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DRIVERS AND BARRIERS OF AGTECH STARTUPS: AN EMPIRICAL STUDY IN JALPAIGURI DISTRICT OF WEST BENGAL

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Abstract

The advancement of technology is changing the face of Indian agriculture unlocking investment opportunities and solving issues of global food security. Central to this evolution is agricultural technology, or Agtech, which is capable of placing India amongst the top countries in terms of agricultural output. This paper evaluates the drivers and barriers to Agtech startup adoption by farmers in the Jalpaiguri district in West Bengal. The research adopted a mixed-method research approach. The results of the analysis show that there is a low level of awareness about Agtech startups among farmers, and adoption rates are even lower with only 15.3% of the respondents having used services of such platforms. Lack of awareness, limited technical knowledge, perceived irrelevance, and infrastructure challenges, were cited as significant barriers hindering their usage. It recommends that such barriers should be effectively addressed through awareness programs, training activities and better rural infrastructure. This will assist Agtech in enhancing food security and promoting the growth of Indian agriculture.

Keywords: Agtech, Agriculture Technology, Agribusiness, India, Startups.

I. Introduction

Society is undergoing a rapid digital transformation with digitalisation impacting every aspect of human interaction. The same however cannot be said for the agricultural sector which still has a long way to go as it works hard to feed about 10 billion people by the year 2050 and perhaps increase agribusiness production by 70% including the supply chains (World Bank, 2016). To deal with those difficulties there are possibilities of innovation at every stage of the agricultural supply chain, from input, production, transportation, processing, storage, distribution, and so forth. In this context, innovative entrepreneurs are combining two seemingly contradictory aims, that is providing solutions for urgent problems of society and at the same time generating economic value by developing new products and processes.

The development of digital technologies has marked the beginning of a new era of technological advancement in agricultural entrepreneurship. This has led to the development of new Agri startups leveraging the technologies and are commonly described as Agtech startups These new startups use technologies like precision farming, IoT devices, robotics and data analytics platforms and other new wave of agricultural innovations to deliver products and services.

The development of digital technologies has marked the beginning of a new era of technological advancement in agricultural entrepreneurship. This has led to the development of new Agri startups leveraging the technologies that are commonly described as Agtech startups. The term "Agtech," a short form of "Agricultural Technology," has become quite common and refers to an aggregate of businesses, and start-ups that take advantage of technology to enhance production capacity, providing a variety of efficiencies, and increasing gains for the stakeholders in the agricultural value chain. The term was defined with the emergence of new technologies that facilitate the creation of various solutions in the agricultural sphere, such as drones, the Internet of Things (IoT), Artificial Intelligence (AI), Machine Learning (ML), blockchain, and image analytics among others. Such tools and techniques form parts of Agriculture 4.0, an advanced stage of the industry where data is incorporated to maximize efficiency and productivity (FICCI, 2021). Due to the realization of such variations in agribusiness, Agtech has become a growing phenomenon across the globe in the agricultural sector. These Agtechs have revolutionized agriculture by enhancing conservation and increasing output through new strategies created by passionate agri-entrepreneurs (Dutia, 2014). In India, the Agtech ecosystem is currently at an early stage of development, which explains the lack of research publications on this topic.

At present, Indian agriculture is in a transition phase and needs to enhance productivity on a large scale to keep up with a growing population and address climate change. Agtech is capable of solving this issue. As India continues to develop its Agtech ecosystem, it is essential to understand the drivers and barriers to its widespread adoption among farmers. The next section of the paper provides an overview of the status of the Indian Agtech Sector.

II. Indian Agtech Startups Scenario

The rising acceptance of technology in agriculture via Agtech-empowered Agri innovations is economising the agricultural space in India and has established the basis for integrated agricultural innovation systems (Poti and Joy, 2021). The advent of emerging technologies in the Agtech space is catalysing the second green revolution in India, with technology shifting the paradigm of agriculture from mechanisation to automation and further enabling sustainable and inclusive farming. Growing internet availability and penetration of digital devices in rural India is favourable for these startups. These Agtech startups are developing and commercializing new products and technologies that minimize inefficiencies related to crop procurement, production, weather monitoring, harvesting, warehousing, logistics, marketing as well as the entire farming experience, considerably favouring the farmers. Numerous startups have cropped up and done well within a very short period harnessing their understanding of the agriculture technology space and innovation. The government's initiatives and technological growth in the industry are also helping to increase farmer's incomes. Furthermore, the severe fragmentation of agricultural supply chains prompted some of the well-established Agtech firms to devise all-inclusive models that address many stakeholders at a go. There are several Agtech products in the Indian market that target different sections of the agriculture value chain and are aimed at increasing farm income, as illustrated in Table 1.

