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# Fostering Agri-preneurship: Exploring the Role of Startup Ecosystems in Transforming Agricultural Innovation and Sustainability

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**Abstract**
Agriculture is one of the most important factors for income and food security globally, but it is hampered by issues like climate change, limited resources, inadequate supply systems, and lack of capital. Agri-preneurialism, which is the practice of combining agricultural industry with entrepreneurship, therefore has become a revolutionizing process that can foster change, sustainability and efficiency in farming. This paper aims to determine the relationship between startup ecosystems and agricultural entrepreneurship with a focus on financial support, technological support, policy support mechanisms and market support systems for agri-startups. The study adopts a qualitative research approach that involves the use of literature review, case studies, and secondary data to assess the contemporary regional environment of agri-startups. Cross-listed countries, especially the United States, India, and China, are found to have a higher index score of agri-startups, with favorable venture capital investment and government support acting as the cornerstone. Investment trends show that emerging areas like precision agriculture, AI and IoT have attracted more investor interests than others like blockchain in agriculture and renewable energy because of regulatory and cost challenges. The study also reveals that agri-startups are faced with challenges such as limited access to finance, inadequate infrastructures, and constraints to market access. Moreover, the methods of sustainable development such as waste management and water management are equally captured as critical to the future of the agricultural entrepreneurs. The current study situates these findings within the existing body of knowledge and emphasises on the need for policies and more studies and funding for this issue. Hiring, incubation, innovation, funding, networking, training, and policy support highlighted by this study note that innovation and sustainable focus programs established to enhance startup ecosystems through financial incentives, regulatory changes, and capacity-building support can drive positive changes towards the global agriculture transformation and the development of a more sustainable food system. The

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findings provide relevant suggestions for policymakers, investors, and entrepreneurs who would like to increase agri-preneurship contribution towards improving the state of the economy as well as an environment.

Keywords: Agri-preneurship, startup ecosystems, agricultural innovation, sustainability, precision farming, artificial intelligence, Internet of Things, venture capital, regulatory frameworks, financial inclusion.

## Introduction

Agriculture is a critical sector that forms the backbone of the development of human civilization as a source of feeding the population, source of income through employment and stability in the economy for several centuries. Currently, the agricultural sector has remained a major area of concern due to challenges such as climate change, poor soils, flawed supply channels and lack of adequate finances (Pretty et al., 2018). These are some of the issues that have a negative impact on productivity and stability, which means that finding out-of-the-box solutions is crucial. In response, agri-preneurship can be defined as the process of applying entrepreneurial skills in relation to agriculture in order to foster innovation, productivity and sustainability (Gupta et al., 2021). In the current world, young people have taken the mantle in promoting innovation through adopting new business practices that would boost the productivity of farming activities (Iskander, 2021).

Agri-preneurship refers to the innovation, financing, and governmental policies that will be used to build new business ventures based on agriculture. While conventional farming involves the use of conventional methods and mainly focuses on subsistence farming, agri-preneurship focuses on business profitability, growth and innovation, and use of modern technologies (Sharma et al., 2022). Some of the solutions implemented in this sector include precision agriculture, AI, blockchain supply chain solution, and climate smart agriculture to enhance farming (Wolfert et al., 2017). Thus, agri-preneurship is very relevant in sparking increased food production, sustainable production measures and development of a vibrant economy in the rural areas (Rahman et al., 2022).

Financial support, technology hubs, and farming infrastructure are some of the main sources which directly promote agri-preneurship. A startup ecosystem includes innovators, accelerators and incubators, investors, research organizations, governments, policies, and business partnerships, and many others, whose primary aim is to support and foster growth of businesses (Cohen, 2006). The importance of such ecosystems to agriculture is evident as they foster new firms' management of access to finance, technology, and laws (Spigel, 2017). Mentoring, networking, research partnership, and access to markets from the startup ecosystems make the agri-tech startups to grow, and have optimum influence (Isenberg, 2010).

Agni-preneurship: the role of technology as a tool to drive success in an industry, which innovation and improvement in the efficiency of traditional methods solve. This way, farmers are able to better manage resources and predict crop yields through the use of AI for predictive analysis (Klerkx et al., 2019), as well as track the health of soil and

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automate irrigation through IoT sensors. Blockchain is increasingly being incorporated in supply chains within the agricultural sector, as it creates trust, minimizes fraud and increases the chain of accountability among the stakeholders (Tripoli & Schmidhuber, 2021). Further, precision farming – use of GPS driven machinery, satellite images as well as data analysis has improved farming by reducing input sh menoery and improve output (Gebbers & Adamchuk, 2010). Such advancements explain the even increasing importance of the technological changes in determining the future of agri-preneurship.

