Nurturing Agri-Startups to Transform Agricultural Extension for Sustainable Agriculture

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Keywords: Agricultural Extension, Innovation, Agri-Startups, Value Chain Extension, MANAGE-CIA, Sustainable Growth.

Abstract: This paper commences with a critical analysis of the inherent significance of agriculture in meeting the sustenance needs of a growing global populace. In this context, the importance of agricultural extension takes center stage. As the world witnesses paradigm shifts in technology, advisory and innovation services, the paper highlights evolving agricultural extension, transitioning into a holistic approach encompassing the sharing of information, knowledge, skills, risk management practices, and cultivating the ethos of farming as an entrepreneurial enterprise. Agriculture characterised by the inefficient supply chains, post-harvest losses, soil health issues,issues of climate change, and the delicate balance between farm size, productivity, and farmers income. Within these challenges, a fertile ground for agri-startups emerges. Driven by the imperative to innovate and address these challenges, these startups find unprecedented opportunities in transforming the agricultural sector. This paper highlights on the role of cutting-edge technologies such as digital media, AI, IoT, and Big Data in redefining agricultural extension services. These tools, with their capacity to facilitate advisory services, usher in a new era of transforming agri-food systems. The heightened reliance on extension services underscores the potential for agri-startups not only to address existing issues but also to advance the agenda of profitable and sustainable agriculture. This paper also elucidates the concept of value chain extension and its intricate linkages with agri-startups. Beyond addressing challenges, these startups play a pivotal role in transforming agriculture into agribusiness. This paper defines the value chain extension as the lifeline connecting every element of agricultural production and consumption, emphasizing the symbiotic relationship between agri-startups and the evolving agricultural value chain.Additionally, the paper explores the support systems propelling agri-startups, highlighting incubation facilities and schemes. Notably, the MANAGE- Centre for Innovation and Agripreneurship (CIA), hosted at the National Institute of Agricultural Extension Management (MANAGE), takes center stage. This center provides a comprehensive solution, fostering successful ventures in agriculture and allied sectors. With a unique methodology guiding innovation from ideation to commercialization, MANAGE-CIA focuses on developing products that address disruptive problems in the agricultural sector. It not only aims to create employment opportunities but also contributes to the inclusive socio-economic development. This paper seeks to provide a comprehensive understanding of the evolving landscape of agricultural extension, positioning agri-startups as catalysts for change in fostering sustainable growth within the agricultural value chain.

1 INTRODUCTION

Agricultural extension in India, traditionally funded and managed by the public sector, has evolved over the decades. Despite a decline in agriculture's GDP share, the sector has effectively addressed food shortages. India's pluralistic extension system involves multiple entities, including the Ministry of Agriculture, State Departments, Agricultural Universities, various producer groups, and civil society organizations. This diverse landscape aims to enhance agricultural outreach, with state governments primarily responsible for extension activities. The evolving nature of Indian agriculture includes the coexistence of private sector firms and NGOs alongside the public extension system.

The agrifood sector remains critical for livelihoods and employment. Achieving the UN Sustainable Development Goal of a ‘world with zero hunger’ by 2030 will require more productive, efficient, sustainable, inclusive, transparent and

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resilient food systems. (Trendov et al. 2019). At the same time agriculture sector faces several critical challenges across its value chain, hindering the efficiency and sustainability of farming practices. These challenges encompass diverse aspects, ranging from input volatility to limited technological access, inefficient supply chains, and inadequate irrigation. Addressing these issues is crucial for enhancing productivity, reducing wastage, and ensuring the well-being of farmers.

1.1 Challenges Exist Along the Agriculture Value Chain

The agricultural and food value chain typically consists of three main segments. The initial segment, known as the 'pre-farm' link, involves suppliers providing tangible and intangible resources for agricultural production (Pham & Stack, 2018; Boehlje&Broring, 2011). The second segment pertains to activities within the farm, encompassing the farmers themselves, often referred to as the "on-farm" phase. Finally, the third segment involves activities occurring after the farm, involving processors, retailers, and consumers (Gereffi et al., 2009; Pham & Stack, 2018).

1.2 Describing the Challenges

Numerous obstacles prevent farmers worldwide from being as productive and profitable as they could be. The fluctuation of input prices and the resulting inefficient selection of components necessary for farming is one of the major obstacles. Due to limited data on supply-demand dynamics, farmers often find themselves at the mercy of fluctuating input costs. This reliance on retailers for input decisions can lead to either excessive or inadequate use of inputs, negatively impacting both yields and costs.

