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Market demand, need-gap analysis, and the disparity between farmers' knowledge in scientific crop production and technology-based needs

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Abstract

This study explores the gap between farmers' knowledge of scientific crop production and the growing technological demands in agriculture, highlighting the disconnect that persists despite agriculture being a primary livelihood for many. Conducted during the Kissan Mela at G.B. Pant University of Agriculture and Technology with 100 farmers from diverse regions, the research used a structured questionnaire to assess awareness of modern techniques, market needs, and innovation adoption. Findings show that only 17.2% of farmers currently use scientific practices, with most relying on traditional methods that lead to lower yields and reduced market returns. The study identifies key barriers to adopting new technologies, including high costs, limited training, and insufficient extension services. These challenges underscore the urgent need for targeted interventions, such as hands-on training, stronger extension networks, and better access to digital resources, to empower farmers, boost productivity, and support more sustainable, market-responsive agricultural practices.

Keywords: Livelihood, modern techniques, market needs, and innovation adoption, etc.

Introduction

Most of our country's population depends on agriculture. Nowadays, in the modern world where scientists recommend newly developed high-yielding varieties, modern agronomic practices of crop production, IoT-based crop production, etc, most farmers are using their traditional way of crop production, which results in low yield and low selling price of their crop in the market.

Due to dietary changes, population increases, and the use of biofuels, the world's food consumption is rising quickly, necessitating nearly quadrupling crop production by 2050. To increase production sustainably and guarantee food security, this emphasizes the critical need for scientific strategies, including yield gap closure, sustainable intensification, and enhanced agronomy (Ray *et al.*, 2013) [23].

Farmers' dependence on conventional methods, particularly in rainfed regions with restricted access to contemporary technologies, is a major contributing factor to the persistence of yield discrepancies. Many areas still barely produce 20-80% of the potential yields, even though some irrigated systems are getting close to their full capacity. Food security depends on closing these gaps, especially in light of climate change. Productivity can be increased sustainably with the use of cutting-edge technologies such as sensor-based water and nutrient management and improved access to scientific knowledge (Lobell *et al.*, 2009) [15].

Precision farming, the Internet of Things, and biofertilizers are examples of agri-tech breakthroughs that have the potential to greatly increase agricultural sustainability and output. However, because of high costs, a lack of technical expertise, and inadequate extension services, adoption is restricted in poor regions. Although they can increase input efficiency and yields, tools like remote sensing and GPS-guided machinery need greater support before they can be widely used (Wolfert *et al.*, 2017; Klerkx *et al.*, 2019) [32, 13]. IoT-based smart farming systems offer real-time monitoring and decision support but face infrastructure challenges, such as unreliable internet connectivity and lack of interoperability (Kamilaris *et al.*, 2018) [11]. Similarly, bio-fertilizers—sustainable alternatives to chemical inputs—are underused due to

limited awareness, market availability, and skepticism regarding their effectiveness compared to synthetic fertilizers (Vessey, 2003; Bhardwaj *et al.*, 2014) [31, 4].

Productivity and sustainability are constrained by a notable disconnect between farmers' traditional knowledge and contemporary agronomic techniques. Low adoption of advances like precision irrigation or integrated pest management is the result of this disconnect, which is fueled by low literacy, limited extension access, and weak research-farmer ties. To close this gap, varied agricultural communities need to be able to use scientific information, which calls for accessible digital tools, context-specific extension, and participatory techniques (Anderson & Feder, 2004; Davis *et al.*, 2012; Giller *et al.*, 2011; Vanlauwe *et al.*, 2014) [2, 6, 10, 29].

Smallholders, who frequently lack access to contemporary technologies, infrastructure, and knowledge, face difficulties meeting the growing demand for safe, sustainable, and high-quality agricultural products. Adoption of quality-enhancing techniques like precision farming and certification is hampered by obstacles like high costs, low awareness, inadequate extension support, and disjointed supply chains. Strong public-private partnerships, inclusive policies, targeted training, and financial availability are necessary to close these gaps and bring agricultural practices into line with market norms (Reardon *et al.*, 2009; Trienekens & Zuurbier, 2008; Feder *et al.*, 1985; Rogers, 2003; Minten *et al.*, 2010) [24, 28, 8, 26, 18].

