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Revolutionizing the Agriculture Supply Chain in Bangladesh: Exploring the Prospects, Challenges, and Future of Implementing AI in the Agriculture Supply Chain of Bangladesh

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Abstract:

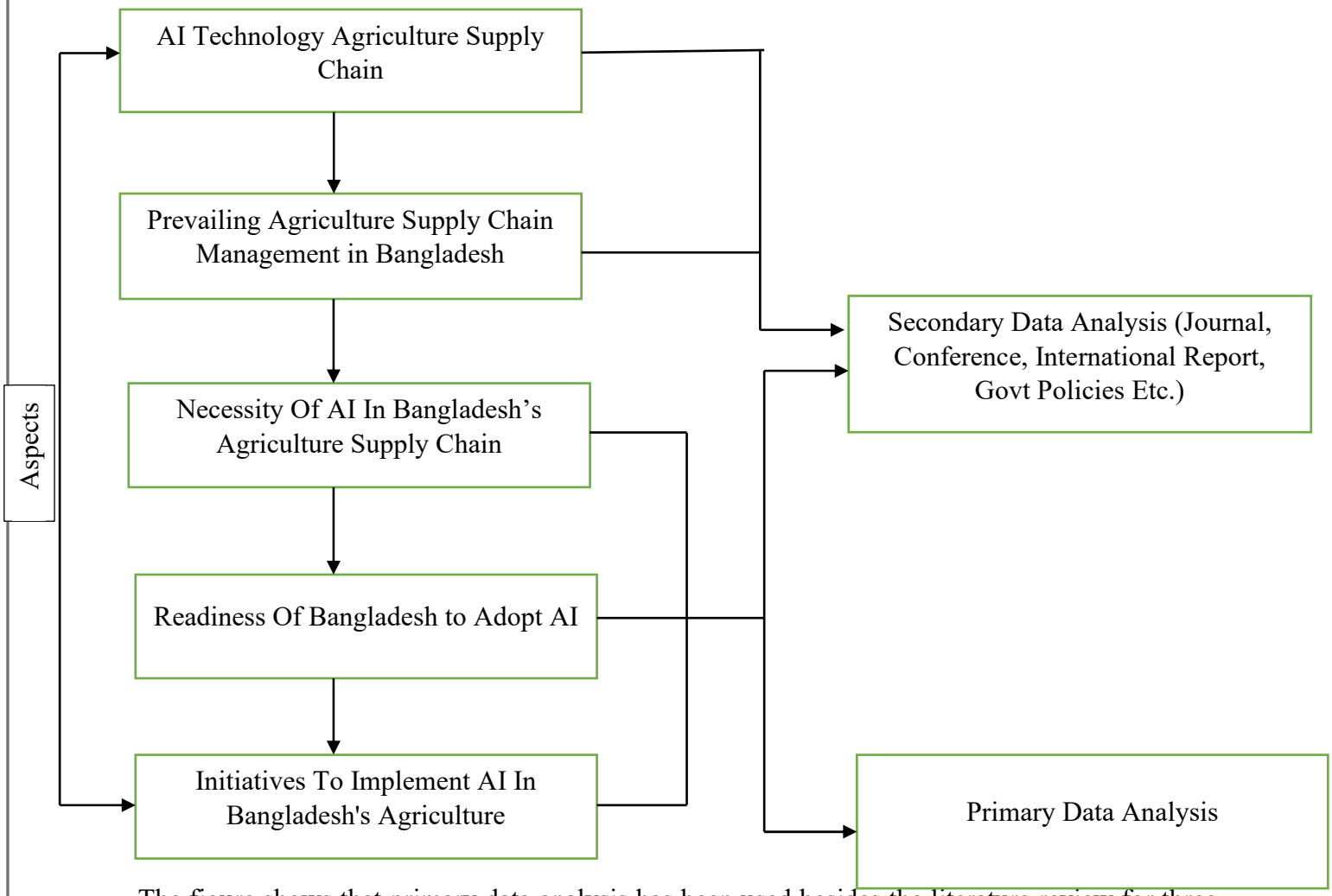
Integrating Artificial Intelligence (AI) into Bangladesh's agricultural sector is essential to prepare the nation for future industrial revolutions, particularly due to its substantial economic reliance on agriculture. This article examines the possible effects of artificial intelligence (AI) on the agricultural supply chain, emphasizing the difficulties and possibilities it brings. The text provides an overview of the existing condition of agriculture in Bangladesh, highlighting the inefficiencies that could be resolved via the use of AI. These inefficiencies include the squandering of resources and logistical challenges. The report assesses the preparedness of Bangladesh to embrace artificial intelligence (AI), taking into account aspects such as digital infrastructure, technical expertise, and regulatory framework. Financial restrictions and limited access to technology are obstacles that impede the mainstream use of AI, despite its clear advantages. The report conducts an extensive examination of existing research and analyses primary data to identify the main obstacles and necessary actions for incorporating AI into the agricultural industry. The research findings indicate that the implementation of AI in Bangladesh's agriculture sector has the potential to greatly improve productivity, sustainability, and resilience. This makes AI a crucial factor for future economic growth and ensuring food security.

Introduction:

The foundation of Bangladesh's economy is agriculture, which employs a sizable section of the workforce and makes a major GDP contribution. However, challenges in the agricultural supply chain, including inadequate resource management, logistical issues, and limited market access, pose significant barriers (Md. Sanadiule Shorif, Rawnak Labiba, Quazi Monjur, & Hridi, 2023). These obstacles underscore the need for modernization and the incorporation of technology. to enhance sustainability and productivity(Mohammed Rakib, Shah Junaed Ahmed, Syed Abrar, Khan Ishfar Bin, & Ridika, 2023). Artificial intelligence (AI) has the power to completely transform global agricultural supply networks. Artificial intelligence (AI) technologies have proven to be highly advantageous in a variety of settings, including automated logistics systems, predictive analytics, and precision farming. These advancements have minimized distribution processes, forecasted crop diseases, and optimized irrigation schedules, leading to a significant boost in productivity and sustainability (Abreu & van Deventer, 2022; Yadav & Singh, 2019). Present agricultural supply chain procedures in Bangladesh frequently follow customary techniques, devoid of the technological innovations observed in other areas. Unpredictable weather patterns, pest infestations, and fluctuating market prices are just a few of the difficulties farmers commonly face and which negatively impact their livelihoods. By offering real-time data and actionable insights, the integration of AI could help with these problems by facilitating improved resource management and decision-making(Chowhan & Rani, 2020; Syeed, Islam, & Fatema, 2020). The application of AI in Bangladesh's agriculture industry is still in its infancy, despite the obvious advantages. Though there are still many obstacles in the way, several public and commercial efforts are supporting the integration of AI and digital agriculture. These consist of financial constraints, limited technical expertise, and restricted technology access. It is crucial to assess Bangladesh's current state of AI adoption to identify any gaps and potential areas for future development (Ane & Yasmin, 2019).

Research Approach:

This article's research strategy is predicated on an extensive study of the literature, which is followed by descriptive and comparative analyses of primary data. This analysis looks at how AI technologies are being used in agricultural supply chains around the world and how they may be successfully applied to Bangladesh, a nation whose economy is mostly dependent on agriculture. The accompanying image provides illustrations of the topics covered in this article.