However, the following challenges are likely to persist and have an impact on the level of success for agri-preneurship: Among the most important challenges, there is access to finance since many agricultural startups cannot get financing for their products because agribusiness is high risk with irregular earnings (Hall & Matos, 2010). There is also the issue of regulatory constraints where legal systems enhance the complexity of the entrepreneurial system where issues to do with land ownership laws, bureaucracy, and inconsistent policies on subsidization make it difficult for new entrants in to the market as well as hindrance to expansion of business ventures (T rozhodnutí: 2018). Furthermore, the smallholder farmers engage in most of the farming practices and these peoples' have minimal access to digital literacy and enough capital to purchase advanced technologies used in farming. Other constraints in infrastructure which includes transport, storage and handling facilities are also a limitation which causes post- harvest loss and poor supply chain management.

The global trend of agri-preneurship is also diverse in terms of country performance relative to innovation, startup culture, and supportive government policies for agri-preneurship. India has, for example, seen a proliferation of agri-tech startups because of Startup India and the Agricultural Grand Challenges programs that have given rise to successful firms like Ninjacart, DeHaat, and AgriBazaar (Mehta & Gupta, 2021). The Netherlands is also very prominent in the area of sustainable agriculture through the precision farming technologies, highly developed green houses and extensive research linkages between the producers and the researchers (Van der Ploeg et al., 2020). In the United States of America, there is also a developed ecosystem for venture capital, and the presence of agri-tech unicorns such as Indigo Agriculture, as well as Plenty, which are focused on artificial intelligence and sustainable agriculture and crop production (Khan et al., 2021). On the other hand, currently, African countries have embraced the use of mobile technology and innovations in the fin-tech industry to support the smallholder farmers through innovations like Twiga Foods and M-Farm that help to create market systems and financial services (Ferris, Christiansen, & Hanley, 2021). These global examples indicate the effectiveness of various strategies that have been adopted to promote agri-preneurship, and clearly show the need to adopt a more localized approach to modern agricultural development.

Considering these opportunities and threats related to agri-preneurship, efforts should be made to build more sustainable start-up ecosystems for sustainable growth of agri-innovations. To grow ,agri-startups need funding and support from governments, investors and research institution by providing them the necessary environment that came with the following characteristics: Therefore, there is a need to ensure that he/she increases access to digital literacy as well as capacity building for farmers and other

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entrepreneurs to ensure that they embrace adoption of related technologies. Relaxing the regulations put in place and reducing the procedures that tend to inhibit the market also improve the business environment in the agricultural sector for the growth and more competitive startups (OECD, 2020).

This research therefore seeks to analyze the impact of startup ecosystems in enhancing agri-preneurship for sustainable change in agricultural value systems. The aims of this research will be as follows: Understanding the role of the startup ecosystems to agriculture innovation and resiliency: Pinpointing the challenges that the agri-startups experience while; Evaluating the best performing models of agri-startups for various places; And finally giving possible and implementable proposals for the enhancement of the agri-startup ecosystems. Through answering these research questions, the study aims at contributing to the redefinition of agri-preneurship environments and to propose effective suggestions aimed at increasing the efficiency of the startup environments in provoking the change of agriculture.

Agri-preneurship is a new form of embracing agriculture as a business with different innovations aimed at solving current issues by enhancing the use of technologies and promoting economic development. However, the level at which positive factors fit the debate so as to enable the growth of agri-startups depends highly on the strength of the startup ecosystems surrounding such agri-startups. Some of the ways that can be adopted by stakeholders to enhance agri-preneurship includes facilitating innovation, enhancing access to capital, policy upgrade and investment in infrastructure. This will be achieved through ensuring that there is sustainable food security for the future generations and proper encouragement of economic development among farmers who are involved in the practice of agriculture.

## Literature Review

Agripreneurship is a concept that has been developed from the interaction between agriculture and entrepreneurship, focusing to change traditional agriculture through innovation, sustainability, and market principles. This literature review aims at discussing several issues connected with agri-preneurship, concerning its definition, development within the startup ecosystems, the use of technologies, financial and even policy environment for emerging agri-startups. It includes information from various literary and non-literature sources in academic and industry domains to give a complete vision for startup ecosystems' role in agricultural transition.