Keeping these problems in state this study aims to bridge the disconnect between traditional agricultural practices and the evolving demands of modern, market-oriented farming. First, it assesses farmers' current knowledge and awareness of scientific crop production techniques, such as improved agronomic practices, input management, and sustainable farming methods. Second, it identifies market-driven demands, including the rising interest in farming, high-yield seed varieties, and technology adoption, which increasingly influence consumer preferences and market access. Third, the research analyzes the gap between farmers' existing practices and the technological innovations required to meet these demands, such as precision agriculture, soil health recommendations, and digital tools. Understanding these gaps is essential for designing targeted interventions that can enhance productivity, sustainability, and farmers' competitiveness in modern agri-markets (Parvathi Sankar P *et al.*, 2023) [30].

Research Methodology

This study is undertaken at G. B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand, during the time of Kissan Mela, which is being organized by the university at that time. In Kissan Mela, farmers of the Uttarakhand Hill area, both Kumaun and Garhwal mandal, also farmers of the plain regions of Uttarakhand and western Uttar Pradesh, especially districts near the Uttarakhand border were participated in the majority. Randomly, farmers present at Kissan Mela were asked to fill out a questionnaire. To accomplish the goals of this study, a questionnaire was created. The questionnaire was examined by the faculty of the departments of communication and agricultural extension, and any necessary changes were made in response to their feedback. The questionnaire was first created in English, but to prevent any comprehension issues, it was later translated into Hindi. A Sample size of 100 farmers was randomly selected for the study from the Kissan Mela.

All of the variables regarding knowledge level, farmers' current knowledge of scientific crop production, market-driven demands (e.g., organic farming, high-yield seeds), gap between

traditional practices and agri-tech needs suggest that policy & extension strategies to bridge the gap are clearly defined and labeled for data analysis. The demographic characteristics of the respondents are assessed using descriptive statistics, mainly through frequency distributions, percentages, and some tests. The data are coded, entered into an Excel file, and then analyzed using the Statistical Package. All tests conducted at $\alpha=0.05$ using SPSS v26. Assumptions (normality, homogeneity) verified via Shapiro-Wilk and Levene's tests.

Results and Discussion

The study shows a glaring discrepancy between farmers' use of contemporary agronomic techniques and their usage of conventional inputs. Only 30% use soil testing, although over 70% use chemical fertilizers, indicating a lack of knowledge about accurate nutrient management. This is indicative of larger issues related to inadequate extension services, a lack of training, and infrastructure impediments. Uptake is poor in the absence of robust institutional backing, localized outreach, and farmer-focused education, despite initiatives such as soil health projects.

1. Demographic and Socioeconomic Profile

The survey included 100 farmers from Uttar Pradesh, Uttarakhand, Haryana, and Bihar. Key demographic findings are summarized below:

Table 1: Farmer Demographics

(N=100)		
Variable	Category	Frequency (%)
Gender	Male	89.2%
	Female	10.8%
Education	No formal education	6.2%
	Primary	13.6%
	Graduate or above	59.1%
Landholding	Marginal (<1 ha)	20.3%
	Small (1-2 ha)	32.8%
	Large (>4 ha)	20.3%

Males are dominant in agriculture about 90% of farmers are male in all states. And most of the farmers are highly educated, as 52% of farmers have graduated in our study. Gender disparity aligns with national data (NSSO, 2019) [19], where women constitute <15% of landholders. High education levels (60% graduates) contrast with low adoption of scientific practices. The majority of farmers in our study are small farmers, followed by marginal and medium farmers as in our country, farmers have small landholdings. Average landholding is Marginal type in U.P. and Uttarakhand as per.

2. Market Demand and Challenges

Table 2: Market Linkages and Challenges

(N=100)		
Parameter	Response	Frequency (%)
Crop Selection Basis	Traditional practices	59.4%
	Market demand	40.6%
Selling Difficulties	Low prices	69.6%
	Lack of market access	48.2%
Preferred Sales Channel	Local markets	77.8%
	Digital platforms (eNAM)	9.5%