The figure shows that primary data analysis has been used besides the literature review for three of the aspects (Necessity of AI in Bangladesh, Readiness of Bangladesh to Adopt AI, and Initiatives to Implement AI in Bangladesh). The purpose is to find –

1. Key Barriers to the Adoption of Artificial Intelligence in Bangladesh's Agriculture Sector
2. Key initiatives that should be taken to ensure the Adoption of AI in Bangladesh's Agriculture Sector
3. Identifying the Most Promising Segment of Bangladesh's Agriculture Supply Chain for AI Integration

Data Collection and Data Analysis:

To effectively create the questionnaire in the data collection strategy, observations from conference papers, journals, and pertinent content were used. Ten major steps to ensure the effective deployment of AI, ten significant impediments to AI adoption in Bangladesh's agriculture sector, and ten highly prospective parts of Bangladesh's agricultural supply chain (AgSC) for AI integration were identified from the literature review. 110 respondents—supply chain analysts (ages 27–35), AI enthusiasts (ages 22–25), agriculture extension specialists (ages 30-35), and young agriculture entrepreneurs (ages 25–35)—were then given a questionnaire. A brief sample of the gathered responses is shown in the following tables, where each factor's relevance was evaluated on a relative scale (1 = Negligible, 2 = Low, 3 = Medium, 4 = High, and 5 = Very High).

Key Barriers to the Adoption of AI in Bangladesh's Agriculture Sector	Relative Value				
	1 = Negligible	2 = Low	3 = Medium	4 = High	5 = Very High
Inadequate Digital Infrastructure					*
Lack of Technical Expertise				*	
Regulatory and Policy Constraints			*		
Limited Financial Resources				*	
To be Continued					
Key Initiatives That Should Be Taken to Adopt AI in the Agriculture Sector	Relative Value				
	1 = Negligible	2 = Low	3 = Medium	4 = High	5 = Very High
Developing Digital Infrastructure				*	

Providing Financial Support and Subsidies			*		
Training and Capacity Building					*
Formulating Supportive Policies and Regulations		*			
To be Continued					
Identifying The Most Promising Segment of Bangladesh's Agricultural Supply Chain for AI Integration	Relative Value				
	1 = Negligible	2 = Low	3 = Medium	4 = High	5 = Very High
Crop Monitoring and Precision Farming				*	
Supply Chain Logistics and Transportation					*
Market Forecasting and Demand Prediction					*
Pest and Disease Management			*		

Table: Sample of Data Collection Table

In the data analysis process, the Relative Importance Index (RII) was utilized to rank the factors influencing three key areas: (1) the main barriers to the adoption of AI in Bangladesh's agriculture sector, (2) the crucial initiatives that should be implemented to facilitate the adoption of AI in the agriculture sector, and (3) the most promising segments of Bangladesh's agricultural supply chain for AI integration. Thanks to this strategy, these aspects were visualized and prioritized according to their relative relevance.

Equation (1) represents the mathematical formula for the calculation of the Relative Importance Index:

Relative Importance Index = $(\sum W)/(AN)$ (1)

Here,

W= The weight assigned to each factor, with 1 denoting the least weight and 5 the most weight.

A= maximum range value (in this case, A = 5)

N= Number of total respondents

Artificial Intelligence (AI) in Agriculture Supply Chain:

Name of AI Technology	**Role of AI In Agricultural Supply Chain Management.**	**References**
Unnamed Aerial Vehicle (UAV)	Detect water status by thermal and multi-spectral imagery which helps improve the production of grapes.	(Baluja et al., 2012)
3-SPS-1S parallel robot-based laser sensing	Determine the quantity of water, fertilizer, or any other nutrient in crops which helps in precise agriculture and irrigation management. Through this, one can know if the crops need more nutrients or fertilizer or not. It will help to minimize the cost by giving the optimum dosage of fertilizer for the plant.	(Zavala-Yoe, Ramírez-Mendoza, & García-Lara, 2016)
Deep Convolutional Neural Network	It can detect 14 crop species and 26 diseases which helps to reduce the crop loss by crops diseases and increase crop production.	(Mohanty, Hughes, & Salathé, 2016)
IoT Based Soil Moisture Monitoring on Losant Platform	Use to measure the soil moisture and also alert the farmer when the moisture is low via SMS or email.	(Kodali & Sahu, 2016)
Agriculture Robot	It will sow seeds more precisely and efficiently at optimal depth and at optimal distances between crops and their rows which helps to reduce stresses of farmer and precise agriculture.	(Naik, Shete, & Danve, 2016)

Intelligent Robots	Intelligent Robot can collect and analyze Individual data of targeted fruits such as harvest time, fruit pose time, Ripeness, defects and environmental information which helps the decision maker on proper cultivation of proper fruit at proper time. They can also do harvesting which is an economically significant solution of labor cost rise.	(Zhou, Wang, Au, Kang, & Chen, 2022)
AI and Satellite data	AI in farming along with satellite data can be used to predict weather forecasting, which helps to deciding farmers in crops cultivation.	(Manaware, 2020)
Smart Livestock Farming	Supports monitoring of productions, health, and welfare of livestock, and to ensure optimal yield, to increase the management capacity of animals	(DayioĞLu & Turker, 2021)
Block-chain Technology	Tracking Crop Prices, stored each transaction, ensuring traceability and transparency.	(Shivendra, Chiranjeevi, Tripathi, & Maktedar, 2021)
Unnamed ground Vehicle (UGV)	Crop Monitoring and Crop Harvesting as a tractor without uses of human which helps in precision agriculture.	(Quaglia et al., 2020)
Machine Learning	Used to predict future demand by determining demand forecasting using LSTM and SSTM methods which will improve production planning.	(Oluwafunmi Adijat, Chinedu Ugochukwu, Olubusola, Favour Oluwadamilare, & Noluthando Zamanjomane, 2024)

