The Role of Data-Driven Agritech Startups—The Case of India and Japan

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Abstract: Global climate change poses many threats, with significant consequences for crop productivity and food security. The agricultural sectors in India and Japan face multiple problems, such as pre-harvest problems (volatility in input prices), post-harvest and supply chain issues in India, and labor shortages, the aging workforce, and the increase in the food self-sufficiency ratio, among others, in Japan. Farming practices and productivity can be improved by employing data-driven insights. This study was primarily conducted using secondary data collection and a literature review to comprehend the current state of data-driven agriculture in India and Japan, including analysis of supporting government policies and patent trends. The same context was further explored by conducting semi-structured interviews with key persons from data-driven agritech startups (capabilities, value proposition, etc.) in India and Japan. The results show that the driving forces of agritech adoption are sustainability, evolving business models, regulations, and macroeconomic conditions. On the one hand, India’s agriculture ecosystem is facing volatility in input prices, inefficient supply chains, low access to technology, limited access to finance, and the lack of dependable agricultural information, while Japan is tackling an aging farming workforce, high production costs, and the need for technological innovation. The findings show that by leveraging bilateral collaboration, agritech startups from India and Japan can mutually benefit from driving innovations in the agritech space as India could maximize its digital potential by leveraging Japan’s digital prowess, and Japan could expand its market base and reap benefits from the enormous agritech potential India.

Keywords: agritech; India–Japan relationship; digitalization; sustainability; data-driven farming

1. Introduction

The United Nations Sustainable Development Goals (UN SDGs) highlight unsustainable practices in global food production systems. They emphasize the urgency to transform food systems to become more nutritious, sufficient, affordable, and environmentally sustainable [1]. Furthermore, as stated by the UN SDGs, the critical objective is food security, which is to be addressed by deploying innovative technological solutions.

Technological innovation plays a vital role in transforming every economic sector. Amongst various sectors, agriculture has not kept pace with innovation and is the least digitized sector [2]. The growing demand for technological innovation in the agricultural sector is due to a multi-faceted problem, such as the rapidly growing global population, impacts of climate change, labor shortages, evolving consumer demand, food waste, farm efficiency and profitability, opaque supply chains, distribution inefficiencies, food safety and traceability, restrictions in the utilization of natural resources, and increasing health problems. It is anticipated that agrifood tech could be a solution to many of these problems [3].

In this context, we explore the evolution of agricultural technology and its conceptualization, as shown in Figure 1. Agricultural technology has been consistently evolving since time immemorial. The initial focus for deploying technology, such as using machinery and
tools in agriculture, was to increase productivity. However, with time passing, the type of technology (IoT, sensors, robotics, and data analytics) and the context for using it for agriculture has evolved, for instance, to improve economic efficiency. Recently, the definition of agritech emphasizes environmental sustainability and climate-resilient solutions. Agriculture 4.0 was framed as analogous to Industry 4.0, which signifies digital agricultural transformation [4]. With the onset of information and communication technology, agricultural technology (agritech) started encompassing precision agriculture and data-driven decision-making. Agritech can be defined in today’s agricultural context (Agriculture 4.0) as the use of data-driven smart technologies, analytical methods, drones, robotics, the Internet of Things (IoT), vertical farms, artificial intelligence (AI), and solar energy for enhancing farming practices, operations, and decision-making to achieve the agricultural field’s economic efficiency and environmental sustainability in multiple forms and ways. It is strongly associated with the use of AI applications [5–9]. Therefore, technologies that promote environmental sustainability, resource conservation, and climate resilience are becoming the focus of companies that develop them [10].

![Figure 1. Evolution of Agriculture 4.0 and its conceptualization. Source: By authors.](image)

Amongst many other agricultural technology suppliers, startups have risen to address the need of the hour by providing data-driven farming products and services through their agile and innovative approaches. Numerous studies have explored the positive impacts of data-driven farming, especially regarding the potential of agri-startups, but to the best of our knowledge, cross-country collaboration studies that provide a unique opportunity for accelerating agritech innovation have not been conducted [11,12]. We argue that such a study on cross-country agritech collaboration efforts is vital to creating a more sustainable global food system. Hence, the aim of this study on “data-driven agritech startups from India and Japan” was to analyze and evaluate the scope and potential of data-driven agritech startups in India and Japan to attain food security in these regions and the world in general.

The scope for collaboration between India and Japan’s data-driven agritech startups lies in the following facts:

1. India’s growing agritech market potential encompasses a three-layer structure for government, business, and consumers. As well as the slow and steadfast growth of Japanese companies such as Sagri Co. Ltd. (Tamba, Japan) in Himachal Pradesh, innumerable upcoming Indian agritech startups are extending indigenous partnerships and thereby facilitating the reach of local farmers with trust and confidence [13].