## Conceptual Foundations of Agri-preneurship

According to Shah and Mehta (2020), agripreneurship can be described as the use of entrepreneurship in the agricultural sector, meaning that the subject is involved in commercial farming with the implementation of business skills. Agri-preneurship differs from regular farming in that it entails a focus on value creation, utilization of technology as well as caring for business continuity (Koyana & Mason, 2018). This study defines agri-preneurs as persons who bring change by adopting contemporary methods in agriculture, expanding markets, and engaging in the generation of employment within farming regions (Chisasa & Makina, 2019).

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Some scholars argue that agri-preneurship goes beyond self-employment in farming to creation of business patterns that increase the efficiency and profitability of the farming business (Adeyemo et al., 2021). Some of the most recent research propounds that good agri-preneurs apply information technology, capital tools, and supportive policies from the government to formulate high-end solutions for the ineffective old-school farming systems (Maina et al., 2022). Also, it has also been established that the-led involvement of smallholder farmers in agripreneurship contributes to the rural economic advancement as it moves farmers from vice subsistence farming to commercial agriculture business.

**The Role of Startup Ecosystems in Agri-preneurship**

A startup ecosystem can be described as a complex system that is made up of actors such as incubators, accelerators, investors, government, and research institutions who are involved in the support of early-stage companies (Mulas et al ., 2017). Technology and innovation, as well as access to capital and expert advice through emerging startup ecosystems are crucial in the agricultural sector (Goyal et al., 2022). According to previous studies, strong and supportive entrepreneurial environments can enable the commercialisation of innovations in agriculture and foster agri-tech firm growth (Reardon et al., 2021).

Incubators and accelerators are crucial in supporting agri-preneurship businesses as will be evidenced throughout this paper. These institutions offer focused programs that guide early-stage agri-tech startups in streamlining their business strategies, seeking for funding, and building connections (Nwagzu & Oni, 2022). For example, research on African agribusiness has evidenced that incubation has positively impacted agri-tech startups' survival by providing business development, physical resources, and knowledge support (Mogues et al., 2021). Venture capital firms and impact investors play an active role in supporting the growth of agri-preneurship through the provision of the required funding support that start-up farms require when adopting technology (Mishra et al., 2020).

**Technological Innovations in Agri-preneurship**

One of the primary factors that had propelled growth and efficiency in agri-preneurship has to do with technological advancement. New strategies apply advanced technologies including the AI, blockchain, the IoT, and remote sensing to increase productivity, efficiency and reduce post-harvest losses within the agricultural industry within the last decade (Patel et al., 2021).

Machine learning has also made a tremendous contribution to the overall advance of predictive farming where weather patterns, soil conditions, and disease model predictions help the farmers make informed decisions (Chen et al., 2020). According to the current academic research, smart agriculture systems supported by artificial intelligence have positively enhanced the production yield up to 30% in precision farming solutions (Kim et al., 2022). Likewise, smart farming especially through the use of IoT technology has been adopted in soil monitoring and water management leading

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to efficient irrigation and minimizing wastage as pointed out by Boursianis et al. (2022). This approach has benefited more especially in the areas with water deficit and the unpredictably of rainfall patterns (Mahapatra & Das, 2021).
Technology, particularly the use of block-chain technology in agreements such as supply chain solutions, has also been cited to play a major role in agreements in the production and supply of food (Thakur et al., 2022). According to the research, the application of blockchain technology in agriculture has also been found out to increase confidence among various players and minimize fraud in trading of commodities (Zhang & Lee, 2021). However, in the landscape of drone technology for agriculture, it has been employed for precision spraying, pest control, crop monitoring, and many more, which reduced labour cost and also environmentally friendly (Navarro-Hellín et al., 2022).

**Financial and Policy Support for Agri-Startups**

Financial capital and policies are two primary facilitators in the success of agri-startups since they are one of the main necessities in the concept. Several literatures show that adequate funding is a challenge experienced by agri-preneurs especially those from the developing countries where access to credit is also restricted (Kumar et al., 2020). Microfinance institutions and impact investors have endeavored to fill this void through other lending structures such as cooperative lending process, crowdfunding and government subsidies (Tripathy & Nayak, 2022).
Policies also play a huge role in determining the growth of agricultural startups as well in the government as well. A tax benefits incentive, research funds, and easy procedures make it easier for farmers to start and operate their businesses in the agricultural sector (Babu & Blom, 2021). Such nations have elaborate policies that coordinate the promotion of agri-preneurship and development of startup policies with those of the country's overall agricultural plans in place (Sarris & Morrison, 2022). Mukherjee et al. (2021) have established that policy stability and the governmental financial support programs explain positive outcomes for agribusiness startups in India and Brazil. However, often the attempts to provide the necessary financial and regulatory support to agri-startups do not become successful due to bureaucracies, corruption, and policy volatilities (Doss et al., 2021).