Table: AI Technology Used in Agriculture Supply Chain Around the World

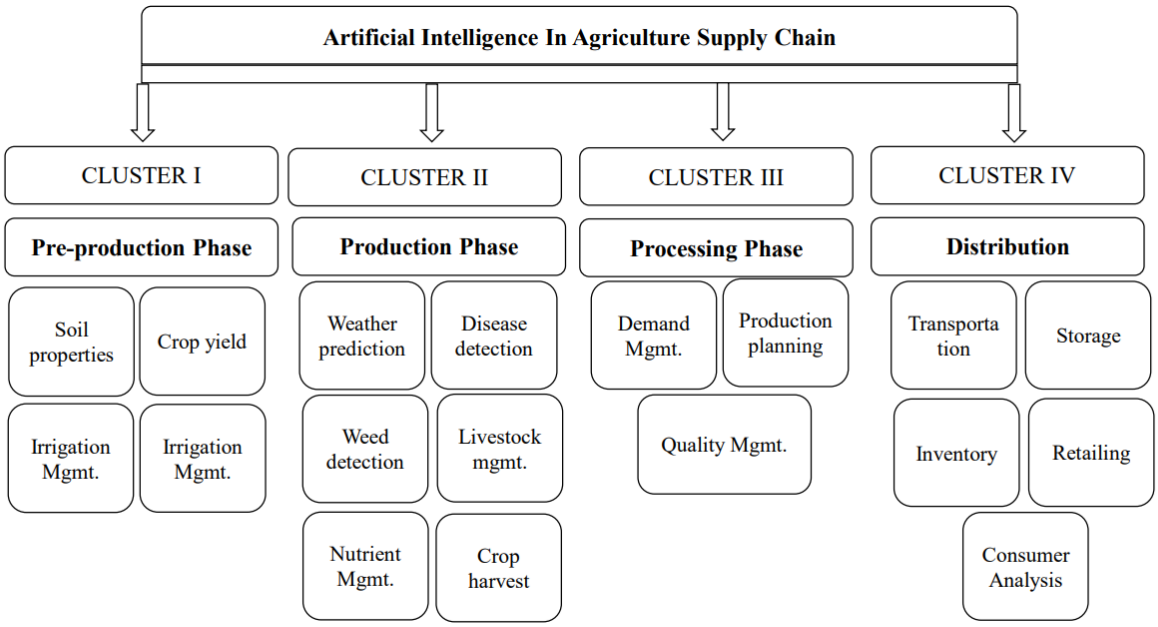


Figure: Areas of the Agricultural Supply Chain belonging to Different Phases where ML principles can be applied. (Aylak, 2021)

Prevalent Agricultural Supply Chain Management of Bangladesh:

Bangladesh's economic situation largely depends on the Agriculture sector, which is also a big sector of employment in Bangladesh consisting of 23% of the Gross domestic product (GDP) and 65% of its labor force (Tabassum & Rezwana, 2021). On the other hand, Supply Chain Management is an integrative philosophy that manages the total flow of distribution of a product in the raw material phase from supplier to the end product to consumer (Cooper, Lambert, & Pagh, 1997). The Agricultural Supply Chain Management of Bangladesh relies on complex intermediaries because it is a common phenomenon of a developing country that its agricultural market chains are long because of the presence of many small-scale intermediaries which makes the farmer's profit lower and consumer prices higher as these small intermediaries profit from the consumer prices (Deb, Lee, & Lee, 2020). The primary Distribution has several intermediaries shown in the figure. The first step in the agricultural supply chain management is the grower/producer/farmer. They harvest and cultivate different types of crops vegetables and other agricultural products in different seasons and also based on market conditions. The next Step and the first intermediary are the Bepari/Faria. Farias are small merchants who sell a small number of products in three or four local markets. They also sell farmers items to beparies (Tasnoova &

Iwamoto, 2006). Beparies are special merchants who buy agricultural products from farmers/faria and then sell to the aratdar which is the next intermediary in agricultural supply chain Management. The Aratdar Buy agricultural products from bepari and they have large storage space for keeping the agricultural products. As a result, they also work as a Keeper of Agricultural products for Wholesale/Retailer with a profitable commission. Finally, the wholesale/retailer Completes the ASCM (agricultural supply chain management) By Selling the agricultural products which they got from bepari/aratdar to the consumer. This is a linear flow of agricultural supply chain management in Bangladesh (Hasan & Habib, 2022).

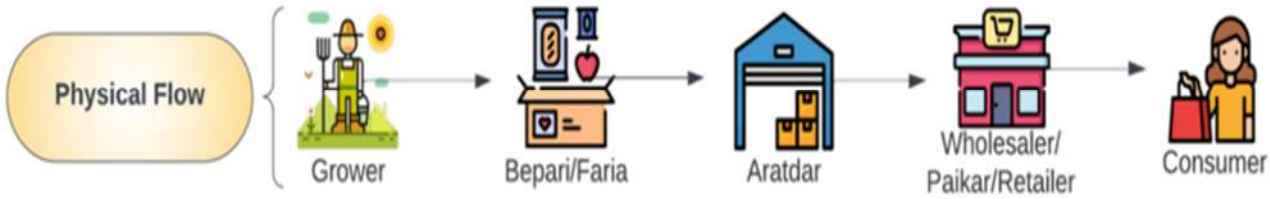


Figure: Agricultural Supply Chain Management of Bangladesh (A physical flow).(Hasan & Habib, 2022)

Necessity of AI in Agricultural Supply Chain Management of Bangladesh

Bangladesh relies heavily on agriculture, which serves as the primary industry and income source for the nation. Effective supply chain management is crucial for the socioeconomic advancement of agricultural products in the country. Bangladesh faces challenges in agricultural supply chain management due to the rapid population growth and industrialization, leading to the depletion of natural resources through landfilling. Furthermore, the Agricultural Supply Chain lacks industrialization (Sachin, Angappa, & Shradha, 2020), lack of management practice in AgSC, Asymmetrical Information, wastage of extra fertilizer, and improper transportation are also a big challenge in AgSC of Bangladesh.

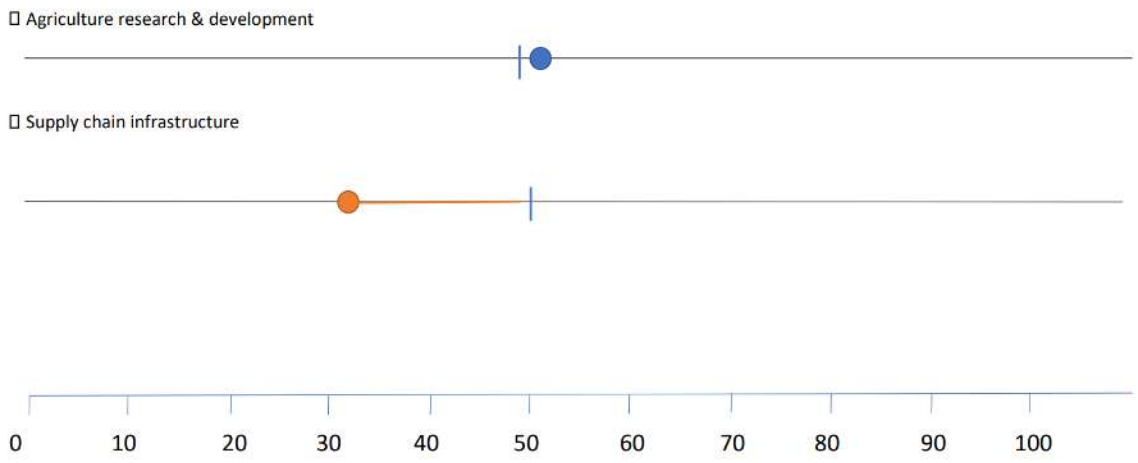


Fig: Bangladesh's Score in Agriculture Supply Chain and Agriculture R&D in Global Food Security Index (https://impact.economist.com/sustainability/project/food-security-index/explore-countries/bangladesh)

Bangladesh is experiencing significant pressure on its agricultural supply chain as a result of its rapidly growing population and limited availability of fertile land (Hossain & Islam, 2022). Urbanization, land fragmentation, and high food demand are leading to a reduction in both agricultural land and farming efficiency. Furthermore, intensive farming practices have resulted in soil degradation, further diminishing agricultural output. Land ownership disputes are impeding investments, placing additional strain on the supply chain, and lowering food security (Alwedyan, 2022)