2. Japan’s agricultural production costs are high, and developments in agritech could ease or alleviate them. With a dwindling and aging workforce, agrotech collaboration can make agriculture more appealing to younger generations.

The collaboration can aim at equal and adequate access to information among farmers and within markets, thereby reducing transaction costs. Data-driven agritech startup collaboration between both countries can ultimately realize economic efficiency, equity, and environmental sustainability, thereby promoting inclusive growth in agriculture in both countries. However, the coexisting digital divide and better data governance must be suitably addressed [14].

Against this background, the paper aims to address the following research questions:
1. What are the core agricultural issues in India and Japan?
2. What are the potentials of India and Japan agritech collaboration?
3. How will the data-driven agritech startup ecosystems in India and Japan reshape the agricultural landscape?
4. What are the strengths, opportunities, and challenges in the India and Japan agritech startup ecosystems?

After thoroughly studying each geography’s potential and challenges, we highlight suggestions for facilitating and enhancing bilateral collaboration in the agricultural sector through joint ventures of agritech startups from India and Japan.

The paper is organized as follows. To clarify the interest in data-driven agritech startups, concepts related to agritech categories, drivers of agritech, and the significance of data-driven farming are elaborated (Section 2). The study’s methodology is outlined in Section 3. The primary analysis and results are summarized in Section 4. For Section 5, relevant stakeholders were interviewed to validate the study findings, and a discussion was formulated based on the same. The paper ends with conclusions and recommendations to enhance agritech startup collaboration between India and Japan.

2. Literature Study

2.1. Deciphering Agritech and Agrifood Tech

Agricultural technology is referred to as agritech and is famously defined as integrating digital technology into farming practices; producers can increase yields, reduce costs, experience less crop damage, and minimize water, fuel, and fertilizer usage [9]. For the consumer, this equals affordable and better-quality food. Disruptive technologies like artificial intelligence, the Internet of Things (IoT), sensors, big data analytics, and machine learning (ML) have enormous potential to revolutionize the agricultural field [15,16]. In the study [17], agritech is classified broadly into three types: physical agritech application, cyber agritech application, and cyber-physical applications.

i. Physical agritech application: Disruptive technologies replace human labor and include agritech hardware, which is synonymous with machinery and tools for agricultural tasks.

ii. Cyber agritech applications: These are related to platform software and are synonymous with data analytics and decision support systems for performing agricultural tasks.

iii. Cyber-physical agritech applications: These combine the above two application types. These are the smart agricultural machinery or robotics, including hardware and software for data analysis, predictive/prescriptive tailored decision-making, advice, and recommendations [18].

Agritech refers to using technology in crop production, livestock management, farm machinery, and precision agricultural techniques. In comparison, agrifood tech refers to the application of technology in food production, food processing, food supply chains, and food safety. Agritech is a broad definition and encompasses agrifood tech within it, spanning the length and breadth of the agricultural sector [3]. Agritech and agrifood tech have been interchangeably used. The two disciplines are interconnected and collaborate to support innovation for efficiency, sustainability, and resilience in the agriculture and food industries.

On the other hand, the agrifood tech solution is classified under 14 categories, as mentioned in Figure 2 [3]. In this figure, the initial stages of the agricultural supply chains are called upstream, and the latter stages, which encompass the process of sending agricultural products from production to end-use customers, are named downstream. The movement from upstream to downstream reflects the movement across agricultural supply chains.
What farmers increasingly need in recent times is agricultural information and knowledge. Local weather and climate data can very much help farmers towards better decision-making. The technologies have been called big data networking technologies that provide invaluable data that can be translated as advisors and help farmers in their decision-making process. The movement from upstream to downstream with different types of agrifood tech companies suggests that technology has been deeply embedded into agricultural supply chains.

2.2. Data-Driven Farming—the Need of the Hour and Its Significance

The use of data in agriculture has been inevitable for a long time. The two broad categories of agricultural data are machine data and agronomic data. Machine data include GPS location and speed, diagnostic codes, fuel use, and engine information. In contrast, agronomic data include moisture levels, harvest time, grain temperature and crop type, planting, and fertilizing target.

Currently, a combination of sensors (hardware), algorithms (software), and networking technologies provide invaluable data that can be translated as advisors and help farmers in their decision-making process. The technologies have been called big data in agriculture, digital farming, precision agriculture, and data-driven farming. All these terminologies refer to the use of quantitative data and statistical analysis guided by computers to make data-driven decision-making in farming. In data-driven farming, data are obtained from devices such as sensors, cameras, and Internet of Things (IoT)-enabled farm equipment, and also from farmers, farm workers, and other online services such as weather forecasts.