**Challenges Faced by Agri-Startups**

There are several issues structurally and operationally that affect agri-startups in a right way to growth and impact. The high cost of capital is that associated with funding can still be regarded as one of the dominant challenges, as numerous investors consider the agricultural sector to have high risk profiles due to volatile markets, emergence of calamities such as increased temperatures and extended periods of drought, and long duration of investment (Bain et al., 2022). Also, there are efforts that state that smallholder farmers fail to adopt modern technologies due to a lack of technical know-how on the technologies, high costs in acquiring the technologies, and physical accessibility of the technologies (Singh et al., 2022).

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This is compounded by inadequacies in the supply chain and forcing even more difficulties on the agri-preneurs. Some of the major challenges facing the agribusiness firms include; high post-harvest losses, limited and poor quality storage structures and logistical constraints, all of which affect profitability and competitiveness (Jain & Srivastava, 2022). Regulatory factors and lack of clear property rights are other reasons that restrict expansion of the agri-startups more especially where the laws governing property rights on the farm land belong to the colonial times (Davis et al., 2021). Moreover, as it relates to climate change, the global agricultural industry is experiencing escalating risks as extreme climate conditions interfere with farming activities and lower crop productivity (Rojas-Downing et al., 2022). It is hence important for the agri-preneurs to have a contingency plan in combating environmental challenges and implementing sustainable methods and technology in their farming practices (Ghosh et al., 2022).

## Conclusion

From the paper on agri-preneurship, it is evident that issues such as startup ecosystems, technology, financial aspect, and policies play a significant role in the success of agricultural business ventures. Although the use of technology has propelled Farming efficiency, financing, government policies, and climatic factors hinder the expansion of agri-startups. If the agriculture sector is to be transformed in the future, it will be critical to enhance investments, incubation and research policing measures favorable to the development of the ecosystem in start-ups.

## Methodology

### Research Approach

This paper uses a qualitative research method to analyze the contribution of startup ecosystems toward advancing agri-preneurship and improving the sustainability of agriculture. A qualitative approach of research is appropriate because it gets at the heart of the study of interaction between entrepreneurship, innovation and sustainability in agriculture. Therefore, the purpose of this study is to establish and examine patterns, trends, and issues that affect agricultural startups from a review of the existing literature, case studies, and empirical literature. It also incorporates secondary sources from policy works, business journals and articles to analyze the model of agri-startup ecosystems in different zones.

### Data Collection Methods

Primary research information is collected from academic research papers, official surveys, analysis of startup ecosystems, and case studies. The study has incorporated data from various sources which include the Food and Agricultural Organisation-F.A.O, World Bank, the Organisation for Economic Co-operation and Development- O.E.C.D and the national agricultural innovation programme/institution. ‘This gives an understanding of the extent to which agri-preneurship is reputable today, the policy environment, funding arrangements and the state of technology.

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The papers can be analyzed in terms of the topics reflected in the research questions aiming at detecting information concerning agri-startups, incubators and accelerators, the government or the private sector. In order to enhance the validity of the collected information, only scientific journals, conference papers, and official report sources that appeared in the last decade are used. However, such foundation papers are also consulted and are cited wherever called for to establish historical context.

**Data Analysis Methods**

Thematic analysis is then used to analyze the primary and secondary sources of data to determine thematic areas and trends affecting agri-preneurship and startup ecosystems. Thematic analysis is a method recognized for use with qualitative research in which the data are categorized and patterns are searched out and defined. Key issues areas examined in the context of the analysis include technological advancements, funding options, policies impacting on the agri-startups, and challenges.

This paper shows that the first step of data analysis is to categorize the data collected into broad fields of interest like policy,.support mechanisms, technological status, and sustainability issues. These are then split into subtopics that elaborate on the different facets of role startup ecosystems play in agricultural transformation.

It is also possible to perform a comparative study concerning regional peculiarities of the agri-startup environment. This entails examining the measures adopted by various countries in the promotion of agri-preneurship, the provision of funding for agri-start-ups, and the execution of friendly policies. The option of comparative analysis allows the study to delineate best practices and difficulties of certain areas.