Moreover, the absence of digitization further exacerbates these issues. With limited access to technology, farmers struggle to gain insights into crucial factors like crop yield and soil productivity. Traditional farming techniques, while deeply ingrained, often contribute to soil degradation over time. Thus, there is a pressing need for technological interventions to improve efficiency and sustainability in agriculture.

Another challenge lies in ensuring consistent quality across agricultural produce. The lack of large-scale quality testing with quick turnaround times complicates efforts to map a farmer's produce to its quality standards. This poses significant challenges for food processing companies and exporters who rely on consistent quality for their operations.

Furthermore, inefficiencies in the supply chain further exacerbate these challenges. Farmers often face lower realization rates due to uncertain demand, inefficient cropping cycles, and higher procurement costs for retailers. Limited infrastructure, such as cold storage facilities, also contributes to increased wastage along the supply chain.

Access to financial solutions remains a significant hurdle for small and marginal farmers, further compounded by limited digitization. Without access to financial resources, farmers struggle to invest in modern farming techniques and equipment, perpetuating a cycle of low productivity and income.

Inadequate irrigation exacerbates these challenges, particularly in regions heavily reliant on rainfall like India. With groundwater levels depleting annually, there's an urgent need for improved irrigation methods to ensure consistent water supply for agriculture.

Lastly, the inverse relationship between farm size and productivity underscores the challenges faced by small and fragmented farms, particularly in comparison to larger operations in countries like Europe and the United States.

Traditional agricultural extension services are facing significant challenges in addressing the complexities of modern agriculture, compounded by the imperative for the agribusiness sector to produce food sustainably to ensure global food security by 2050. As highlighted by Gelderen et al. (2021), entrepreneurship in this context becomes increasingly crucial, focusing on addressing social and environmental challenges at the local level. This shift towards necessity-driven entrepreneurship creates fertile ground for agri-startups, presenting an opportunity to innovate and transform the agricultural sector. As a result, investments in agricultural technology have increased exponentially, as mentioned by Kakani et al (2020). This trend underscores the importance of leveraging entrepreneurial solutions to drive sustainability, efficiency, and resilience in agriculture, thereby contributing to the long-term viability of food production systems.

1.3 Changing role of Agricultural Extension

The Inter-Ministerial Committee on Doubling Farmers' Income (DFI) recognizes agriculture as a value-driven enterprise. It emphasizes empowering farmers through improved market linkages and self-

sustainable models for sustained productivity, production growth, and increased income. The key strategy focuses on optimal monetization of farmers' produce, production sustainability, resource use efficiency, extension services strengthening, and risk management. Agricultural extension goes beyond the mere transfer of technology; it is an empowering system designed to share a comprehensive array of information, knowledge, technology, skills, and practices related to risk and farm management. This process is not confined to a specific segment but encompasses the entirety of agricultural sub-sectors, extending support throughout the agricultural value chain. The overarching objective is to equip farmers with the necessary tools and insights that enable them to realize higher net income from their agricultural enterprises on a sustainable basis. Recognizing the diverse needs of farmers, agricultural extension functions as a guiding force, helping at every stage of the value chain to foster resilience, productivity, and economic well-being. (DFI committee, 2017)

2 OBJECTIVES

1. To study the role of Agri startup'sin Agricultural development

2.To highlight the role of different schemes and support systems particularly incubation facilities like MANAGE-CIA, in propelling the success of agri-startups and contributing to socio-economic development

3 METHODOLOGY

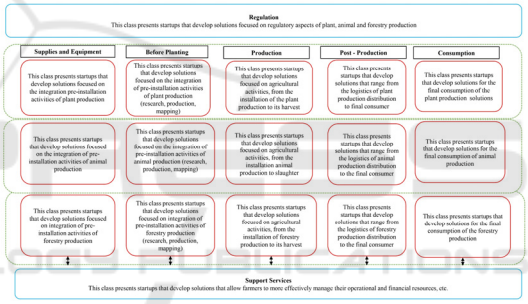
The present study is based on secondary data. The data has been procured from the related articles, research papers, and reports of Ministry of agriculture, ICAR report, startup's India report, some has been furnished from the website of agricultural startup's, incubators, and department of agricultural websites.