Table 1: Indian Agtech Landscape

Agtech		Startups
Big Data	*Using Farm data to determine opportunities and key areas*	agroconnect, Cropin, फसल सलाह

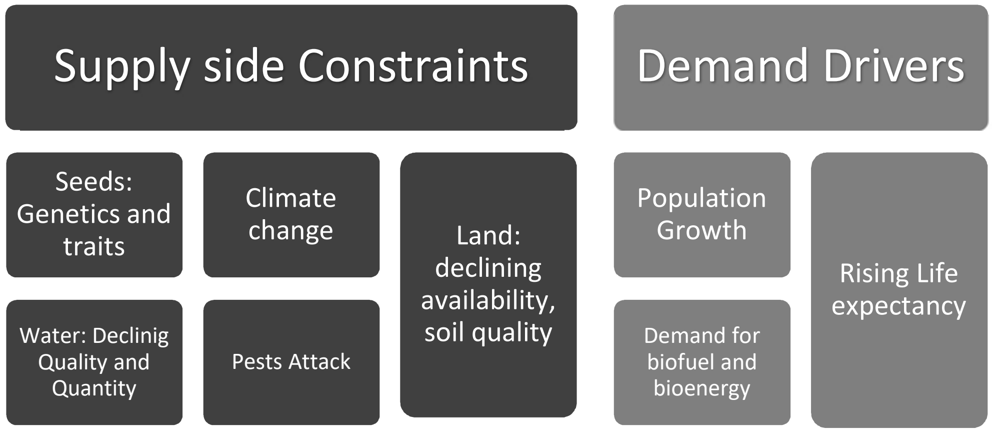
Internet of Things (IoT)	*Using IoT devices for remote monitoring and tracking*	bitmantis, FutureFarms, Nubesol, HAMARIKRISHI, FLYBIRD FARM INNOVATIONS
Farming as a service	*Providing an affordable technological solution for efficient farming*	crofarm, BigHaat.com, KHETHINEXT, EM3
Upstream input marketplace model	*Matching Agri Input Sellers to Farmers*	AgroStar, the agrihub, ninjacart, agrevolution, AGRONXT
Downstream output marketplace model	*Matching farmers to businesses or retail customers for fresh produce, processed food*	bharat bazar, SABZIWALA, KRISHI STAR
Agricultural Mechanization and Equipment	*Providing engineering solutions with Smart mechanization intervention*	KHEYTI, KAMAL KISAN, drip TECH
Agri Fintech	*Providing Financial solutions to farmers*	farMart, payAgri, KRISHI TRADE, Jai Kisan

Source: Author.

The Indian supply chain pitfalls present several opportunities for supply chain solutions that ensure traceability, reduce food wastages and losses, and improve the standard of the produce while increasing the earnings of the farmers. However, engaging and recruiting individual smallholder farmers may present challenges for startups because of their low-risk appetite and the expensive cost of onboarding them. In India, 86 per cent of all farmers are small and marginal, the most disadvantaged among them. Such farmers only cease to be resistant to Agtech if such platforms provide better remuneration and tangible evidence of benefits. Hence, small farmers' acceptance of the technology is of utmost importance and it can be enhanced by ensuring that the services have a visible presence of its benefits.

Agtech also provides a wealth of investment opportunities. Because of the ever-increasing requirement for food, fibre, and energy, agriculture has remained in the ranking of the best industries to invest in. The growing need for environmentally friendly energy solutions, diminishing arable land, and water scarcity underscore the urgency for innovative solutions. These challenges present a fertile ground for entrepreneurs to pioneer Agtech innovations. The figure below gives a further illustration of all the factors that determine the entire agriculture industry, asserting that, indeed, the need for agricultural products will still be increasing, however, lack of supply will hinder this from coming to fruition. This opens a pathway for investors and entrepreneurs to pioneer new ways and concepts in Agtech innovations and create products that deal with these issues.

