including means, percentages, and frequency counts, will assist to represent the trends of farmers' awareness of the use of IoT tools, as well as the benefits and challenges. The Chi-square test will also be utilized to analyze the relationships among the variables gender,

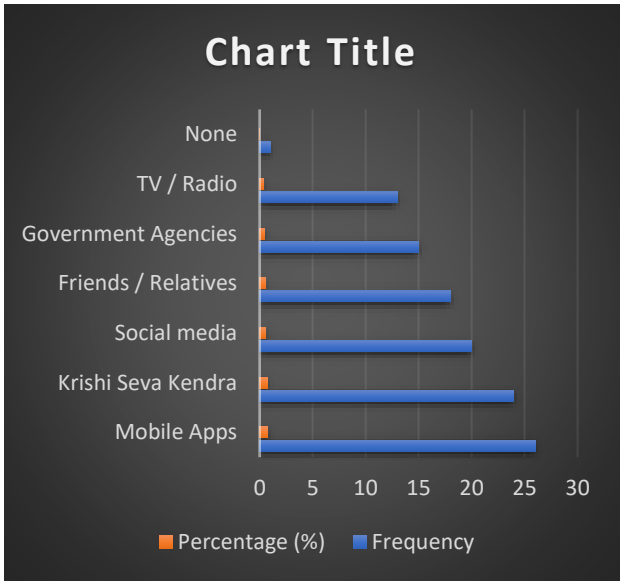
level of education, size of landholding, and the adoption of IoT-based farming practices.

7. Data Analysis and Interpretation

1. Which source informed you about IoT tools?

Source of Information	Frequency	Percentage (%)
Mobile Apps	26	76.5%
Krishi Seva Kendra	24	70.6%
Social media	20	58.8%
Friends / Relatives	18	52.9%
Government Agencies	15	44.1%
TV / Radio	13	38.2%
None	1	2.9%

(Source: Primary Data)



Interpretation

The chart shows that mobile apps are the most important source of information about IoT-based farming tools among small farmers, followed by Krishi Seva Kendra and social media. Friends/relatives also play a supportive role in spreading awareness. In comparison, government agencies and TV/Radio have a relatively lower influence. Very few farmers reported having no source of information, indicating that most respondents have some level of awareness about IoT tools.

2. How often do you use smartphone for farming purpose?

Usage Frequency	No. of Respondents	Percentage (%)
Daily	18	52.9%
Weekly	7	20.6%
Monthly	0	0.0%
Rarely	9	26.5%
Never	0	0.0%
Total	34	100%

(Source: Primary Data)