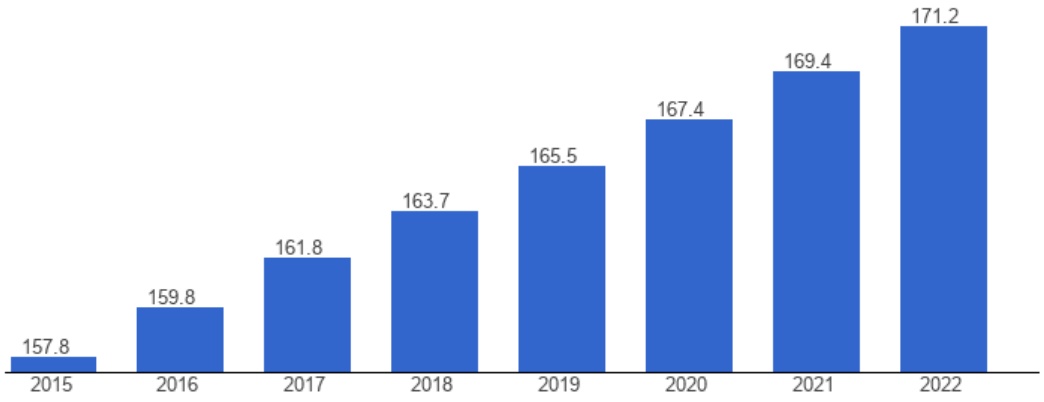


Figure: Bangladesh's Recent Population Growth (in million)

(https://www.theglobaleconomy.com/Bangladesh/population_size/)

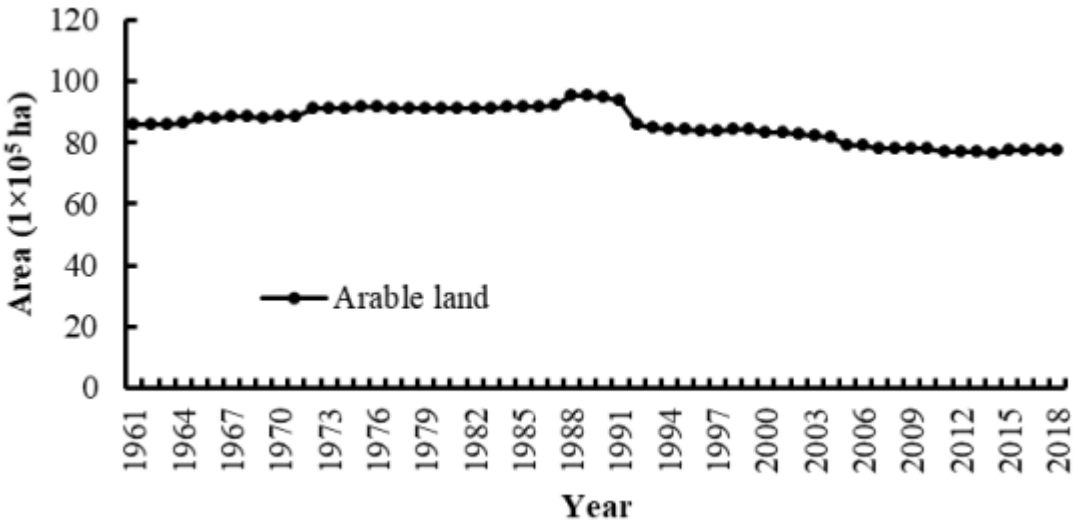


Figure: Total Arable Land Status of Bangladesh (1961-2018) ((Hossain & Islam, 2022)

In Bangladesh, middlemen in the supply chain for agriculture frequently result in inefficiencies and higher prices. The presence of multiple tiers of intermediaries may result in higher consumer prices and lower farmer earnings. Additionally, this strategy may cause post-harvest losses and lower-quality produce to reach the market by delaying the distribution process. As such, the agricultural supply chain's overall sustainability and efficiency are negatively impacted by the reliance on middlemen (Abrar, Abdullah Al, Khandker Mohammad, & Tahseen, 2020; Zaima, 2019)

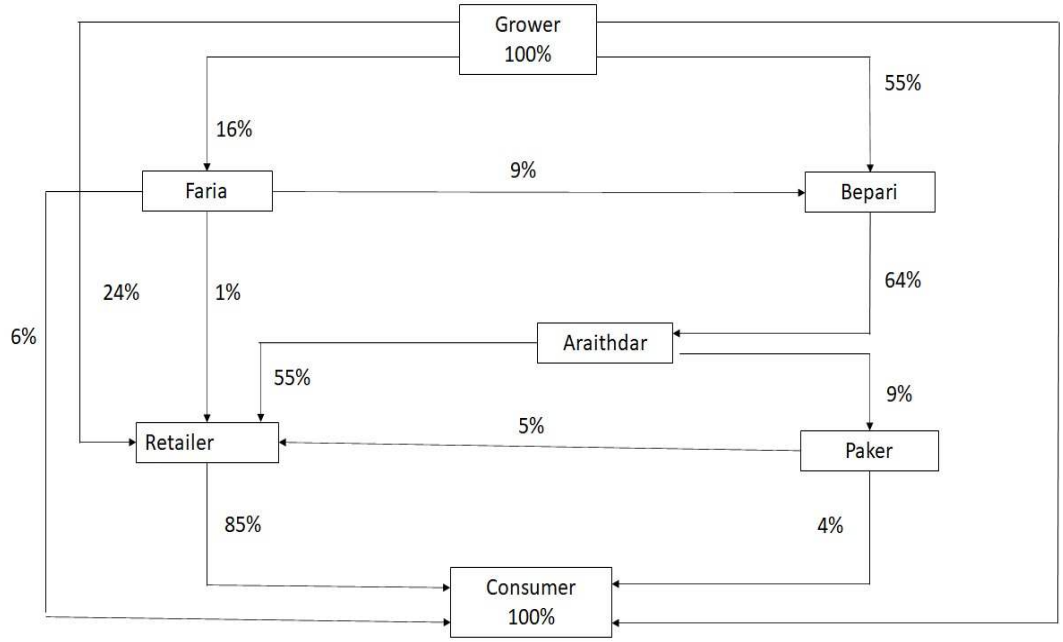


Figure: Dependence of Intermediaries in AgSC of Bangladesh ((I. Hasan & M. M. Habib, 2022)

It is assumed that the current harvesting process and digital technologies are insufficient to meet the demand of this growing population and industrialization (Elferink & Schierhorn, 2016). So, proper supply chain management in the agriculture sector is essential to overcoming and developing this problem. AI will be one of the pioneer solutions for efficient agricultural supply chain management in Bangladesh (Sharma, Kamble, Gunasekaran, Kumar, & Kumar, 2020).To cope with the Industrial Revolution -4.0 and to prepare for the next revolution it is a must to ensure the implementation of AI in the agriculture supply chain of Bangladesh (Foysal, Sohaib, & Fatema Akter, 2023)