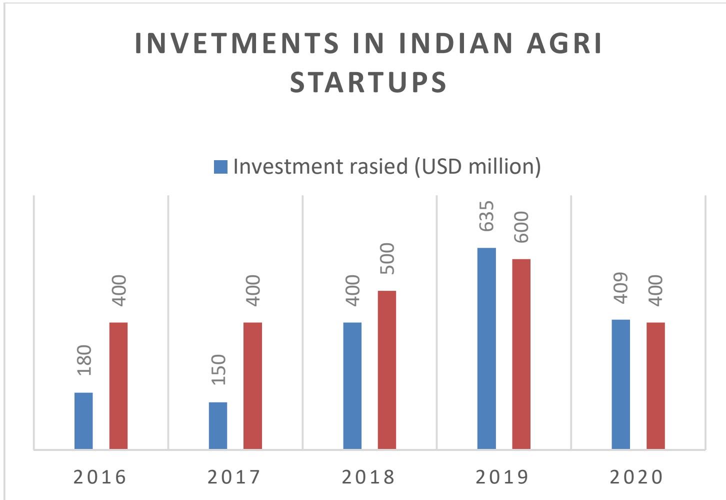
Figure 1: Demand Drivers and Supply Constraints



Source: Author.

The Indian Agtech industry has been gaining momentum since 2010 owing to the rising interest from investors and engagement by well-known entrepreneurs. Data reveals that only five foreign Agtech start-ups have shifted their base to India, while around 25 Indian Agtech companies have gone global in their operations. Further, in the past decade, over 700 Agtech start-ups in India have managed to attract more than \$1.5 billion in investment, which is a 14 times increase on the 45 million dollars witnessed in 2011. FICCI estimates that in ten years to come the sector will receive 10 billion dollars in funding. Currently, the valuation of the Indian Agtech startups stands at \$204 million which is a mere one percent of the total available market opportunity of \$24 billion leaving a large room for the growth of the start-ups as they venture into the ten billion and above market.

Figure 2: Total investments in Indian Agtech Startups



Source: FICCI.

The amount of funding directed towards Agtech startups in India dropped by approximately 35% from last year's $409 million investment (Figure 1). This could be partially explained by the pause in deal-making efforts driven by the ongoing Pandemic. That said, the Pandemic has also accelerated the digitalization of different industries and different income strata which should also help the Agtech startups. There is also a slowdown in funds but agri business models are proliferating faster and fetching larger portfolios. Investments across the industry are relatively appealing to non-sector specialists and new entrants such as Ascent Capital, ABC World Asia, and STIC Investments are coming in. Further, e-commerce leaders like Walmart and Alibaba, who consider food and groceries business as core to their India operations, are exploring new kinds of investment in the industry.

III. Literature Review

There have been a number of studies on the adoption of agricultural technologies throughout the world emphasising its importance in mitigating the problems in modern-day agriculture. Several researchers have attempted to determine the factors affecting the adoption of agricultural technologies and found that there exist several factors such as gender, education, age, off-farm income, etc. which impact farmers' decision-making processes on the adoption of agricultural technologies (Cavane & Donovan, 2011; Ae, 2017). These factors are further compounded by farm-specific characteristics such as land size, agro-ecological settings, and cropping systems which also define the adoption patterns (Takahashi et al., 2019). Besides, these, technological characteristics also affect the rate of adoption of agricultural innovations. Researches show that adoption can be improved by attributes such as perceived ease of use, perceived usefulness, and perceived compatibility (Pignatti et al., 2015). Access to extension services, access to training, and access to public finance have also been cited as factors of adoption and demonstrates the importance of strong support (Takahashi et al., 2019; Pignatti et al., 2015). Additionally, behavioral and perception constraints such as risk attitudes toward technology add a further layer of complexity to the adoption process (Zhao & Zhou, 2021). Some measures that have been employed to improve adoption include provision of practical illustrations, setting up knowledge sharing facilities, and the use of competent intermediaries, which have been able to make the transition from the innovative idea to the practical one (Pignatti et al., 2015).

Regarding the adoption of Agtech enabled startups, researchers found that farmers are more likely to adopt Agtech due to its advantages over more traditional undertakings, such as its ease of use, and its practicality (Lohento & Sotannde, 2019; Von Veltheim & Heise, 2020). On the other hand, various factors are also found that prevent farmers from incorporating Agtech into their farms such as lack of expertise, poor perceived utility, unavailability of necessary infrastructure, and trust issues. For example, Marshall et al. (2021) confirm that although farm practices could greatly be enhanced through Agtech, the technology had not reached optimal levels because of infrastructural challenges and sociocultural differences within the communities.