3.1 Role of Agri-Startups for Agricultural Development

A startup refers to a company recently founded in the market and is currently in the phase of validating its business model. Typically, startups are known for their innovation and disruptive nature, as well as their high-risk product concepts and relatively low operating costs (Ries, 2012). A startup diverges from a conventional company in its initial focus; while the latter pursues growth and profitability, the former aims to validate whether its business model can evolve into a sustainable and profitable venture. As uncertainty surrounding the viability of the business model dissipates, the startup transitions to a new stage, where its primary objective shifts towards growth and profitability, aligning with the goals of established companies (Blank & Dorf, 2012).

There are different classifications of start-ups proposed by different authors, Ramos and Pedroso (2020) proposed a model (Fig.1) has an amplitude that covers the entire agricultural production chain. Its configuration allows the separation of the agtechs that provide services in the initial stage of the operational production process (supplies and equipment category) from those that provide services to the final consumer (consumption category)

Fig.1. Classification of startup proposed by Ramos and Pedroso (2020)



The roots of trends in the global technology market can be traced back to Silicon Valley in the US. Since it emerged from an innovative environment, the agricultural industry has been in the forefront of developing and applying new technology for production processes. Due to this, investments have increased significantly, influencing the "Agri-tech revolution"—a term used to describe businesses creating new technology for use in agriculture (StartAgro, 2016). Agristartups are offering new business models and promoting innovative forms of collaboration amidst digital transformations. The use of AI and IT in agriculture during this digital revolution has accelerated the development of technologies like drones, robots, and sensors that can take and recognise pictures, monitor field conditions, soil quality, water resources, nutrients, and even control machinery and equipment remotely (Pham; Stack, 2019; Boursianis et al., 2021).

Both large and small-scale farms can use this new agricultural paradigm, which is revolutionising field operations and having an influence on customers,

producers, and society at large (Miranda et al., 2019). AgTechs—tech-driven businesses with an emphasis on agribusiness solutions—are actively looking for customised solutions to increase yields and accomplish the objective of guaranteeing future-proof food production (Dutia, 2014). (Kakani et al., 2020). AgTechs, according to Dutia (2014), have the enormous potential to completely transform the agricultural industry by utilising technological breakthroughs to increase productivity while also lowering the costs associated with production techniques on the social and environmental fronts.

Mendes et al. (2021) have delineated that prominent enabling technologies include the Internet of Things (IoT), blockchain, robotics, smart devices, big data, cloud computing, ICT, cyber-physical systems (CPS), sensors, and artificial intelligence. To increase technical efficiency in agricultural operations, a lot of focus is placed on integrating smartphones and mobile technologies, frequently in connection with the Internet of Things (IoT) and digitization (Schulz et al., 2021). However, as Yoon et al. (2021) have emphasised, the effective integration of these disruptive technologies necessitates a careful assessment of their utility to farmers, giving top priority to the creation of innovations that solve their core problems or demands.

3.2 New Business Models by Agritech Companies in the Agritech Space

3.2.1 Margin-Based Model

According to this business model, the agritech player generates margin by establishing marketplace linkages at the input or output side and by providing fulfilling services in segments like "market linkage – farm inputs" and "supply chain tech and output market linkage."

3.2.2 Subscription-Based Model

Agritech companies that operate in the "precision agriculture and farm management," "quality management and traceability," and other categories provide a range of hardware, software, and services-based solutions all year long. They charge their clients a monthly or yearly subscription fee.

3.2.3 Transaction-Based Model

Participants in the "financial services" market use a transaction-based pricing strategy that takes into account the volume of loans or insurance policies they provide.

According to the study by Florida and Hathaway (2018), there is an extensive increase in startup and venture capital activity since 2009. Globalization processes and the new era of technological innovation rapidly change the geography of startup activity around the world.

Savin Et.al, 2023 did a comprehensive analysis of global startup activities utilizing textual descriptions from the Crunchbase database, covering a significant dataset of 250,252 startups founded between 2009 and 2019. Employing topic modeling, the researchers devise a novel classification system comprising 38 distinct topics, aiming to offer a classification free from expert bias.