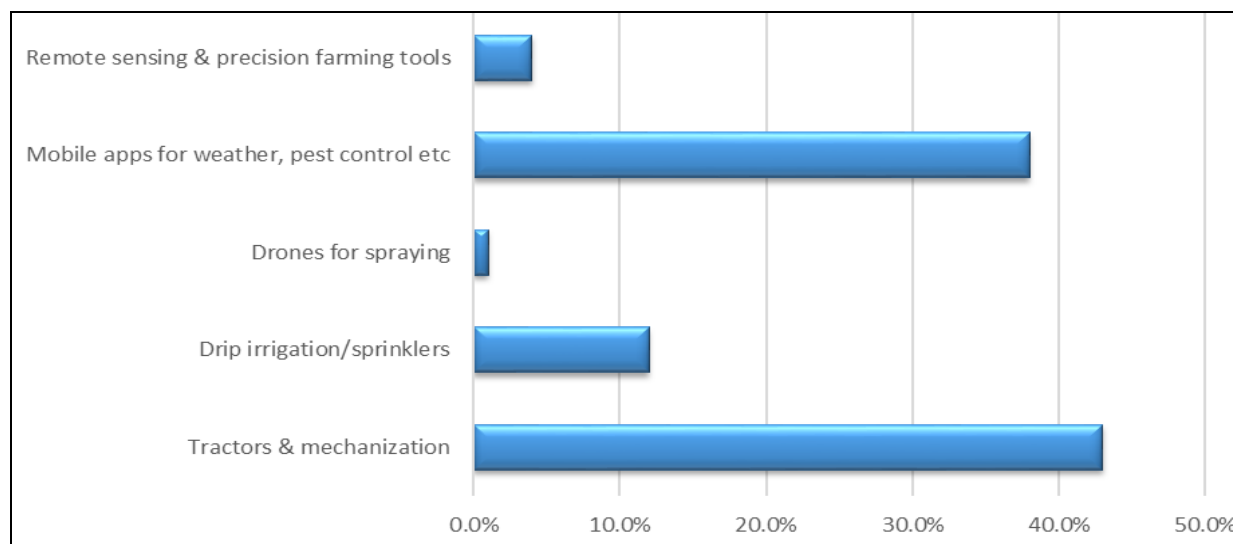


Fig 1: Farmers decide to grow their crops on this basis

This study describes that the highest number of farmers grow their crops based on traditional practice (59.4%), followed by market demand and price trends (40.6%), and availability of inputs (29.2%). Farmers' reliance on traditional practices and local markets reflects weak market integration, consistent with Reardon *et al.* (2019) [25]. The study found that most farmers face difficulties in selling their products, with which main challenges being low price for produce (69.6%), followed by lack of market access (48.2%), and middleman exploitation. The majority of Indian farmers sell their produce in local markets, 55-93%, in APMC markets, which ranged from 3-22% in the

77th round of the National Sample Survey by the National Statistical Office (2019) [20]. About 62.5% of farmers don't know about digital platforms (like eNAM, AgriBazaar) for selling their produce. In hilly areas of Uttarakhand, storage is the main challenge. Despite awareness of digital platforms (61.9%), usage remains low due to infrastructural gaps (Aker, 2011). Chi-square test revealed a significant association ($p < 0.05$) between landholding size and market access challenges ($\chi^2 = 8.24$, $df = 3$), with marginal farmers facing greater barriers.