In India, the use of Agtech solutions can be quite helpful due to the ongoing detractions such as low agriculture productivity, inefficient resource deployment and the ravaging impacts of climate change. However, it remains unclear how encouraged farmers in India are to adopt Agtech since studies addressing this issue are largely sparse. Drivers and barriers are mentioned also in available studies. For instance, according to Sharma and Mathur (2018), farmers' productivity and resource management improved because ofmobile-based agricultural advisory services to the farmers. Indian Agtech adoption has, however, been hampered by socio-economic factors such as farm size, access to credit facilities and lack of knowledge about digital systems (Tzachor, 2021). Also, infrastructural issues like sub-standard internet services or the incapability of most sophisticated equipment’s availability have drawn the adoption rate down.

In spite of these challenges, farmers in India are showing interest in Agtech adoptions due to the expected increase in efficiency, cost, and benefit to the environment. Although there has been a number of research investigating the adoption of Agtech across the globe, it is of concern that little attention has been catered towards the Indian case. This study is an attempt to fill this gap by investigating the drivers and barriers to the adoption of Agtech in Jalpaiguri district of West Bengal.

IV. Objectives of the Study

The study tries to achieve the following objectives:

I. To assess the level of awareness and adoption of Agtech among the farmers in the study area

II. To evaluate the drivers and barriers of Agtech startup adoption among the farmers in the study area

V. Methodology

The research for this study adopts a mixed method approach consisting of both qualitative and quantitative data, to investigate the drivers of the adoption of Agtech and the barriers impeding it. The study was exploratory and descriptive in nature. Data were obtained from the farmers using a questionnaire survey. The study was conducted in the Jalpaiguri district of West Bengal, India. The population for this study were the farmers in the study area. The required sample size for making reasonable statistical inferences about the population was calculated using Yemen's formula for sample size determination:

$$n = \frac{N}{1 + N(e)^2}$$

In this formula, the variables are:

n: The sample size

N: The population of the study

e: The margin of error in the calculation

The population (N) for this study is the total number of farmers in Jalpaiguri District. According to the 2011 census, the total farmer population in Jalpaiguri is 1,13,290. The margin for error (*e*) for this study is taken as 0.05.

$$n = \frac{113290}{1 + 113290(0.05)^2}$$

$$n = 398$$

Thus, according to the formula, the sample size required for conducting this study is 398. A random sampling technique was used to select the sample. Proportional stratification was used to allocate the sample size to each of the nine blocks in the district proportional to their total number of populations. In this manner, proportional allocation guaranteed that the proportion of every block in the sample was equal to the proportion of that block in the total population of the district engaged in farming.

To accomplish the set research objectives, data was obtained through a structured survey administered to farmers across the nine administrative blocks of the Jalpaiguri district in West Bengal, India. The survey design was shaped by the previous literature on technology adoption in agriculture usage and as well as discussions with experts in the field, ensuring the reliability of the survey questions. The final survey was developed in English, and translated into Bengali so that the target audience could understand it. The questions were also pretested among a small group of farmers to make sure that they engaged in the relevant cultural context. The survey was conducted in person by the researchers during the period of October to December 2020. For the analysis of the data collected, descriptive statistics were used on the quantitative data while the qualitative data were analysed using thematic analysis.

VI. Results and Discussion

6.1. Demographic Profile of the Respondents

Table 2: Demographic Profile of the respondents.

Characterises		Responses	Percentage (%)
Gender	Male	315	79.17
	Female	83	20.83
Age	Below 30	90	22.5
	31-50	191	47.9
	41 and above	117	29.5
Education	Illiterate	40	10
	Primary	201	50.5
	Secondary	93	23.3
	Graduate	64	16.08
Landholding size	Small	260	65.4
	Medium	113	28.3
	Large	25	6.2