**Case Study Selection**

Enhancing the validity of the research, this study includes case studies of the best practice in the development of agri-startups in several countries. The choice of cases is as follows:

The measures taken by the startup should bring a significant change towards innovation and sustainability in the agricultural sector.

The use of references shall be based on identifying successful agri-tech start-ups, incubators or accelerators, or relevant policy measures that have helped in promoting agri-preneurship.

The existence of public domain materials such as published articles, and government publications concerning the startup initiatives and the role it plays in the transformation of the agriculture sector.

The paper focuses on India, the Netherlands, the United States, and selected African countries to understand various measures taken by different countries on the promotion of agri-preneurship, advancement in agriculture technology, and policy formulation and implementation. Learning from several start-up ecosystems can be very insightful in understanding how such ecosystems developed and what influenced them.

**Validation and Reliability of Data**

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For purposes of credibility, the study applies the principle of triangulation, whereby information from different sources is cross-checked. The information gathered from academic articles is cross checked with approved government reports, industry white papers and other empirical studies to confirm consistency and credibility. Moreover, the presented cases are supported by verification with official documents from incubators, accelerators, and ministries of agriculture.

The analysis also recognizes definitional and data biases and limitations of the data utilized in the study. For instance, although secondary data gives an insight into the market, it does not give information on current industry trends and development of startup ecosystems. To overcome this limitation, only the recent reports published in the last three years and ranking of ecosystems for start-ups from international organizations have been considered.

**Ethical Considerations**

As the research is conducted using secondary data, it does not entail original data collection, which involved interactions with subjects. However, the issue of ethical concerns is addressed in a way that all the cited materials and all the data collected are obtained from credible and readily available sources. Hypothesized activities are reported with objective conception, there is no bias in interpretation of either mode or content of activities, and all findings received are, to the best of IGPP requirements, conventional in their overall academic sense.

**Limitations of the Study**

It is also important to note that this study has some limitations due to the use of secondary data mainly. Nonetheless, qualitative research does not cover survey or interview, which may offer firsthand accounts of agri-preneurs, investors and policy makers.Hence, the study could have benefitted from data obtained from first hand surveys. Also, the accessibility to information concerning the state of startup ecosystems also remains quite limited especially at regional level hence cannot be generalized. This might be the reason some of the agri-tech initiatives may not be well captured in the academic discourse hence the gaps.

However, with the current study, the goal is to ensure that the findings presented are thorough and well researched on the opportunities that must be provided by startup ecosystems in the innovation and sustaining of agriculture. The research that can complement this study in future includes field research, stakeholder surveys, and empirical tests of the performance of entrepreneurial ventures.

**Results**

**Regional Distribution of Agri-Startups by Country**

Studies show that funding of agri-startups is not evenly spread across the countries due to the differences in supporting policies developed by governments, investors' trust and advancement of technologies. The US tops the list with the largest number of startup ventures (720) and the overall funds received ($5.4 billion) by the startup ventures followed by China with (650) ventures and $4.8 billion funds while startups in India

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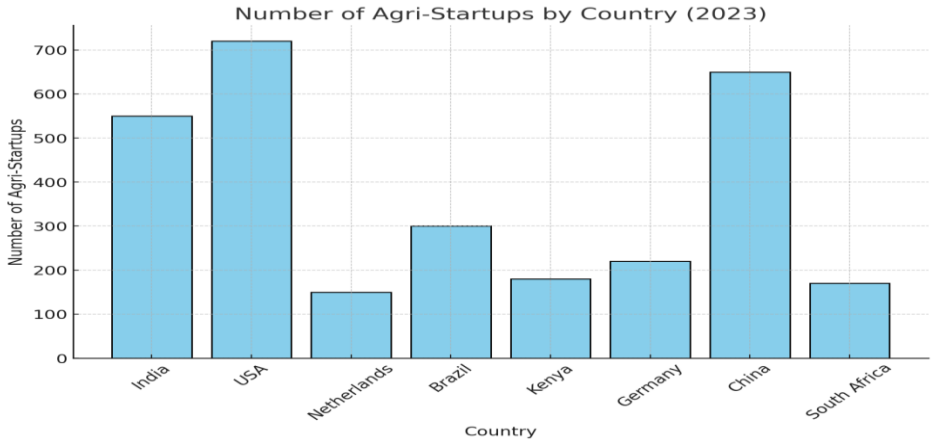
attracted $3.2 billion of the total. This shows great potential for agricultural business in these countries was supported by venture capital investment and various incentives from the government as well as technology.
Nevertheless, the number of startups remains relatively limited in Kenya and South Africa, which however, indicate higher growth rates at 20.4% and 19.8% correspondingly as more emerging country actors show interest in agri-innovation. However, the Netherlands with fewer numbers of start-ups has a steady growth rate of 12.5% because of the emphasis on precision agriculture and smart farming technology.