Referring to Figure 2, which shows the upstream agrifood tech classification from the Agfunders framework, data-driven farming falls under the second category: Farm Management Software, Sensing, and IoT. This can be called ag data capturing devices, decision support software, and big data analytics. For consistency in this study we will refer to such technology as data-driven agritech.

From farmers’ perspectives, the important thing is profitability, improving efficiency in farming, reducing costs, and receiving better prices for their products. All these factors necessitate better and optimal decision-making by farmers, which is constrained by a lack of dependable agricultural information. In the past, agricultural advisory services were provided based on lab research, which recently does not seem to be contextual or relevant. What farmers increasingly need in recent times is agricultural information and knowledge that is generated on farms and is in a locale-specific context. It has been anticipated that data-driven farming can significantly help to achieve these goals.

For example, agriculture is primarily influenced by varying climate conditions and weather. Local weather and climate data can very much help farmers towards better decision-making. The information and data evolution of agriculture, accompanied by...
artificial intelligence techniques, act as an enabler in catering to the information needs of the farmer by deploying one or more agricultural technologies such as precision agriculture, multi-source data, sensors, satellite images, and weather tracking. Thereby, data-driven farming employs quantitative data and computer-enabled statistical analysis to guide farmers’ decision-making process.

Data-driven farming has become widely applicable to both large- and small-scale farms. It enhances the value at different stages of the agricultural value chain and to different agricultural stakeholders (farmers, consumers, and society) [24]. For example, farmers cultivating maize in Cordoba, Colombia, employed data-driven farming incorporating information from their own experiences and from other sources to make improved crop management decisions [25]. Additionally, data, data-driven mobile phone-based digital extension services, and price information subsystems are being used by farmers in India and sub-Saharan Africa [26].

2.3. Who Drives Agricultural Technology?

Birner et al., 2021 [27] specifies five types of agricultural technology supplying firms that focus on developing and marketing digital agricultural technologies and services, as mentioned in Figure 3. Although academic institutions, organizations, and others drive agricultural technology, the firms below are the major developers and suppliers of agricultural technology:

<table>
<thead>
<tr>
<th>1. large multinational agricultural input companies</th>
<th>seeds, fertilizers, plant protection, products (pesticides), &amp; agricultural machinery</th>
<th>build own, buy s/w h/w companies, marketing existing dealers</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. large multinational software and big-data companies</td>
<td>IBM, Microsoft, SAP, TCS, Tencent &amp; Alibaba</td>
<td></td>
</tr>
<tr>
<td>3. nonagricultural “hardware” companies</td>
<td>Bosch</td>
<td>hydraulic systems for tractors, sensors &amp; s/w for precision agriculture</td>
</tr>
<tr>
<td>4. start-up companies</td>
<td>entrepreneurs, IT firms &amp; input companies( spin off), universities</td>
<td></td>
</tr>
<tr>
<td>5. agricultural processing and trading companies</td>
<td>provides information &amp; inputs to increase farm productivity</td>
<td></td>
</tr>
</tbody>
</table>

Figure 3. Agritech suppliers. By authors, from source: [27]. Red box denotes that the study focuses on the category of 4. start-up companies.

i. Large multinational agricultural input companies: These companies are suppliers of seeds, fertilizers, agricultural machinery, and pesticides. They mostly build digital agricultural services internally and outsource the development of small software or hardware to external companies. They market their existing digital agricultural technologies and services through their existing network of dealers.

ii. Large multinational software and big-data companies: These are companies like TCS in India, Alibaba in China, and Microsoft and IBM in the USA that are investing in digital agricultural technologies.
iii. Nonagricultural “hardware” companies: Some companies like Bosch, which initially provided hydraulic systems for tractors, now provide sensors and software for precision agriculture.

iv. Startup companies: These are the origins for providing the most creative digital agricultural technologies. The startups are established by independent entrepreneurs or financed by venture capitalists or multinational input and tech firms.

v. Agricultural processing and trading companies: These companies provide inputs and information to improve farm productivity and the quality of products that farmers sell to them.

Amongst the other agritech supplying firms, innovative and agile ways startups are equipped to design data-driven farming products and services make them unique and interesting for our study.

2.4. What Do Data-Driven Agritech Startups Do?

Data-driven farming startups have a broad range of operations in nature. The startups may fall under one of these categories or overlap:

- Sensors and analytics, sensors for plants and wearables for animals to collect data and analytics for interpreting and visualizing the collected data; farm management software, a platform that helps interpret and visualize manual data from farmers or other imported services; aerial imagery and analytics, which provide aerial images from camera-equipped drones, and an analytical platform to interpret and visualize data; robotics and analytics, automating identified farm labor through robots and analytics platform; data sharing network, provides a platform to share data and access other farms data for farmers; food tracing, provides scannable labels for fresh produce and logistical information for farmers and food chain transparency for consumers; mobile voice interaction service, converts recorded voice into structured data, streamlining note-taking in the field.