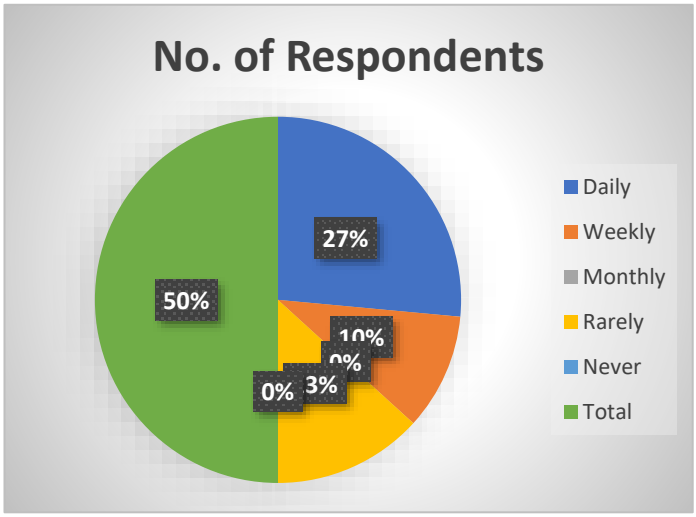
Interpretation

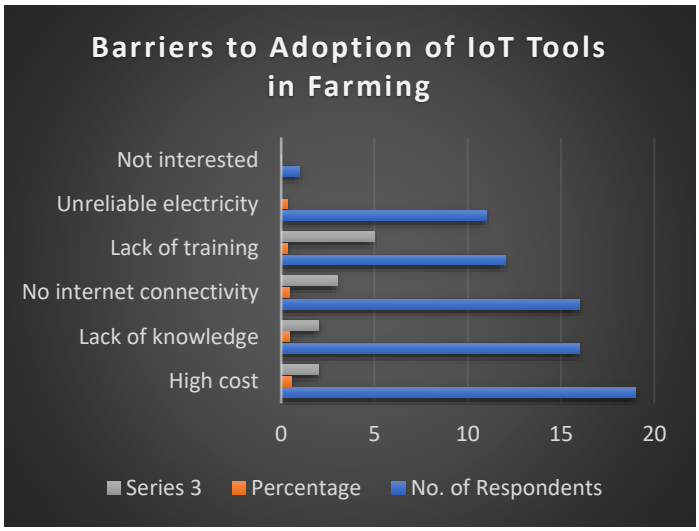
Most farmers are on their smartphones all the time for farming stuff. About 27% check daily, and another 10% check weekly. Only 13% hardly ever use them. Nobody said they only use their phones once a month or never, so it looks like smartphones are a big part of farming now.

3. What prevents you from using IOT tools?

Barrier	No. of Respondents	Percentage
High cost	19	55.9%
Lack of knowledge	16	47.1%
No internet connectivity	16	47.1%
Lack of training	12	35.3%
Unreliable electricity	11	32.4%
Not interested	1	2.9%

(Source: Primary Data)





Interpretation

The table shows farmers aren't using IoT tools mainly because they're too expensive, they don't know how to use them, and their internet is bad. A lot of people also said they haven't had training and their power supply isn't reliable, which stops them using it. Almost everyone actually wants to use IoT if they get the right help, training, and stuff they need to plug in. Basically, it's not that farmers don't like the idea of IoT. It's just the tech and money that get in the way.

4. What Benefits have you observed?

Benefit Observed	Frequency (n)
Reduced water usage	20
Higher crop yield	21
Reduced labour cost	23
Early pest/disease warning	13
Time saving	20
No major benefit	2
Total respondents	34

(Source: Primary Data)

Chi-Square Calculation Table

Benefit	Observed (O)	Expected (E)	O - E	(O - E)²	(O - E)² / E
Reduced water usage	20	16.5	3.5	12.25	0.742
Higher crop yield	21	16.5	4.5	20.25	1.227
Reduced labour cost	23	16.5	6.5	42.25	2.576
Early pest/disease warning	13	16.5	-3.5	12.25	0.742
Time saving	20	16.5	3.5	12.25	0.742
No major benefit	2	16.5	-14.5	210.25	12.742
Total	99	99		χ^2 = 18.76	

Interpretation

The chart shows most farmers got better crop yields, spent less on labour, and used less water with IoT farming. Only a few didn't see any big changes, suggesting IoT really helps boost how much small farmers in Akola district can grow and how well they do it.

The χ^2 statistic of 18.76 exceeds the critical value of 11.07 (df=5, α=0.05), yielding p=0.002 and rejecting H_0 in favour of H_1.

5. What type of IoT training do you prefer?

Training Method	Responses
Online mobile app	19
On-field demo	10
Video-based	5
Krishi Kendra	1
Total	**34**

(Source: Primary Data)

Chi-Square Calculation Table

Training Method	Observed (O)	Expected (E)	O-E	$(O-E)^2$	$(O-E)^2/E$
On-field demo	10	8.5	1.5	2.25	0.265
Video-based	5	8.5	-3.5	12.25	1.441
Krishi Kendra	1	8.5	-7.5	56.25	6.618
Mobile app	18	8.5	9.5	90.25	10.618
Total	34	34		$\chi^2=18.94$	

Interpretation

The calculated Chi-square value ($\chi^2 = 18.94$) is greater than the critical value at the 5% level of significance (df = 3), indicating a significant difference between observed and expected frequencies. This shows that farmers' preferences for IoT training methods are not evenly distributed. Mobile app–based training and on-field demonstrations are preferred significantly more, while Krishi Kendra and video-based training are less preferred. Hence, the null hypothesis is rejected, and training method preference among farmers is statistically significant.