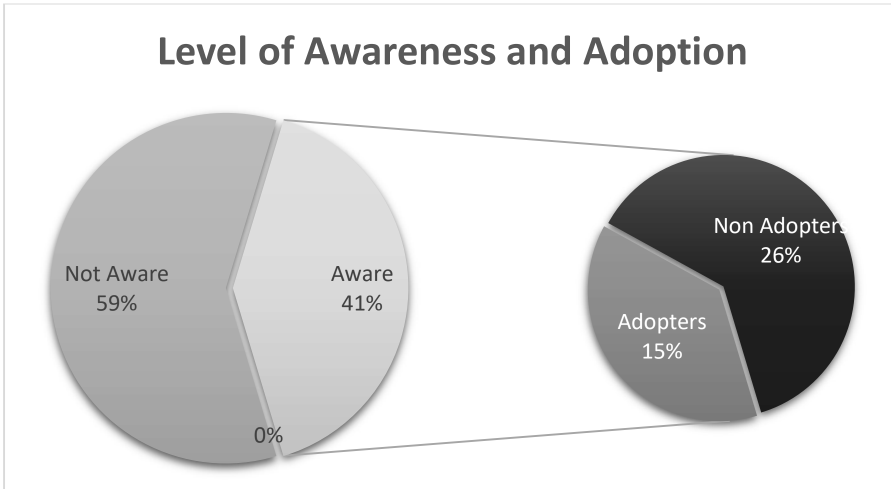
Source: Author's calculation.

The majority of farmers constituting the sample are male farmers (79.17%) an imbalance which may be attributed to gender roles largely embedded within Indian farming culture. The sample has a smaller female proportion (20.83%) of the respondents which is consistent with the socio-cultural context of Jalpaiguri district. The respondents exhibiting the highest participation were in the age bracket of 31 to 50 years which brings the respondents comprising about 47.9% of the sample. With regard to the educational level of the respondents a number of limitations can be pointed out within the sample population. The majority of the farmers (62.0%) have primary education, 23.3% are secondary graduates and only 4.6% have a tertiary level of education. 10.0% of the respondents have no formal education. Such a high percentage of uneducated farmers is likely to influence the level of Agtech presented to the farmers, as farmers are likely not capable of comprehending the technology that is being presented to them. Concerning the size of landholding, the data indicates that a high percentage of respondents 65.4% were small-scale farmers who had less than 2 hectares of land.

6.2. Awareness and Use of Agtech Solutions

The research aimed to examine both the awareness and actual usage of Agtech solutions by the farmers in the Jalpaiguri district. Awareness in the context of these studies simply means whether they have heard about the existence of such a service. In order to evaluate the level of awareness and adoption of Agtech solutions, farmers were shown a list of Agtech startups operating in the market. The aim was to simply assess the level of exposure of the farmers to these innovations as well as to find out if the farmers had ever utilized any of the services or the applications. Farmers who recalled at least one type of an application and its brand name were said to have awareness, while those who had ever used any of the mentioned companies were classified as adopters.

Figure 3: Awareness and use of Agtech by farmers



Source: Author's calculation.

Out of the total 398 respondents, 40.8 % of the respondents were aware of Agtech solutions, while 59.2% did not have knowledge of these types of technologies. This implies that although some of the farmers have exposure to Agtech solutions, a considerable section of the farming population is still uninformed. With regards to the sources emanating information about Agtech. Digital Platforms (e.g. YouTube, Facebook, etc) were cited by most of the farmers followed by their peer groups. This underscores the growing importance of internet-based services in the sourcing of agricultural knowledge. Nevertheless, the quite low dependence on agricultural institutions and NGOs suggests that there are missed opportunities for the institutional and community networks.

Table 3: Sources through which respondents learned about Agtech solutions.

Source of Information	Percentage of Respondents
Agricultural Institutions	8%
Peer farmers	23%
Digital platforms (e.g., YouTube)	59%
NGOs	7%
Other	3%

Source: Author's calculation.

The adoption rates of the Agtech solutions were however rather low. Only 15% of the respondents reported having used any Agtech solutions. There exists the issue of penetration level i.e. the existence of interrelated factors preventing farmers from adopting the technologies that are most likely readily to be accessible out there. The table below shows the types of Agtech apps that the farmer uses.

Table 4: Agtech Startup Categories and Adoption Rates

Agtech Startup Categories	Percentage
Downstream output marketplace model	81
Farming as a service	64
Upstream input marketplace model	57
Agricultural Mechanization and Equipment	42
Agri Fintech	37

Source: Author's calculation.