3. Methodology

The methodology adopted for this study was a combination of a scoping literature review and a field study through interviews with agricultural startups’ representatives. This mixed-methods approach was chosen to provide a holistic understanding of the data-driven agritech startup ecosystem in India and Japan through both secondary and primary lenses. In the scoping literature review, this study critically reviewed the literature on agritech startups to answer the four main research questions as discussed in Section 1. The aim of the field study, with the employment of interviews, was to obtain insights into the performance of agritech startups as well as the opportunities for the relationship between agritech startups in the two countries.

A scoping review: Our analysis was guided by Arksey and O’Malley’s five-stage framework [28], including identifying research questions associated with agritech startups’ data-driven decision-making, identifying relevant studies, study selection, charting the data, summarizing, and reporting the results. In response to the previously outlined research questions, this study employed a multifaceted analytical approach. The primary objective was to evaluate the extent and possibilities of bilateral agritech collaborations among startups between India and Japan through the collection of secondary data from credible sources and the undertaking of comprehensive literature assessments.

Patent trend analysis: Patents are an essential parameter of innovation activity. To understand the innovation quotient of agriTech across the globe, as well as in India and Japan, we conducted a patent search. The search was conducted in the patent search database Questel Orbit using a number of keywords to depict various technology usages for precision agriculture and farm management. These keywords include geospatial or weather data, IoT, sensors, robotics, drones, big data analytics, and blockchain. Granted patents and published patent applications for the last ten years (2013–2022) were searched, and a patent publication trend graph was drawn to understand the thrust of innovation in AgriTech.
Field study through interviews: Expanding upon the findings of the preliminary investigation, a field study was devised to obtain a direct comprehension of agritech startups utilising data-driven approaches in both India and Japan. The research methodology employed in this study entailed the utilization of structured interviews with representatives from four carefully chosen startups, with the aim of achieving a well-rounded representation from both nations. Startups were selected based on the purposive sampling method, which refers to a method that allows the authors to judge samples and to decide which samples should be included based on the authors’ knowledge of the study as well as startups. Since this study just focused on agricultural startups, survival firms with a wide-ranging business portfolio were selected. Therefore, samples could represent the population while allowing the authors to investigate insights into the role of data-driven decision-making in diversified business startups in two countries. The interviews were structured to include 10 open-ended questions that were carefully formulated to obtain complete insights on their business models, technological adoption, and operational enablers.

Acknowledging the worldwide scope of the research and the difficulties posed by time zones and logistical considerations, respondents were provided with the opportunity to submit their responses using email or online platforms, with a focus on accommodating their convenience.

Combined discussion of analysis: After the interviews, the collected data underwent a detailed analytical process. A thematic analysis approach was employed, where responses were systematically coded and grouped to identify recurring patterns and central themes. This method ensured a deep and grounded interpretation of the participants’ experiences, enhancing the study’s validity [29]. Subsequently, findings from both the scoping review and interviews were integrated, providing a comprehensive perspective on the subject.

The research design process is illustrated in the diagram below for clarity (Figure 4).

4. Analysis and Results

The global trends shaping agricultural technology adoption are the consumer focus on sustainability, evolving business models, regulations, and macroeconomic conditions. There has been considerable growth in the agricultural food tech industry. In 2021, the agricultural food tech industry received USD 18.2 billion, experiencing 38% year-on-year growth since 2013. These play out as push factors for the increasing trend of agritech startups.
growth since 2013. These play out as push factors for the increasing trend of agritech startups. The number of farmers facing agritech startups has also been on the rise [19].

Disruptive innovation can lead to restructuring the agricultural value-creation process. The emergence of new players and startups reinforces this. Startups with teams of young innovators develop most agro-technology solutions. The agro-technological innovations of new players create new value and take a share of their business and investors [30].

Startups are at the center of the action, offering solutions across the value chain, from infrastructure and sensors to software that manages the numerous data streams across the farm, while corporates engage in big data and agriculture. Many small tech startups are entering the agritech market and competing with larger players by launching products as the market heats up.

Startups have the potential to offer a set of technological innovations enabling the growth of agriculture. Their business model is also relatively easier to progress and scale. Additionally, they open opportunities and work for other technological sectors. For example, drone institutions operating in the agricultural sector realize various procedures, and provide better resolutions and accurate data compared to satellites, or supply pesticides and other chemicals to help achieve a good harvest [31].