The study identified trends over time and variations across geographical regions. Notably, certain topics exhibit upward trajectories, such as data analytics and AI, time management, social platforms, and financial transfers including cryptocurrency. Conversely, downward trends are observed in sectors like mobile gaming, online social networks, marketing services, online news and blogs, and legal and professional services.

3.3 Agri-Startups Revolutionizing the Value Chain

Technology adoption in agriculture has a US$24 billion market potential and is assisting in the resolution of numerous issues along the traditional agriculture value chain. (Table.1)

Table 1: Pain Points and Market Potential in the Agritech Segment

Pain-point	Agritech segment	Market potential
Volatility in input prices; sub-optimal input selection	Market linkages – farm inputs	US$1.7b
Limited access to technology for efficient cropping	Precision agriculture and farm management	US$3.4b
Uneven quality and lack of large scale testing	Quality management and traceability	US$3.0b
Inefficient post-harvest supply chain	Supply chain tech and output market linkages	US$12.0 b
Lack of access to financial solutions	Financial services	US$4.1b
Volatility in input prices; sub-	Market linkages – farm inputs	US$1.7b

optimal input selection		
Limited access to technology for efficient cropping	Precision agriculture and farm management	US$3.4b

Source: Industry discussions, EY analysis

Each pain point in the agritech segment presents a unique opportunity for entrepreneurs to start agristartups and tap into significant economic potential:

3.3.1 Volatility in Input Prices and Sub-Optimal Input Selection

Agristartups focusing on improving market linkages for farm inputs can address this challenge. By providing farmers with better access to information and resources, such startups can help optimize input selection, leading to more efficient use of resources and potentially saving billions of dollars in the market.

3.3.2 Limited Access to Technology for Efficient Cropping

There is a substantial market potential for agristartups specializing in precision agriculture and farm management. By leveraging technology such as drones, sensors, and data analytics, these startups can help farmers improve crop yields, reduce resource wastage, and enhance overall efficiency, unlocking a market worth billions of dollars.

3.3.3 Uneven Quality and Lack of Large-Scale Testing

Agri-startups focusing on quality management and traceability can address this pain point. By implementing technologies like blockchain and IoT, these startups can ensure transparency and accountability throughout the supply chain, thus improving quality standards and capturing a significant portion of the market potential worth billions of dollars.

3.3.4 Inefficient Post-Harvest Supply Chain

Agri-startups specializing in supply chain technology and output market linkages have a vast economic potential. By streamlining post-harvest processes, reducing wastage, and improving market access for farmers, these startups can tap into a market worth billions of dollars, contributing to a more efficient and sustainable agricultural ecosystem.

3.3.5 Lack of Access to Financial Solutions

Agristartups offering financial services tailored to the needs of farmers can address this pain point. By providing innovative financial products and services, such as microloans, crop insurance, and digital payment solutions, these startups can empower farmers and unlock a market worth billions of dollars, driving financial inclusion and economic growth in the agricultural sector.

Agri technology start-ups are such a meaningful solution across the agricultural value chain and can be in the form of a product, a service, or an application.(Table.2). These startups can leverage technology, data analytics, and modern farming techniques to address the gaps in the existing agricultural ecosystem. By introducing smart farming practices, efficient supply chain management, and financial solutions tailored for small-scale farmers, agristartups can play a pivotal role in transforming the agricultural landscape. Their nimbleness and adaptability make them well-suited to provide scalable and sustainable solutions, ultimately contributing to the growth and resilience of the agriculture sector.

Table 2: Value Chain Segments Supporting the Agristartup Ecosystem

Value chain	Segments	Segment that support broader agristartup ecosystem
Farm inputs	Market linkage-farm inputs Biotech	Financial services loans and credit arrangements for the purchase of equipment, inputs, etc. Crop insurance and reinsurance Information platforms online platforms for agronomic, pricing, market information Farming, cultivation and harvesting Distribution and transportation
Farming, cultivation and harvesting Distribution and transportation	Farming as a services Precision agriculture and farm management Farm mechanization and automation Farm infrastructure	
Post-production processing and handlining Retailing/ selling	Quality management and traceability Supply chain tech and output market linkage	
Consumer		