Among the major categories of Agtech in the Indian market, marketplace model categories were the most popular, with 81 per cent of the adopters indicating that they used Downstream output marketplace model apps while 57% of them mentioned the use of Upstream input marketplace model, since it gave them better access to the market as well as enhanced prices. For instance, a farmer noted: "*I used a marketplace app and managed to sell directly my produce at better prices instead of dealing with middlemen*." Startups from the Farming as a Service (FaaS) category were used by 64% as it enabled a farmer to incur less initial expenditure on the acquisition of machinery and specialised services. Cost-effectiveness and ease of doing business emerged as major factors enhancing the use of FAAS services. This inference emerged from follow-up qualitative responses, when a good proportion of adopters noted that purchasing Agricultural tools and implements were quite expensive and deleterious to their farming operations. One respondent mentioned: "*I am not able to purchase this costly equipment but the renting option available on the app gave me options to use that equipment without spending much".*

Categories such as 'Agri Fintech' and 'Agricultural Mechanization' on the other hand posted low adoption levels of merely 37 and 42 per cent of other adopters' respectively. Digital barriers like lack of internet infrastructure, low levels of education, and fear of online transactions were overwhelmingly mentioned in the open-ended responses. As one farmer stated: "*I am not comfortable with using the financial apps because I have never used them before and there is no one to direct me where to go*."

The qualitative feedback from the farmers has been synthesized collectively in order to comprehend the incentives for farmers. Analysis brought to light four interrelated reasons that drove their adoption:

i. **Improved Efficiency**: Farmers often mentioned that the use of services from Agtechs reduced their time and labour, especially when they employed mechanized and automated systems. A lot of people noted this as a key advantage, linking it to higher efficiency levels.

ii. **Better Market Access**: Farmers were most positive about the downstream marketplace model since it allows them to directly connect with buyers. This is also supported by some of the quantitative data noting that 81% of the adopters preferred this model.

iii. **Cost Reduction**: Farmers pointed out the role of technologies such as smart irrigation and the availability of rented machines through FaaS in reducing operational expenditures. They stated that such services helped them better invest resources in essential activities like pest management and crop diversification.

iv. **Risk Mitigation**: Applications providing services using big data and IoT monitoring tools were mentioned as useful in dealing with high levels of uncertainty due to climate variability.

The benefits perceived by farmers who adopted Agtech solutions closely align with these primary motivators. Most respondents rated the potential benefits of Agtech as high, with more than seventy-five per cent assigning four or five on the 5-point Likert scale. These respondents mostly associated Agtech with:

i. **Higher Yields**: Farmers' productivity improved as a result of improved pest management, effective water use, and efficient management of the farm courtesy of Agtech applications.

ii. **Cost Savings**: Both adopters and non-adopters of Agtech expressed a belief in the potential of Agtech to reduce input costs in areas like irrigation and fertilization.

iii. **Market Integration**: Direct selling platforms were acknowledged as tools to reduce dependency on intermediaries, ensuring better prices for produce.

Despite the potential benefits associated with Agtech solutions, the low adoption rates highlight several barriers hindering their adoption among farmers. The next section discusses the barriers to its adoption.

6.3. Barriers to Adoption of Agtech Solutions

To analyse the factors that contribute to the slow uptake of Agtech, responses were taken from only those respondents who indicated that they did not adopt any Agtech solutions. To gain an understanding of such barriers, an open-ended question was used, thus allowing farmers to express the barriers they experienced in detail. The qualitative responses were synthesised and organized into six principal themes which were subsequently analyzed for a deeper understanding of the factors that impede the adoption of Agtech in Jalpaiguri district. These barriers include lack of awareness, lack of technical knowledge, poor infrastructure, trust issues, lack of perceived benefit, and perceived irrelevance. The frequency of their mentions is provided in the subsequent table which is evidence of the myriads of problems faced by farmers in the region.

Table 5: Barriers to Agtech Adoption

Barriers	Percentage (%)
Lack of Awareness	78.4
Lack of technical knowledge	67.9
Perceived irrelevance	54.3
Lack of Perceived Benefit	44.9
Trust Issues	42.1
Poor infrastructure	32.1

Source: Author's calculation.

According to the table above, the largest share of respondents pointed out barriers linked to awareness and knowledge of Agtech solutions, at 72%, followed by the low level of technical knowledge regarding the use of such services as tools at 67.9%, and the perceived irrelevancy that Agtech solutions are tailored for larger farms and may not respond to the needs of smallholder farmers at 54.3%. About 44.9% of farmers expressed their uncertainty about the perceived benefit of Agtech, as to how it would translate into increases in yields or profitability. Other barriers involved were a lack of trust in these new innovations (42.1%)and the absence or poor infrastructure necessary to support the uptake of digital technologies 32.1%.