8. Findings of the Study

The study finds that small farmers in Akola district are getting to know more about farming tools that use the Internet of Things. They are learning about these tools from apps Krishi Seva Kendra and social media. Most small farmers in Akola district use their smartphones a lot for farming work, which's a good thing because it shows they are ready to use digital things.

The thing is, not many small farmers in Akola district are using Internet of Things tools because they are expensive and the farmers do not know much about them. Also the internet connection is not very good. They are not getting enough training on how to use these tools. It is not that the small farmers in Akola district are not interested, in Internet of Things tools. Farmers who use IoT tools report clear benefits such as higher crop yields, reduced labour costs, better water management, and time savings, and statistical analysis confirms a significant positive impact on productivity. The study also reveals a strong preference for mobile app–based and on-field training methods, highlighting the need for affordable, practical, and technology-driven support to promote wider adoption of smart farming solutions.

9. Managerial Implications

The study shows that just using IoT tools for a while doesn't automatically lead to better results. What really makes a difference is how well farmers get the tech and put it to work. Because of this, managers and agri-tech companies should really focus on good training, simple systems, and support that's always there when needed. Also, since cost is tough on farmers no matter how big their farm is, we should try to make IoT tools cheaper with things like subsidies, payment plans that work for them, and buying together. The study pointed out that not many women are using the tech, thus there is a need for awareness campaigns and training programs made for female farmers. By backing farmers up, cutting costs, and getting more women involved, managers can help make farming with IoT better for everyone.

10. Limitations of the Study

Every research study has certain limitations that may affect the scope and generalisation of its findings. The following are the key limitations of the present study:

1. The study will be limited to irrigated farmers in Digras BK & Sasti villages only.

2. The study will be limited to IoT-based (Solar-Powered Water Pumps, Electric Fence Energizers, Smart Farming Apps) solutions only.

3. The Study will be Limited to the year 2025–2026 only.

11. Recommendations

Here's what really stands out from this study: If we want small farmers in Akola to use more IoT tools and technology, we need to meet them where they are. Farmers like learning through mobile apps, so let's lean into that. Bring in on-field demos too—seeing things in action always helps. Cost is a big deal, so let's make these tools cheaper, whether that means subsidies or just smarter designs. But honestly, none of this works if the basics aren't there. Things like steady electricity and good internet—without those, digital tech just collects dust. We also need to get the word out about what IoT actually does for them. Show how it boosts yields, cuts labour, saves water, and spots problems like pests early. That kind of proof gets people interested. And don't just train them once and walk away—farmers need ongoing support to keep these tools working for them. Stick with them, and you'll see real change.

12. Scope for Future Research

This study looks at how small farmers in Akola use IoT tools and mobile tech, but there's plenty more to dig into. For one, it's worth tracking what happens to farmers' income, productivity, and sustainable practices when they stick with these tools over the long haul. It also makes sense to compare farmers in different districts or states—maybe their tech habits and training needs aren't all the same. Factors like gender, education, and farm size probably shape how quickly farmers pick up new tech, so those deserve a closer look too. And what about digital training? There's a lot to learn by testing out different formats—maybe gamified apps, maybe virtual workshops, or even mixing things up with hybrid models—to see which ones actually help farmers learn and use the tech. Lastly, if we dig into the real costs and benefits, plus the impact of government policies, we can give governments and agritech companies a clearer roadmap for helping small farmers get the most out of these new tools.

13. Conclusion

This study shows that IoT-based farming tools really make a difference for small farmers in the Akola district. When farmers use things like soil moisture sensors, smart irrigation, crop advisory apps, and weather monitoring, they don't just cut down on wasted resources—they actually boost their crop yields. The research points out that farmers need to know about these tools, get the right training, and have access to affordable technology if they're going to use them. On the academic side, this work deepens our understanding of how farmers take up new tech and what that means for productivity. It also makes it clear that factors like how much land a farmer owns and their education level play a big role in whether they adopt these digital solutions.

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