Source: Industry discussions, EY analysis

3.4 Role of Agri Startups in India's Agricultural Revolution

The startup ecosystem is essential to the agriculture sector's steady progress towards digital transformation in India since it brings innovation and disruption to areas that are desperately needed. Agriculture has historically required a structured institutional focus for technology adoption, and technology companies are attempting to enter the agricultural market with more modern business models (NASSCOM 2019). These startups employ a variety of technological advancements. In terms of infrastructure (storage and warehousing), farm automation (digital farming, advisory services), precision agriculture, input delivery and advisory, market linkages, agri-finance and insurance, agri-biotech (new inputs, postharvest methods), etc., they develop products and/or services to improve efficiency at various stages of the value chain. Technology has the potential to significantly enhance agriculture advice services for farmers, bringing objectivity and transparency in the post harvest value chainVarious business models have emerged in India in the agricultural space, including downstream 'farm-to-fork supply chain model, IoT or big data-led innovation model and the upstream marketplace model. These agristartups are leveraging technology, for instance, data digitization, SaaS (software as a service), machine learning, data analytics, artificial intelligence (AI), Internet-of-Things (IoT), satellite data, drone, and blockchain, to make agriculture and agri-industry more efficient (Mikhailov et al., 2019).

Table 3: Focus Areas of Major Agri-startups in India

Focus Area	Services	Startups
Big Data	Determine Soil and Crop Health, Drones, or tractor-based solution to get data on field, Data based decision making to farmers for improving productivity and reducing unit costs.	Agrostar, RML
Farming as a Service	Agri-equipment renting, because moderns equipment is expensive these services can reduce input costs for small and marginal farmers.	EM3, Ravgo, Oxen,andFarmart
Market Linkage Models	Timely and accurate estimation of sowing and harvesting in sync with consumer demand.	MeraKisan
Fintech for Farmers	Digitise payments for farmers through payment gateways linked their accounts, create credit profile environment for funders and lenders	PayAgri
IOT for Farmers	Smart farming like high-precision crop control, data collection, automated farming, information about crop yields, rainfall patterns, pest infestation and nutrition.	CropIn

Source: Chandana, T. & Madhuri, K.

3.5 Role of Support Systems, like Various Schemes Incubation Facilities like MANAGE-CIA, in Propelling the Success of Agri-Startups and Contributing to Socio-Economic Development

Various national initiatives taken up by the departments and organisations are given below

3.5.1 Rashtriya Krishi Vikas Yojana - Remunerative Approaches for Agricultural and Allied Sector Rejuvenation (RKVY-RAFTAAR)

The Department of Agriculture, Cooperation, and Farmers Welfare (DACFW), Ministry of Agriculture and Farmers Welfare, introduced the Rashtriya Krishi Vikas Yojana — Remunerative Approaches for Agricultural and Allied Sector Rejuvenation (RKVY RAFTAAR) scheme in 2018. This initiative, falling under the "Innovation and Agri-Entrepreneurship Development" segment, seeks to strengthen the incubation environment and offer financial backing to agricultural startups. Through the creation of new avenues and the promotion of job opportunities for young individuals, the program aims to boost farmers' earnings. The RKVY-RAFTAAR Agribusiness Incubation Centers, totaling 24 across India, receive support from five Knowledge Partners, including

esteemed institutions such as the National Institute of Agricultural Extension Management in Hyderabad and the Indian Agricultural Research Institute (IARI) in New Delhi. These partners also serve as Centers of Excellence in Agribusiness Incubation, offering guidance to entrepreneurs in both the conceptualization and expansion phases of their ventures.

3.5.2 Department of Science and Technology (DST)

This department operates Science Technology and Entrepreneurship Parks across India, supporting entrepreneurs in establishing and expanding businesses, particularly those leveraging advanced technologies. The National Science and Technology Entrepreneurship Development Board (NSTEDB), established in 1982 under DST, assists individuals in transitioning from job seekers to job creators through science and technology interventions.

3.5.3 Atal Innovation Mission (AIM)

A flagship initiative of the Government of India under NITI Aayog, aims to cultivate a culture of innovation and entrepreneurship nationwide. AIM designs programs and policies to foster innovation across various sectors, promoting collaboration among stakeholders and overseeing the country's innovation and entrepreneurship ecosystem.

3.5.4 The Department of Biotechnology (DBT)

DBT operates the Biotechnology Industry Research Assistance Council (BIRAC), which supports emerging biotech enterprises in strategic research and innovation. BIRAC provides financial assistance of up to Rs 50 lakh through the BIRAC BIG Grant to address nationally relevant product development needs.