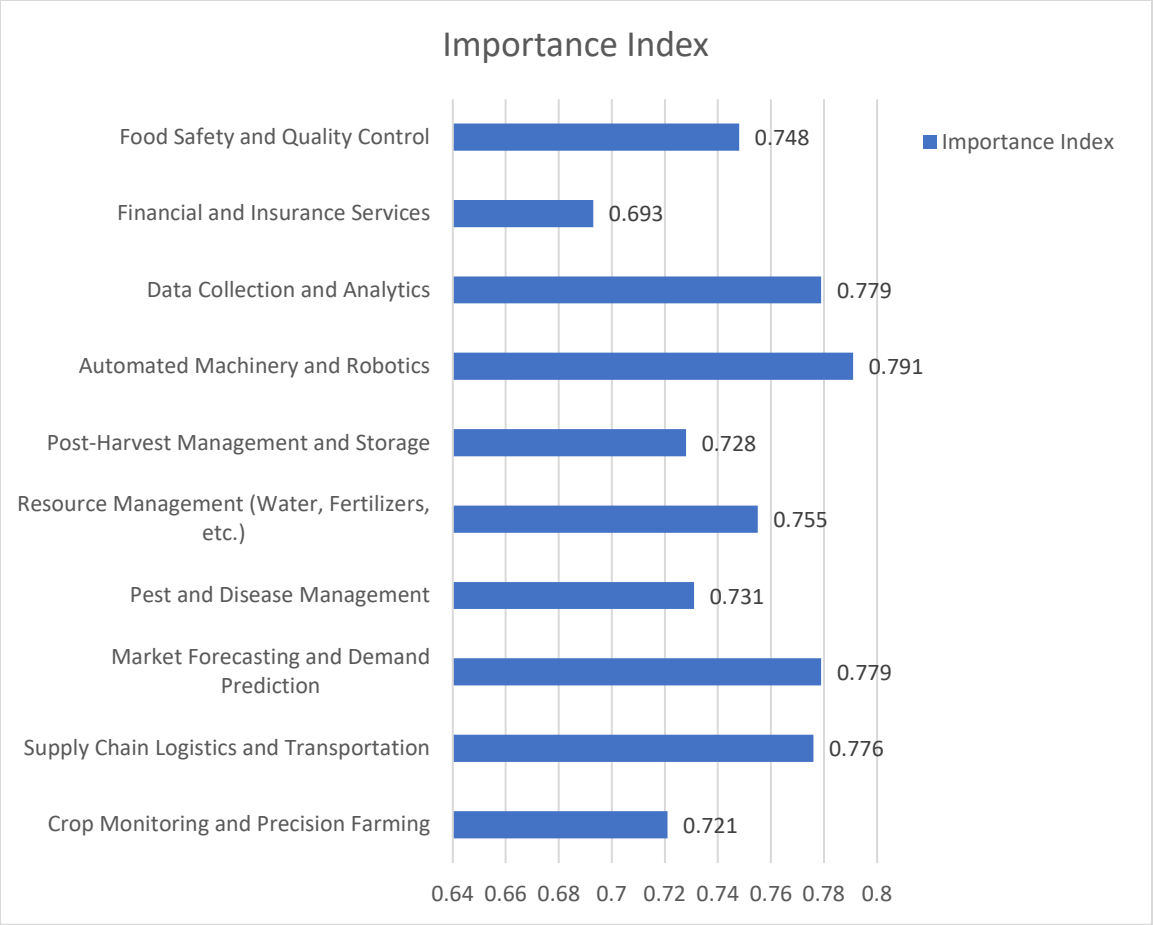


Fig: The Most Promising Segment of Bangladesh's Agriculture Supply Chain for AI Integration (Analyzed Using Primary Data)

Readiness of Bangladesh to Adopt AI:

The Global Innovation Index (GII) is a useful tool for evaluating a country's capacity to embrace artificial intelligence (AI) by examining its innovation ecosystem as a whole. The GII relies on

essential elements such as human capital, research infrastructure, ICT infrastructure, and business sophistication, which are crucial for the development and implementation of AI technology. Significant achievements in various domains provide a solid basis for AI advancement, encompassing a proficient labor force, state-of-the-art research facilities, and a resilient digital infrastructure. In addition, the GII assesses the legal environment and market sophistication, which impact the ease of implementing and expanding AI technologies. Countries that have favorable regulations, thriving research and development sectors, and vibrant business ecosystems are more likely to successfully incorporate AI technologies. The GII provides a detailed overview of the aspects that might either support or impede a country's adoption of artificial intelligence (AI), emphasizing the overall preparedness and capacity for technological progress.

Main Pillar	**Sub-Pillar**	**Description**
Institutions	Political Environment	This metric assesses the degree of stability in a government, the level of political engagement, and the effectiveness of the legal system. Encompasses metrics such as political stability, government effectiveness, and the lack of violence/terrorism.
	Regulatory Environment	Evaluates the caliber of legislation and laws, encompassing the effectiveness of the legal system, the safeguarding of property rights, and the simplicity of resolving insolvency.
	Business Environment	Assesses the level of simplicity in commencing and conducting commercial operations, the accessibility of finance, and the taxation framework. Encompasses indicators such as the simplicity of beginning a business and the simplicity of resolving insolvency.

Human Capital and Research	Education	Encompasses the standard of primary and secondary education, which includes factors such as the ratio of students to teachers, the expected duration of schooling, and the amount of money spent by the government on education.
	Tertiary Education	Evaluates the levels of enrolment in higher education, the caliber of universities, and the extent of international student presence.
	Research and Development (R&D)	This metric assesses the extent of research and development (R&D) efforts, encompassing factors such as the number of researchers, the total amount of money spent on R&D within a country (gross domestic expenditure on R&D or GERD), and the caliber of scientific research organizations. Additionally encompasses funding and partnership for research and development.
Infrastructure	Information and Communication Technologies (ICT)	Evaluates the availability, use, and provision of information and communication technology (ICT), as well as the delivery of government services through online platforms. Indicators encompass metrics such as the rate of internet penetration, the number of broadband subscriptions, and the availability of e-government services.

	General Infrastructure	Encompasses fundamental elements of infrastructure such as energy, water, transportation, and logistical efficiency. Additionally, it encompasses the accessibility and caliber of infrastructure such as roadways and airports.
	Ecological Sustainability	Assesses the ecological effectiveness, encompassing environmental strategies, energy conservation, and responsible utilization of natural resources. Encompasses metrics such as environmental performance and ISO 14001 environmental certifications.
Market Sophistication	Credit	This metric assesses the accessibility of financial assets for enterprises, encompassing both domestic loans to the private sector and the level of difficulty in obtaining credit.
	Investment	Evaluates the extent of financial resources being allocated to the economy, encompassing investments such as venture capital agreements and foreign direct investment. Additionally, it encompasses indicators about the safeguarding of minority investors and the accessibility of financial resources.
	Trade, Competition, and Market Scale	Encompasses factors such as the level of trade liberalization, the magnitude