Agritech startups synonymously working with big data and IoT imply greater control in the monitoring and automation of crops. This, in turn, results in higher crop productivity and serves as an opportunity for constant growth. The capability of agritech startups is not restricted to steering crop yield but also has the potential to create balance in economic, social efficiency, and environmental issues and increase productivity growth in the agricultural sector.

The patenting trend suggests steady and continuous growth in patenting in the agritech domain for the last 10 years. A total of 24,353 inventions were recorded during this duration. China dominated the race with 70% of the patent filings, whereas India ranked third with 4%. Japan contributes 1% of the patent filings in this domain (Figure 5 and Table 1).

![Patenting Trend for AgriTech Innovations (2013-2022)](image-url)

**Figure 5.** Patenting trend. Trend of granted and applied-for patents across the globe (2013–2022). Sourced from Questel Orbit and organized by authors.
Table 1. Publication trend of granted and applied-for patents across India and Japan (2013–2022). Sourced from Questel Orbit and organized by authors.

<table>
<thead>
<tr>
<th>Country</th>
<th>No. of Patents Originating (in %)</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>70</td>
</tr>
<tr>
<td>United States</td>
<td>6</td>
</tr>
<tr>
<td>India</td>
<td>4</td>
</tr>
<tr>
<td>South Korea</td>
<td>3</td>
</tr>
<tr>
<td>Russia</td>
<td>3</td>
</tr>
<tr>
<td>Germany</td>
<td>3</td>
</tr>
<tr>
<td>Japan</td>
<td>1</td>
</tr>
<tr>
<td>European Union</td>
<td>1</td>
</tr>
<tr>
<td>Others</td>
<td>4</td>
</tr>
</tbody>
</table>

This comparative analysis clearly states that India’s contribution to the Internet of Things and data analytics is very high. In contrast, Japan is not very active in using data analytics, robotics, or blockchain to improve their agricultural activity. Unmanned aerial vehicles and sensors are the areas where India and Japan are actively working, though India is dominating this space with three-quarters of the total India–Japan filings. Geospatial technology for agricultural purposes is a new phenomenon, and both countries have started exploring this space (Figures 6 and 7).
Agricultural issues in India:

The agricultural issues across the value chain in India are pre-harvest problems such as volatility in input prices, sub-optimal input selection, affordability from sowing to harvesting and storing; post-harvest or supply chain issues such as a low realization rate for farmers, high procurement cost for retailers (intermediaries), poor transportation and storage services, unorganized and fragmented agricultural markets; failure in crop yield, soil productivity and access to agricultural input on time due to limited access to technology; limited access to finance and unserved credit needs; and lack of agri-data, small farm holdings, and low penetration of the FPO model [32,33]. The primary challenge for farmers and other agricultural value chain stakeholders is the lack of sufficient agricultural information. Agricultural information can be categorized as demand-specific and supply-specific, of which the first category, i.e., the demand for the agricultural produce, is comprehensible. The second category, i.e., data regarding what other farmers are producing, what is selling in the market, and accessibility and availability of the cold chain, is not trustworthy as a result and is hard to decipher [34].

Agricultural issues in Japan:

The key agricultural issue existing in Japan is farmers’ aging. This factor restricts the implementation of new agritech solutions as farmers are faced with digital illiteracy as a significant barrier. Additionally, Japanese youth do not consider agriculture as an lucrative occupation because it is laborious or provides a low income. The situation is further aggravated by recent extreme climatic conditions affecting agricultural production. High production costs, especially of machinery, inhibit Japanese agriculture, where farmers mostly own small-scale farms [35].

RQ 2: What are the potentials of India and Japan agritech collaboration?

This section discusses how the two geographies of India and Japan are similar, and have potential, and are interesting in terms of an agritech bilateral collaboration.

The various agritech collaborations between India and Japan include the following: the Act East forum, which was established in 2017 to develop the north-eastern region of India where capacity enhancement for sustainable agriculture and irrigation development in Mizoram was pursued; The Ministry of Agriculture, Forestry, and Fisheries (MAFF), Japan, with the support of 16 Japanese companies technology, products, and services; SEWA (self-employed women’s association), which manages the J-method farming at Anand,
Gujarat, and has grown delicious and quality tomatoes and cabbages; and a Japanese startup, Sagri Co., Ltd., in association with JICA (Japan international cooperation agency), which has been engaged in India, as it was adopted in the first Japan–India startup hub promoted by JETRO(MEXT) in Bengaluru, India [36]. Sagri has helped Indian farmers improve productivity by visualizing farmland with satellite data, improving awareness among farmers through educational activities, and expanding future possibilities for local farmers [37].