Qualitative feedback further elucidated these barriers. Farmers frequently mentioned the lack of information about Agtech solutions. For instance, one of the participants reported *"We are not aware of how these tools are used and whether they would be relevant to our type of crops."* Another farmer also affirmed, *"Yes, we need to be trained on how to use these technologies effectively."*

Several respondents expressed skepticism about the relevancy and adaptability of Agtech solutions, with one farmer commenting, *"These services may probably work elsewhere for the large landholders, but whether they will be feasible for most of us with small farm size, I don't know."* Concerns were also raised on the issue of the digital divide, especially the lack of technical know-how such as the inability to use some devices such as a smartphone, which is a common limitation among the farmers and limits the functionality of many Agtech tools.

Farmers also identified contextual barriers linked to their farming goals and priorities. For instance, some respondents expressed that Agtech adoption might interfere with traditional farming practices or even existing workflows. As one farmer put it, *"We've been using the same methods for generations; it seems risky and senseless to use new tools."* Some farmers also emphasized significant barriers associated with trust and perceived utility. For example, farmers who had never employed Agtech solutions were hesitant about any effectiveness. As one farmer said after putting it up quite simply, *"What guarantee is there that these technologies can actually perform as intended?"*

These findings suggest that a combination of barriers, which are contextual and informational or systemic, contributes to the low adoption of Agtech solutions in Jalpaiguri. In order to overcome these constraints, specific measures must be undertaken in the form of awareness campaigns through demonstration projects, financial incentives or subsidies, and appropriate solutions for smallholder farmers. Similarly, expanding efforts to enhance rural connectivity and ensuring access to technical assistance will assist in promoting greater levels of trust in line with the effective acceptance of Agtech innovation.

VII. Conclusion and Recommendations

Agtech provides significant opportunities to address the challenges of food insecurity at a global level while improving the productivity and sustainability of the Indian agricultural sector. This study on Agtech explores the awareness and adoption of Agtech solutions among farmers in the Jalpaiguri district of West Bengal, focusing on the drivers, barriers, and perceived benefits of Agtech. Employing a mixed method approach, with data collected from 398 respondent farmers using a random sampling technique, the study reveals the level of awareness among farmers regarding Agtech is generally low and digital platforms emerged as a major source of awareness about such services. The adoption rate of Agtech is significantly lower with only 15.3% of the respondents reporting having implemented Agtech practices on their farms. Among the categories of Agtech apps available to the farmers, most farmers use the marketplace model apps reflecting farmers' desire for better market access and price realization. Qualitative analysis of the responses revealed that improved efficiency, better Market Access, cost Reduction, and risk mitigation emerged are key factors driving the adoption of Agtech in the study area. Several barriers have also emerged from this analysis, with farmers citing lack of awareness as the most significant barrier, followed by technical knowledge, perceived irrelevance, and others.

Thus, the study recommends that in order to tap fully into the potential of Agtech in India, there is a need to adopt a collaborative approach targeting multiple stakeholders. All players including educational institutions, investors, government agencies and the Agtech startups themselves need to work together to overcome the barriers. To address the most cited factor which is lack of awareness, large-scale awareness campaigns focusing on educating farmers about the availability and benefits of Agtech solutions must be set up. This could utilise digital platforms like social media and YouTube, which have already shown high potential as sources of awareness. At the same time, there should be technical skills training that should be offered, which incorporate agricultural officers, NGOs, and fellow farmers in practical settings. Transparency in the technology's performance should be ensured, while peer-to-peer learning and community-level success stories can help build credibility. Finally, Agtech solutions need to be developed specifically for local farmers by looking at parameters such as climate, crop types, and farming practices and then seeking input from farmers on how best to improve these solutions through feedback mechanisms that are set in place. By tackling these interrelated problems, progress in Agtech adoption can be significantly scaled up and thus be able to shift the region towards efficient and sustainable agricultural practices.

In order for Agtech startups to succeed, they must have access to finance and human capital. Ongoing improvement and expansion in the sector however require a focus on venture capitalists, angel investors, and government funding to achieve growth. Equally significant is the availability of such human resources when needed and such development will come through employing appropriate training and education strategies. By addressing these barriers and capitalizing on the opportunities in the sector, India's Agtech industry has the potential to meet the increasing demand for food and promote national economic growth.

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