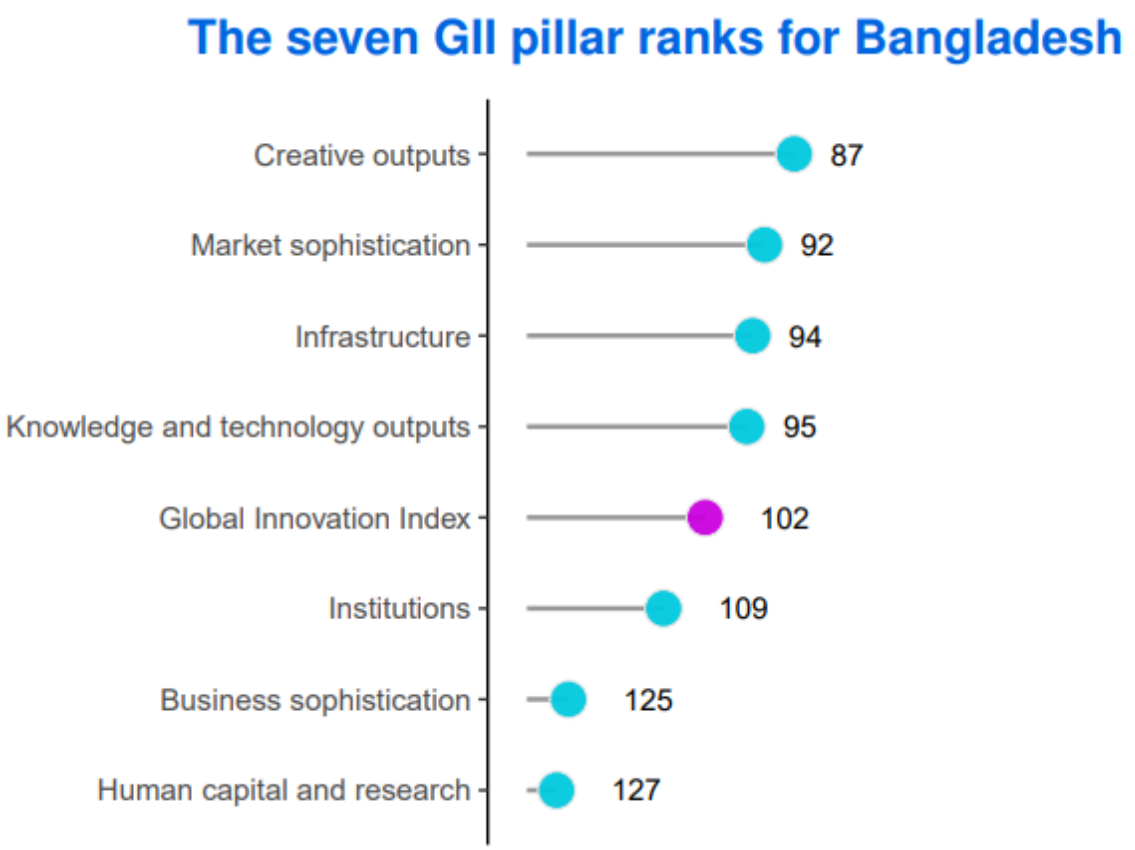
		of tariff rates, the degree of market competition, and the scale of the domestic market. It encompasses metrics such as the level of local rivalry and the size of the market.
Business Sophistication	Knowledge Workers	Assesses the extent of employment in tasks that require a high level of knowledge, such as the employment of highly skilled workers and the presence of qualified labor.
	Innovation Linkages	This assesses the degree of collaboration between business and academia, the existence of clusters, and the availability of venture capital. Encompasses measures such as collaboration between universities and industries in research and the formation of joint ventures.
	Knowledge Absorption	Evaluates the degree to which companies assimilate and apply novel technology and expertise. The data encompasses metrics about intellectual property remittances and imports of advanced technology products.
Knowledge and Technology Outputs	Knowledge Creation	Assesses the generation of novel information, encompassing patents, utility models, and scientific publications. Additionally, it encompasses signs like as patent applications and trademark registrations.

	Knowledge Impact	This study assesses the influence of knowledge on the economy by examining indicators such as the rate of productivity growth, the density of new businesses, and the volume of high-tech exports. The indicators encompass factors about the influence of emerging technology and knowledge on the economy.
	Knowledge Diffusion	Evaluates the spread of knowledge, which encompasses the export of innovative products and services as well as the distribution of information and communication technologies. Additionally, it encompasses data about net outflows of foreign direct investment (FDI) and the exportation of information and communication technology (ICT) services.
Creative Outputs	Intangible Assets	This course focuses on the development and utilization of intangible assets, such as the process of registering trademarks, industrial designs, and the production of digital material. The indicators encompass aspects of branding, design, and various other forms of intellectual property.
	Creative Goods and Services	This metric quantifies the output and international trade of artistic and innovative

		products and services, while also considering the economic impact of creative sectors. The data comprises metrics about cultural and creative industries and their economic influence.
	Online Creativity	Evaluates the existence and utilization of digital platforms and the production of content, encompassing domain name registrations and the development of mobile applications. Additionally, it encompasses indicators about the utilization of digital technologies for artistic endeavors.

Table: Main Pillars and Their Sub Pillars of Global Innovation Index

(https://www.wipo.int/edocs/pubdocs/en/wipo-pub-2000-2022-en-main-report-global-innovation-index-2022-15th-edition.pdf)


The seven GII pillar ranks for Bangladesh
Creative outputs
87
Market sophistication
92
Infrastructure
94
Knowledge and technology outputs
95
Global Innovation Index
102
Institutions
109
Business sophistication
125
Human capital and research
127

(a)

Strengths and weaknesses for Bangladesh

Strengths			Weaknesses		
Code	Indicator name	Rank	Code	Indicator name	Rank
2.3.4	QS university ranking, top 3	65	2.1.1	Expenditure on education, % GDP	127
3.2.3	Gross capital formation, % GDP	24	2.1.2	Government funding/pupil, secondary, % GDP/cap	103
3.3.1	GDP/unit of energy use	13	2.1.5	Pupil-teacher ratio, secondary	120
4.1.3	Loans from microfinance institutions, % GDP	11	2.2.2	Graduates in science and engineering, %	106
4.3.3	Domestic market scale, bn PPP$	30	2.3.3	Global corporate R&D investors, top 3, mn USD	38
5.3.2	High-tech imports, % total trade	68	3.3.2	Environmental performance	127
6.1.5	Citable documents H-index	63	4.2.2	Venture capital investors, deals/bn PPP$ GDP	95
6.2.1	Labor productivity growth, %	5	5.3.3	ICT services imports, % total trade	129
7.1.1	Intangible asset intensity, top 15, %	26	6.2.2	New businesses/th pop. 15–64	122
7.1.4	Industrial designs by origin/bn PPP$ GDP	59	7.2.4	Printing and other media, % manufacturing	96

(b)

Figure: (a)-Rank of Bangladesh in Seven GII Pillars in the World (b)-Strengths and Weaknesses of Bangladesh in GII (https://www.wipo.int/edocs/pubdocs/en/wipo_pub_2000_2022/bd.pdf)

Bangladesh now has a poor ranking on the Global Innovation Index (GII). This score represents the diverse obstacles that the country encounters in improving its innovation ecosystem. Notable weaknesses encompass restricted research and development (R&D) capacities, poor infrastructure, and insufficient market sophistication. The GII evaluates many elements such as human capital, business sophistication, and creative outputs to measure a country's total capability for innovation.