The agricultural maturity matrix helps visualize the position of a country in terms of its agricultural ecosystem vs. digital capabilities. It can serve as a basic framework for analysing the possibility of the collaboration between Japanese and Indian agritech startups. In this matrix, the agritech maturity of a country is defined in terms of the size and significance of the agricultural industry, the sector’s contribution to the GDP of the economy, and the robustness of its digital economy. In the agritech maturity matrix below, India falls under explorers (agrarian economies adopting digital technology), and Japan falls under experimenters (strong digital backbone for growth). The implication for India is that the agricultural sector could realize the maximum growth potential through agritech investments; on the other hand, Japan has a high potential as it has advanced digital technology, but the agricultural market is relatively smaller, resulting in low market potential (Figure 8).

A bilateral collaboration between the two countries would be mutually beneficial to drive innovations in the agritech space as India could increase its digital potential by leveraging Japan’s digital prowess, and Japan could expand its market base and reap benefits from the huge agritech potential of India. Such agritech bilateral collaboration between the two countries can be helpful to exchange experiences and agricultural technologies.

RQ 3: How will data-driven agritech startup ecosystem in India and Japan reshape the agricultural landscape?

Data-driven agritech startups will be instrumental in guiding agricultural stakeholders, especially agritech startups from India and Japan, in comprehending the potential, uniqueness, and growth factors of the smart farming market in both geographies, thereby acting as a seed for possible bilateral collaboration and business expansion (i.e., Indian

Figure 8. Agricultural matrix map. source: [38].

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agritech startups to provide services in Japan, or vice versa). In Table 2, a comparative study of India and Japan’s agritech startup ecosystems further elaborates on this.

Table 2. A comparison of the agritech startup ecosystems in India and Japan. Agritech startup ecosystems in India and Japan—a comparison. Source: By authors.

<table>
<thead>
<tr>
<th>CATALYST</th>
<th>Agritech Startup Ecosystem in India</th>
<th>Agritech Startup Ecosystem in Japan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-harvest problems (volatility in input prices)</td>
<td><strong>Labor shortage and aging workforce</strong></td>
<td><strong>Labor shortage and aging workforce</strong></td>
</tr>
<tr>
<td>Post harvest and supply chain issues</td>
<td><strong>Improving the food self-sufficiency ratio</strong></td>
<td><strong>Improving the food self-sufficiency ratio</strong></td>
</tr>
<tr>
<td><strong>MARKET</strong></td>
<td><strong>Funding is small scale</strong></td>
<td><strong>Startups are having difficulty raising funds.</strong></td>
</tr>
<tr>
<td>The market potential and the investment landscape are more clearly defined in India</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Already significant funding.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A vast untapped market remaining</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TECHNOLOGY</th>
<th>Agritech Startup Ecosystem in India</th>
<th>Agritech Startup Ecosystem in Japan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mobile applications, data analytics</td>
<td><strong>Drones, robotics, and cutting-edge technologies (cloud, AI, sensors and big data)</strong></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>USE CASE (Major)</th>
<th>Agritech Startup Ecosystem in India</th>
<th>Agritech Startup Ecosystem in Japan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consumer-proximate or downstream supply chain solutions</td>
<td><strong>Management Procedures and Infrastructure</strong></td>
<td></td>
</tr>
<tr>
<td>Business support, productivity-driven</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>GAP AREA</th>
<th>Agritech Startup Ecosystem in India</th>
<th>Agritech Startup Ecosystem in Japan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-harvest services such as access to better inputs, agronomic advisory and precision technology advisory, and precision technologies</td>
<td><strong>Utilization of blockchain technology</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Fertilizer wastage, reduce machinery related cost</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Technology to alleviate high production costs</strong></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SYNERGY (India and Japan)</th>
<th>Agritech Startup Ecosystem in India</th>
<th>Agritech Startup Ecosystem in Japan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drone technology is receiving a large amount of attention in both Japan and India. Environmental solution and climate resilience agricultural opportunities could be explored for sustainability</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

RQ4: What are the strengths, opportunities, and challenges in the India and Japan agritech startup ecosystems?

Agritech startups in India:

A World Economic Forum report anticipates that India will be a leader in agritech sector by transforming agriculture in terms of production efficiency, sustainability, and inclusiveness through employing path-breaking innovations. Such technological agricultural transformations are expected to create many job opportunities for young people. The transformations will focus mainly on improving the well-being of small land-holding farmers and women [39].