3. Knowledge-Practice Gap in Agronomy

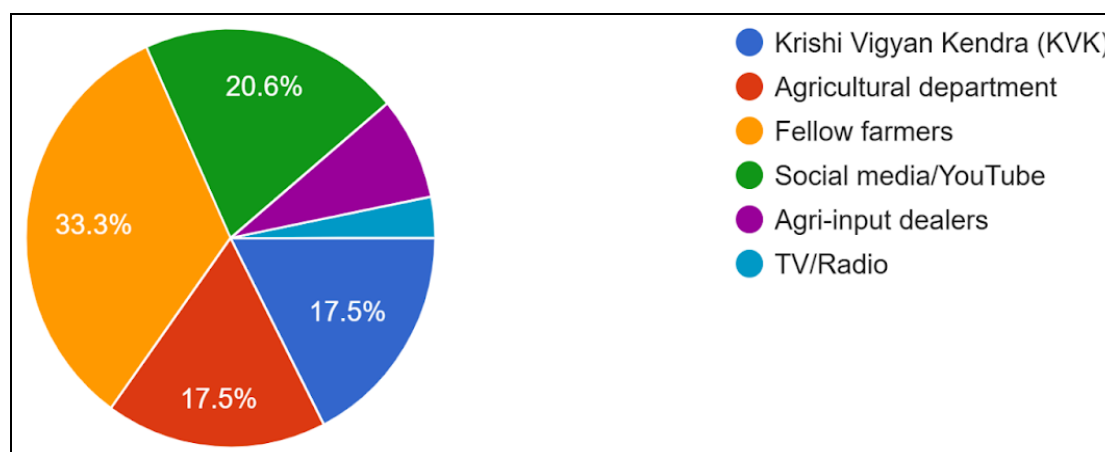


Fig 2: how farmers get information about scientific crop production

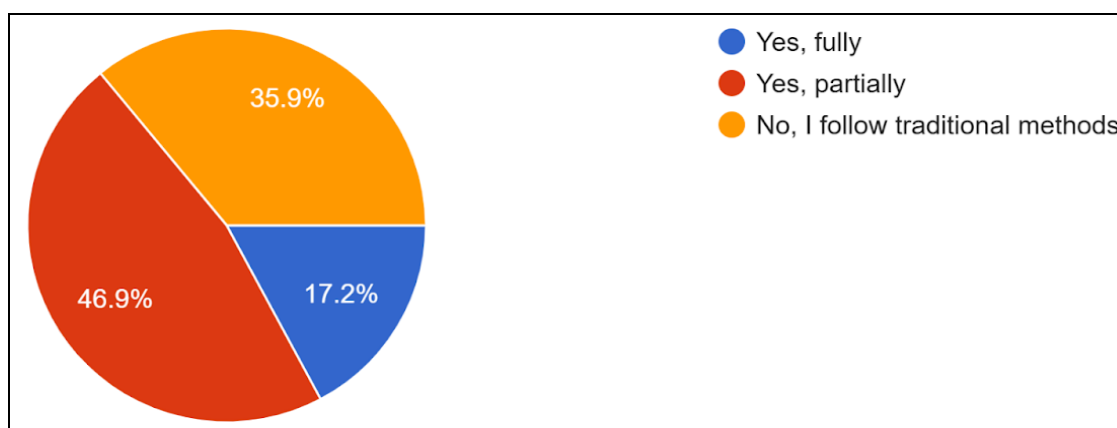


Fig 3: Farmers follow scientific crop production practices

The study revealed that the highest number of farmers get information about modern farming practices from their fellow farmers (33.3%), followed by KVKs and the agriculture department (17.5%). Study also revealed only 17.2% of farmers follow scientific crop production (crop rotation, Rejuvenation of soil fertility, intercropping, etc.) This knowledge gap is further widened by reliance on informal sources of information, such as peer farmers or input dealers, who may not always provide scientifically accurate guidance (Asfaw *et al.*, 2012) [3], and the

majority of farmers partially follow scientific crop production, and 35.9% farmers still follow traditional methods crop production. Scientific crop production attributes, driven by scientific advancements and technological adoption, aim to enhance agricultural productivity. The Crucial issue of farmers not receiving adequate compensation despite increased demand, underscoring the need for policies that ensure economic sustainability alongside agricultural modernization.

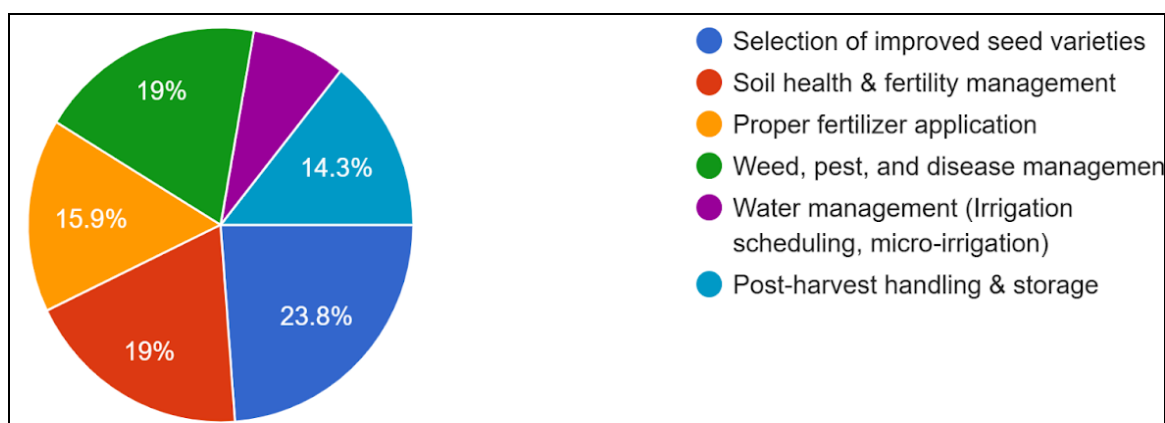


Fig 4: Major gaps in agronomic knowledge

Table 3: Knowledge gap in scientific crop production

Knowledge Gap	Percentage (%)
Selection of improved seed varieties	23.81%
Weed, pest, and disease management	19.05%
Soil health & fertility management	19.05%
Proper fertilizer application	15.87%
Post-harvest handling & storage	14.29%
Water management (Irrigation scheduling, micro-irrigation)	7.94%