3.5.5 The Ministry of Micro, Small & Medium Enterprises

Runs the ASPIRE scheme, which promotes innovation, rural industry, and entrepreneurship by establishing Livelihood Business Incubators and Technology Business Incubators. Startups can receive funding of up to Rs 4 lakh at the ideation stage and Rs 20 lakh at the scale-up stage under this scheme.

3.5.6 Pradhan Mantri Mudra Yojana (PMMY)

The Pradhan Mantri Mudra Yojana, launched by the Prime Minister, offers low-interest loans through MUDRA Banks to micro-finance institutions, benefiting startups and MSMEs with loans of up to Rs 10 lakh across three categories.

3.5.7 Agri-Clinics and Agri-Business Centres (ACABC), DAC&FW, MoA&FW

A Ministry of Agriculture initiative, ACABC aims to provide self-employment opportunities to agricultural graduates, promote entrepreneurship, and support farmers through consultancy services for overall agricultural development.

3.5.8 MANAGE-CIA

The MANAGE Centre for Innovation and Agripreneurship (MANAGE-CIA) operates as a Center of Excellence in Agribusiness Incubation and a Knowledge Partner for RKVY-RAFTAAR Agribusiness Incubators (R-ABIs). It offers guidance, best practices, and implementation support for Startup Agribusiness Incubation and Agripreneurship Orientation Programmes under the RKVY-RAFTAAR scheme.

The project collaborates extensively with startups across India, having supported over 158 grantees with substantial financial backing, facilitating their growth and development. Through this initiative, significant funds totaling nearly Rs 15.88 Crores have been allocated, empowering these innovative ventures to thrive. With a primary focus on agricultural advancement, efforts have directly impacted an impressive outreach of over 8.5 lakhs farmers, catalyzing positive change at the grassroots level. Leveraging strategic partnerships and robust market strategies, collaboration has facilitated the successful launch of more than 350 products, effectively meeting diverse consumer demands. Moreover, collective endeavors have contributed to the creation of over 760 direct employment opportunities, while also fostering numerous indirect employment avenues, bolstering economic prosperity across various sectors. Notably, dedication to innovation has resulted in the protection of over 50 intellectual property rights, safeguarding the unique technologies and brands developed by these startups, thus ensuring their sustainability and continued growth in the dynamic Indian market. (Source: http://cia.manage.gov.in/)

Table 4.Few successful startupsfrom MANAGE- CIA are listed bellow

Name of the startup	Focus area	Location
SNRAS Systems	Aquaculture	Pune, Maharashtra
Agrirain	Irrigation as a service	Hyderabad, Telangana
Pakshimitra	NET ZERO Poultry Farm/ Waste Management	Pune, Maharashtra
Marut Drones	Precision agriculture, Agriculture automation and intelligence	Hyderabad, Telangana
North-East Farm Sales	Value addition and Marketing	Guwahati, Assam
Bariflolabs	Aquaculture	Bhubaneswar, Odisha
Turf Pearl Agritech – Dr Vishwa Priya & Dr Siva.	Essential oils	Madanapalle, Andhra Pradesh
Agriwala	Organic farming	Maharashtra
Roots goods	Post harvest	Bangalore

4 CONCLUSIONS

This paper aimed to showcasethe pivotal role of agri-startups as engines of economic growth and agents of transformation within the agricultural sector. Through the application of modern technologies and indigenous innovations, these startups are not only enhancing production, efficiency, and profitability but also positively contributing to income and employment generation. Despite the myriad challenges facing the Indian agriculture sector, including inefficient supply chains, post-harvest losses, soil health issues, and climate change, agri-startups find fertile ground for innovation and opportunity. Leveraging cutting-edge technologies such as digital media, AI, IoT, and Big Data, these startups are redefining agricultural extension services and advancing the agenda of profitable and sustainable agriculture. Furthermore, the concept of value chain extension underscores the symbiotic relationship between agri-startups and the evolving agricultural value chain, positioning them as crucial players in transforming agriculture into agribusiness. Supported by incubation facilities like MANAGE-CIA, these startups are guided towards successful ventures, contributing not only to employment opportunities but also to inclusive socio-economic development. Thus, this paper provides a comprehensive understanding of the evolving landscape of agricultural extension and highlights the indispensable role of agri-startups in fostering sustainable growth and development within the agricultural sector.

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