Agritech startups in India are solving multiple problems across the agricultural value chain and undeniably revolutionizing the agricultural industry. Technological solutions have been leveraged as a vital tool by these agritech startups in solving issues related to the food supply chain [40]. The growth in the agritech space has increased through the number of startups appearing and the funding they have received within the last five years. There are more than 450 agritech startups in India, and the funding received by them has increased 25% year-on-year. The Indian agritech startup space is distinct. Karnataka, Maharashtra, and Delhi NCRs have become major hubs for agritech startups [41].

Precision agriculture and farm management (data-driven farming) fall under key market segments regarding future opportunities and the current funding state. At the same time, the other key areas recognized to have the potential to drive growth in the agritech sector are quality management and traceability, diversified solution providers, and financial services [38].

Towards the goal of doubling farmers’ income, the policies from the government of India towards enhancing agri-produce and other promotional opportunities have become an impetus for the growth and prospects of agri-startups in India in recent times.
In Figure 9 below, strengths, weaknesses, opportunities, and threats of Indian agritech startups are summarized. These startups have several strengths: good abilities to tap into new agricultural segments, agile and highly technology oriented, and flexible business models. However, these startups are mostly at the early stages of their business lifecycle, so they are sensitive to shocks, with a low degree of competitiveness. In terms of opportunities, Indian agritech startups have high demand for advanced farming techniques. They have also received significant supports from the government in terms of policies and finance and obtained benefits from technological advancement. Nonetheless, these startups have also faced fierce competition, especially from mature agritech companies. The fragmented agricultural systems in India also challenged these startups in creating direct links between farmers and consumers. Additionally, infrastructure issues in rural areas also posed several challenges to Indian agritech startups in terms of logistics and transportation.

![SWOT analysis of the agritech startup ecosystem in India](image)

**Figure 9.** SWOT analysis of the agritech startup ecosystem in India. Source: By authors.

**Agritech startups in Japan:**

Japanese agritech capabilities are very advanced, especially in using drones, robotics, AI, and ICT. These capabilities are backed by their legislation, structural reforms, and efficient infrastructure services. Land reforms have been meticulously implemented to cultivate barren lands or boost large-scale farming. The agricultural aggregator data platform (WAGRI), QZ satellite system, 5G, etc., boost digital growth in Japanese agriculture.

Drones and precision farming solutions are expected to grow exponentially in the coming years.

The Small Business Innovation Research Program in Japan caters to the needs, from providing technological support to commercialization. The SBIR system was allocated funds to be spent on startups, set with spending targets and uniform rules for public solicitation, thereby increasing the effectiveness of grants, and underwent a major reformed in 2021 [42].

The growth potential in the smart farming market in Japan is aided by the comprehensive plan from MAFF for smart agriculture technology and services [35].

**SWOT analysis of the agritech startup ecosystem in Japan:**

Figure 10 summarizes the strengths, weaknesses, opportunities, and threats of agritech startups in Japan. These firms mostly adopted cutting-edge technologies and were able to develop new business models that transformed the Japanese agricultural sector, such as rotational farming, farmland characteristics prediction, and automation using robots. Nevertheless, these firms have faced funding difficulties and high production costs because of the shortage of natural resources in Japan, as well as high labor costs. The success rate of these firms is also low.
Regarding opportunities, agritech startups in Japan have several opportunities for international collaborations with others. They have received significant support from the government regarding R&D and international relationships. Moreover, international demand for agricultural products from Japan is increasing, creating business opportunities for agritech startups in this country. Rapid technological advancement also helps these firms obtain opportunities. However, agritech startups in Japan are facing depopulation and aging. Therefore, they may lack human resources. The weak domestic market is also threatening the survival of several agritech startups, making the success rates low.

6. Interview Results

The below discussion is based on interviews with some of the data-driven agritech startups from India and Japan (Table 3).

Table 3. Summary of agritech startups. Source: By author’s interview with agritech startups.

<table>
<thead>
<tr>
<th>Startup</th>
<th>Country</th>
<th>Key Solution</th>
<th>Technology</th>
<th>Customer Segments</th>
<th>Challenges Faced by Respective Country’s Agriculture Community</th>
</tr>
</thead>
<tbody>
<tr>
<td>Terracemile</td>
<td>Japan</td>
<td>Digital Infrastructure for data interpretation</td>
<td>Data, Analytics</td>
<td>Agricultural equipment manufacturer, Agri corporation, agro cooperatives, government</td>
<td>Income structure and supply chain not adapted to environment, and production structure’s dependency on foreign countries</td>
</tr>
<tr>
<td>Tenchijin</td>
<td>Japan</td>
<td>Data based insights from satellite data and AI powered analysis</td>
<td>Satellite, Remote Sensing</td>
<td>Governments, Companies, Infrastructure management companies and Renewable Energy business</td>
<td>Shortage of successors due to an aging population and climate change</td>
</tr>
<tr>
<td>Farmonaut</td>
<td>India</td>
<td>Satellite based health monitoring and remote sensing</td>
<td>Satellite based sensing and tele-communication network</td>
<td>Farmers, agricultural consumer goods companies</td>
<td>Small land ownership, Climate change, Lack of awareness on solutions available</td>
</tr>
<tr>
<td>Satsure</td>
<td>India</td>
<td>Farm credit risk assessment, monitoring health and predicting crop yield through satellite data analysis</td>
<td>Satellite Remote Sensing, Machine Learning, Artificial</td>
<td>Banks, Financial institutions and government.</td>
<td>Access to market, access to timely and reasonable credit, and policy and schemes</td>
</tr>
</tbody>
</table>
6.1. Tenchijin (Japan)