The use of AI in Bangladesh is impeded by these fundamental difficulties. The nation suffers from an inadequate digital infrastructure and has a comparatively low level of high-skilled jobs. Notwithstanding these difficulties, there are promising prospects, such as a burgeoning enthusiasm for technology and a rising level of cooperation between universities and industry. Nevertheless, to successfully incorporate AI, substantial enhancements are required in research and development spending, information and communication technology infrastructure, and the entire regulatory framework.

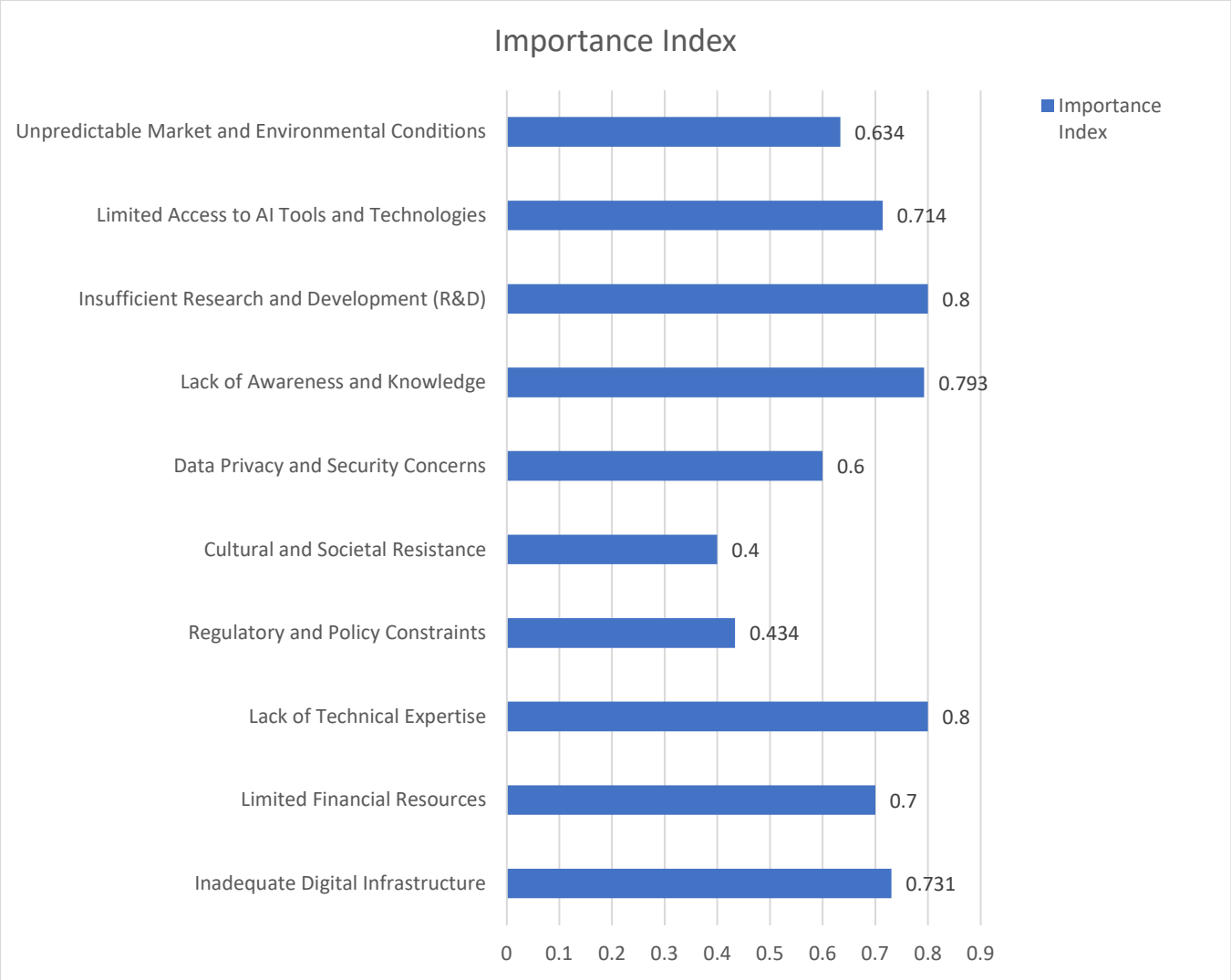


Fig: Barriers to the Adoption of Artificial Intelligence in Bangladesh's Agriculture Sector (Analyzed Using Primary Data)

Initiatives to Implement AI in Bangladesh's Agriculture Sector:

To adequately prepare the nation for the forthcoming industrial revolutions, it is imperative to include artificial intelligence (AI) in Bangladesh's agriculture sector, considering its crucial contribution to the economy. With the global shift towards Industry 4.0 and beyond, the integration of artificial intelligence (AI) has the potential to completely transform agricultural methods completely, enhancing their efficiency, productivity, and sustainability. For this shift to take place, the government must take proactive measures. Possible measures encompass allocating resources towards AI research and development, offering comprehensive training and education programs for farmers and agricultural professionals, and formulating policies that incentivize the integration of cutting-edge technologies. The government might provide financial incentives and assistance to startups and organizations that are creating AI solutions specifically designed for the agricultural sector. Moreover, establishing resilient digital infrastructure and guaranteeing dependable internet connectivity in rural regions are crucial measures to enable the extensive adoption of AI technologies. These activities would not only update the agricultural sector but also contribute to achieving food security and economic growth, enhancing Bangladesh's readiness for future industrial advancements.

Initiatives	Objective	Details
Integration of IoT-Enabled Handheld Devices	To optimize the use of resources such as water and fertilizers	These devices observe and analyze the state of the soil and offer immediate suggestions on when to irrigate and apply fertilizer. The technology enhances farmers' decision-making by integrating data on crops, weather, and soil, resulting in higher agricultural yields and decreased resource wastage.
Krishoker Janala App		This application, powered by artificial intelligence, identifies and provides remedies for crop illnesses by

	To provide immediate and accurate solutions for crop disease management	utilizing advanced machine-learning algorithms. The application utilizes an extensive repository of crop diseases, production data, and pesticide information, enabling farmers to access vital agricultural services with more efficiency and reduced expenses.
Smart Agriculture Development	To modernize agriculture through digital and AI technologies.	The policy prioritizes the advancement of intelligent agricultural systems that incorporate digital logistics, establish standardized assets, and measure service quality against a benchmark. These systems have the objective of optimizing logistics, enhancing decision-making through data-driven insights, and ensuring effective coordination throughout the supply chain.
Data-Driven Logistics Systems	To enhance logistics efficiency and reduce costs.	Our main objective is to create data-driven solutions that can monitor many aspects of the logistics ecosystem. These solutions will enhance efficiencies by delivering real-time data and analytics to optimize transportation routes, inventory management, and overall supply chain operations.
Advanced Supply Chain Management	To improve the overall supply chain infrastructure.	The strategy encompasses strategies for integrating digital logistics systems, enhancing warehousing practices, and assuring optimal inventory

		management. AI technologies are employed to enhance supply chain operations, minimize duplications, and maximize resource utilization.
Fostering Private Sector Engagement	To involve the private sector in logistics improvements.	Promoting involvement of the business sector is crucial for the advancement and execution of AI-driven logistics solutions. The strategy seeks to stimulate innovation and enhance efficiency in the agriculture supply chain by offering incentives and establishing a favorable environment for private investment.
Training and Capacity Building	To equip the workforce with the necessary skills for AI integration.	Logistics development Human resources and developing skills are crucial elements of the policy. Training programs and educational activities will be implemented to guarantee that workers acquire proficiency in using AI technologies and digital tools specifically for agricultural purposes.
Monitoring and Evaluation	To continuously assess and improve logistics performance.	It is essential to implement a data-driven monitoring system to accurately track and evaluate the effectiveness of logistical operations. This involves utilizing analytics to detect areas of congestion, assess effectiveness, and apply necessary corrective measures.