Study revealed that the most frequently reported knowledge gap was selection of improved seed varieties (23.81%), followed closely by weed, pest, and disease management, and soil health & fertility management (each 19.05%). These issues reflect a critical need for better access to modern seed technologies and sustainable crop protection strategies (Singh and Sharma, 2019) [27]. Farmers may benefit from targeted extension programs focusing on varietal selection, integrated pest management

(IPM), and maintaining soil productivity through appropriate amendments and cropping practices (Meena *et al.*, 2017) [17]. While proper fertilizer application and post-harvest handling & storage were also notable concerns (15.87% and 14.29%, respectively), water management was identified less frequently (7.94%). This could imply relative awareness or better practices in irrigation, but it also suggests the need for deeper evaluation, especially in areas prone to water stress (FAO, 2021) [9].

Table 4: Preferred Training Methods (N=100)

Training Method	Demand (%)
Practical field demonstrations	37.5%
Workshops on crop management	31.3%
Farmer-to-farmer learning groups	21.9%
Online training programs	9.4%

The study revealed that practical field demonstration (37.5%) is the most preferred way by farmers to improve agronomic knowledge for scientific crop production. Farmers' preference for field demonstrations over online training aligns with Rogers' (2003) diffusion theory. Farmers also preferred Workshops on crop management (31.3%), farmer-to-farmer learning groups

(21.9 to improve agronomic knowledge for scientific crop production, but online training programs (9.4%) are least preferred by farmers. The theory-practice divide underscores inefficiencies in extension services (Anderson & Feder, 2007) [2].

4. Technology Adoption Barriers

Table 5: Technology Use and Barriers (N=100)

Technology	Adoption Rate (%)	Barrier	Frequency (%)
Tractors	71.2%	High cost	45.2%
Mobile apps	40.7%	Lack of training	33.9%