Tenchijin created the “Tenchijin Compass”, which recommends the most suitable crop varieties and cultivation methods based on location. It also provides the ideal location for the crop variety that farmers want to grow. It deploys satellite analysis and AI analysis technology to generate data insights that help aging farmers make climate-smart decisions and practice automation that translates to making agriculture profitable [43].

6.2. Terracemile (Japan)

Terrace Mile leverages data and the ability to interpret data by providing digital infrastructure to large agricultural companies, local governments, agricultural cooperatives, farm managers, etc. The insights provide help to analyze actual performance, factors, and forecast trends in the agricultural value chain. They also provide education on data utilization. The company’s core competency is its in-depth knowledge of agricultural data management [44].

6.3. SATURE (India)

The startup SATSURE is in the fields of farm credit risk assessment, crop damage assessment, crop stress monitoring, and regional crop risk assessment. It leverages a combination of technologies such as satellite remote sensing, machine learning, and artificial intelligence. One of the startup’s challenges is improving the low insurance coverage and access to credit for agriculture-based businesses. Their solution is to remotely monitor large areas of crop health and accurately predict crop yield [45].

6.4. Farmonaut (India)

The startup Farmonaut aims to improve farming practices through satellite-based crop health monitoring and remote sensing data. Broadly, the challenge the startup is addressing is making satellite data accessible and adoptable at the grassroots level. The variety of services provided include crop health monitoring, crop area and yield estimation, and soil moisture and soil organic carbon calculation. Satellite technology and the 4G network drive the services for Farmonaut [46].

7. Conclusions

The role of data-driven agritech startups in the agricultural sector is of paramount importance in addressing various challenges and driving innovation in the context of India and Japan. These challenges include pre-harvest problems like input price volatility in India, and labor shortages, an aging workforce, and the need to improve food self-sufficiency in Japan. The integration of digital technology into farming practices through data-driven insights has the potential to enhance crop productivity, reduce costs, and improve environmental sustainability. Agritech startups are providing innovative solutions that harness the power of data, artificial intelligence, and other technologies to improve farming practices, decision-making, and overall economic efficiency. Data-driven agritech startups have a pivotal role to play in revolutionizing agriculture and addressing the challenges faced by the agricultural sectors in India and Japan.

In India, agritech startups are addressing a wide range of agricultural issues across the value chain. These issues include volatility in input prices, inefficient supply chains, low access to technology, limited access to finance, and the lack of dependable agricultural information. Data-driven farming is seen as a solution to these challenges, as it provides farmers with real-time data, weather forecasts, and other insights to make informed decisions. Japan, on the other hand, faces challenges related to an aging farming workforce, high production costs, and the need for technological innovation. Japanese agritech startups leverage advanced technologies such as drones, robotics, AI, and ICT to address these challenges and improve agricultural practices. The Japanese government has also been proactive in supporting smart agriculture technology and services.
Interview results of agritech startups from India and Japan were presented, showcasing their innovative solutions and the challenges they aim to address. These startups use technologies like satellite remote sensing, machine learning, artificial intelligence, and data analytics to provide services related to crop health monitoring, farm credit risk assessment, and more. There is immense potential for bilateral collaboration between India and Japan in the agritech sector. India can benefit from Japan’s digital prowess, while Japan can expand its market base and tap into India’s vast agritech potential. This collaboration can lead to knowledge sharing, technology transfer, and joint ventures, driving innovation in the agritech space. Collaboration between these two countries can lead to mutually beneficial outcomes, fostering innovation and sustainability in agriculture.

A bilateral collaboration between the two countries would be mutually beneficial to drive innovations in the agritech space, as India could maximize its digital potential by leveraging Japan’s digital prowess, and Japan could expand its market base and reap benefits from the huge agritech potential of India. Such a bilateral agritech collaboration between the two countries can be helpful in exchanging experiences and agricultural technologies.

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