Table: The initiatives of implementing AI in the agriculture supply chain according to the 'National Logistics Policy' of Bangladesh (https://logistics.gov.bd/page-content/13)

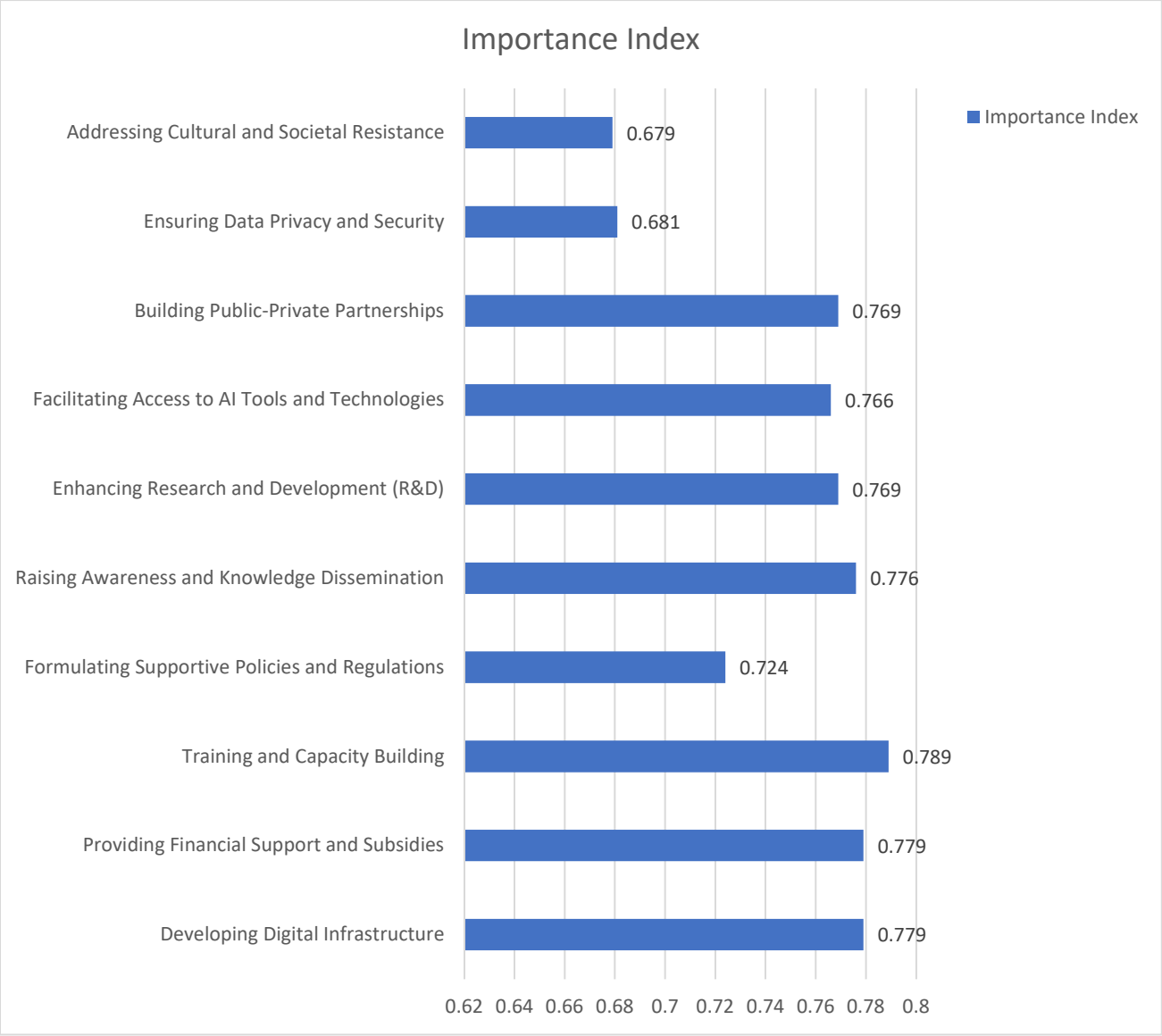


Fig: Initiatives that should be taken to ensure the adoption of AI in Bangladesh's agriculture sector (Analyzed Using Primary Data)

Discussion:

Integrating Artificial Intelligence (AI) into Bangladesh's agriculture sector offers a significant chance to tackle long-standing inefficiencies and difficulties. According to this study, the agricultural industry is affected by problems such as unexpected weather, pest infestations, and shifting market prices, which have a substantial influence on farmers' lives. Artificial intelligence (AI) technologies, such as predictive analytics and automated systems, can reduce these issues by delivering up-to-date data and practical insights. For instance, artificial intelligence (AI) can improve irrigation schedules, forecast agricultural diseases, and streamline logistics, thereby increasing production and promoting sustainability.
Nevertheless, the implementation of AI in Bangladesh's agriculture industry faces several challenges. The study emphasizes significant obstacles, such as insufficient digital infrastructure, restricted availability of cutting-edge technology, and a scarcity of technical proficiency. These difficulties are made worse by limited financial resources and a legal framework that has not yet completely embraced the digital revolution. Notwithstanding these obstacles, there is an increasing acknowledgment among key players, such as the government, corporate sector, and academic institutions, of the necessity to update the agriculture sector. Training programs for farmers, investment in digital infrastructure, and policy reforms are essential measures to promote the adoption of AI

Conclusion:

Ultimately, the incorporation of artificial intelligence into Bangladesh's agricultural industry is not only a choice, but a must to attain sustainable economic advancement and ensure food security. The potential advantages of AI, ranging from increasing crop productivity to optimizing supply chain effectiveness, are significant. However, achieving these advantages necessitates a deliberate endeavor to surmount current obstacles. The report highlights the significance of a comprehensive strategy that involves the establishment of digital infrastructure, the improvement of technical expertise, and the implementation of a supporting regulatory framework. By tackling these obstacles and harnessing the potential of artificial intelligence, Bangladesh has the opportunity to not only revolutionize its agriculture industry but also become a model for other emerging countries. The successful incorporation of AI is crucial for the advancement of agriculture in Bangladesh, necessitating collaboration and investment from all parties involved to achieve this technological transformation**.**

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