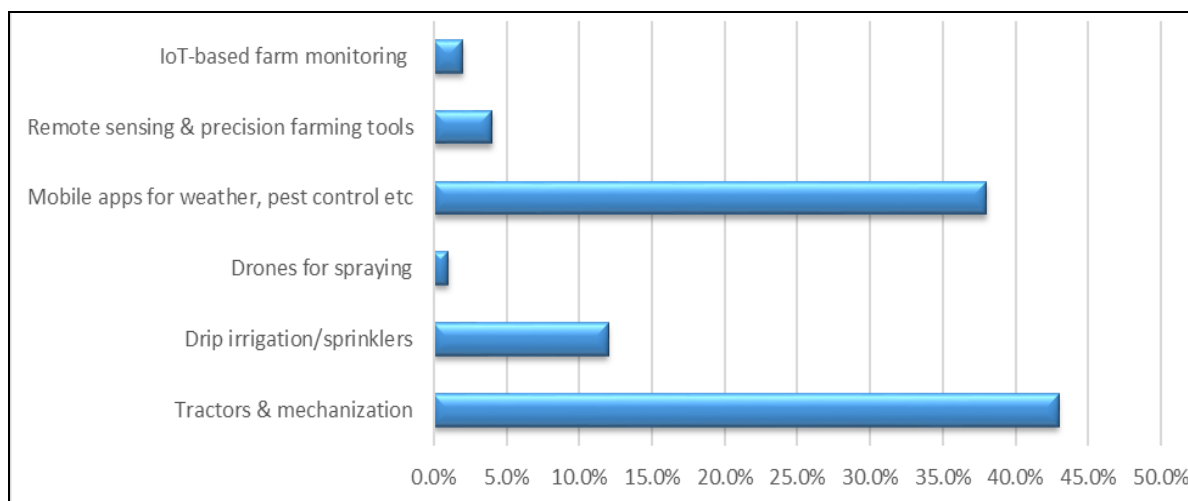


Fig 5: Modern technologies adopted by farmers

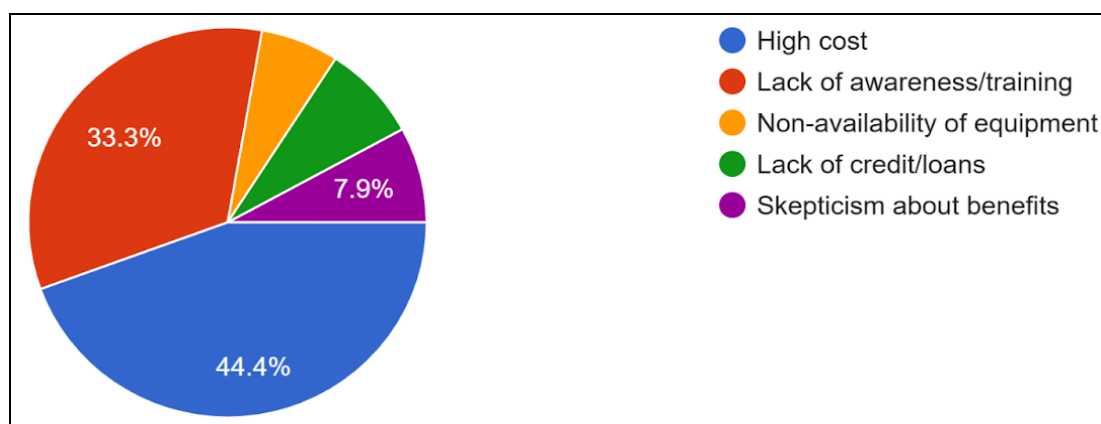


Fig 6: Main barriers to adopting modern technology

The study describes that most farmers have adopted tractors and mechanizations (43.71%) as modern technology, followed by mobile apps (for weather, pest, etc.) (40%) and Lowest adoption was seen in precision agriculture tools, IoT-based farm monitoring of and use of drones all contributes less than 5%. It can be concluded from the results that these tools are not easy to use and require technical knowledge to use them. Precision tools (e.g., drones: 1.7%) contrast with global trends. As per study results main barriers to the adoption of modern

technology are high cost (44.4%) and lack of awareness/training (33.3%). A systems approach (e.g., Kenya's digital extension model) could address multiple gaps (Aker, 2011). Also, it can be concluded that farmers prefer low-cost equipment, and if they are provided proper awareness and training about modern technology and equipment, and scientific crop production technology, they will easily adopt them. Cost and training gaps necessitate subsidies and farmer-centric tech hubs.

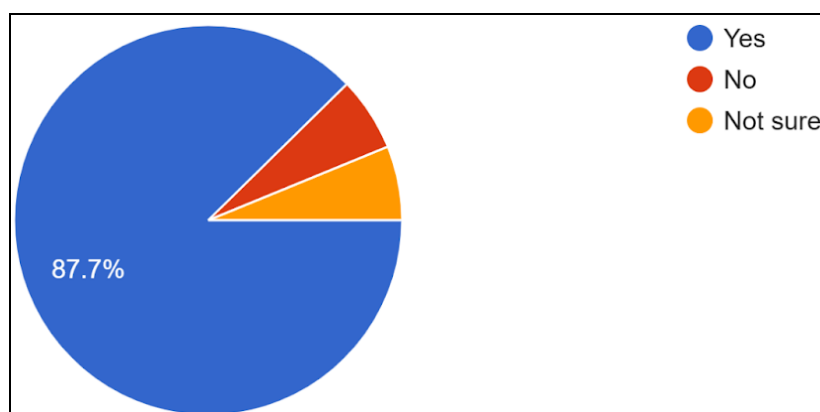


Fig 7: Farmers willing to adopt new agricultural technologies if provided with proper training and subsidies

Conclusion

The study identifies market inefficiencies, knowledge-practice gaps, and tech cost barriers as key constraints. Farmers lack knowledge about innovation and technologies, and following

traditional practices for crop production, which results in low yield and high-cost inputs in comparison to scientific crop production, also lack awareness to use modern tech equipment and methods, with a high-cost barrier. To mitigate these

problems, we should provide extension services with proper scientific knowledge about crop production, revamp extension services with ICT tools (e.g., WhatsApp-based advisories), and suggest cost-effective technologies to farmers. Awareness of digital platforms will strengthen market linkages through FPOs and e-platforms for selling their products. Also, practical field demonstrations, subsidize precision agri-tech via PPP models and Workshops on crop management will help them for adoption new methods and technologies for scientific crop production to achieve higher and sustainable yields with low-cost inputs.

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