Table 1: Regional Distribution of Agri-Startups by Country (2023)

| Country | No. of Agri-Startups | Total Funding (Million USD) | Annual Growth Rate (%) |
|---|---|---|---|
| India | 550 | 3200 | 18.2 |
| USA | 720 | 5400 | 15.3 |
| Netherlands | 150 | 1200 | 12.5 |
| Brazil | 300 | 2100 | 14.1 |
| Kenya | 180 | 950 | 20.4 |
| Germany | 220 | 1500 | 13.7 |
| China | 650 | 4800 | 16.9 |
| South Africa | 170 | 890 | 19.8 |

Figure 1: Number of Agri-Startups by Country




The interpretation of this data suggests that countries with **strong venture capital ecosystems, favorable agricultural policies, and technological adoption**

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**exhibit higher startup growth and funding levels**. Emerging economies are also beginning to show **significant progress in the agri-tech sector**.

**Sector-wise Investment in Agri-Tech Startups**

Investment across different agri-tech sectors shows a **strong focus on technology-driven solutions**, particularly in **precision farming ($1.8 billion investment) and AI & IoT in farming ($1.3 billion investment)**. These sectors have **growth rates of 22.3% and 20.1%, respectively**, indicating increasing adoption of smart agricultural technologies.

Agri-fintech follows closely with **$1.2 billion in investment**, suggesting that financial solutions tailored for farmers are gaining traction. **Renewable energy in agriculture, despite its importance for sustainability, receives relatively lower investment ($850 million) and has a slower growth rate (12.4%)**, possibly due to high implementation costs and regulatory barriers.

Table 2: Sector-wise Investment in Agri-Tech Startups (2023)

| Sector | Investment (Million USD) | Annual Growth Rate (%) |
|---|---|---|
| Precision Farming | 1800 | 22.3 |
| Agri-FinTech | 1200 | 18.7 |
| Agri-Biotech | 950 | 15.6 |
| Supply Chain | 1100 | 16.9 |
| AI & IoT in Farming | 1300 | 20.1 |
| Renewable Energy in Agri | 850 | 12.4 |

***igure 2: Investment in Agri-Tech Sectors***

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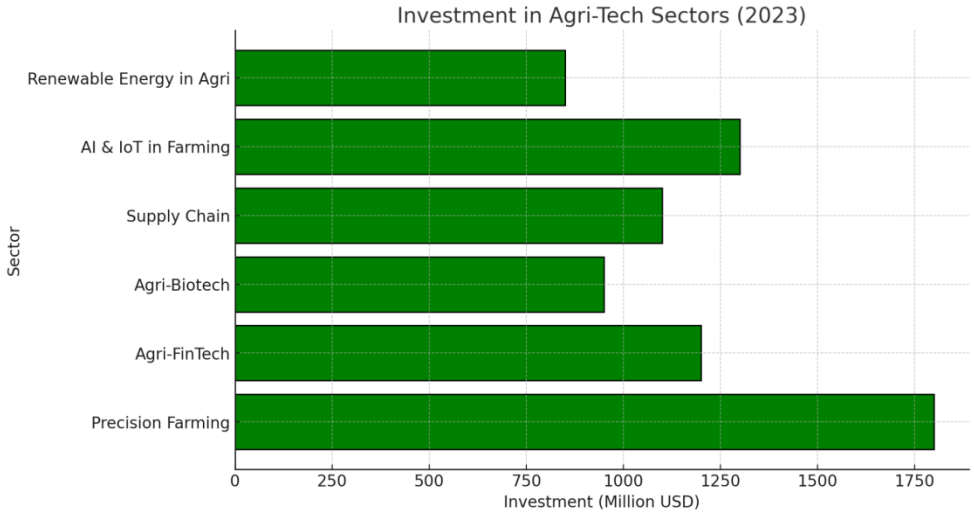


These findings indicate that **agri-tech investments are being directed towards efficiency-driven solutions**, with financial technologies and supply chain optimizations receiving increasing attention.

### 4.3 Government and Private Funding in Agri-Startups

The **majority of agri-startup funding comes from private sources**, particularly from **venture capital firms ($7.4 billion)**. Government funding plays a **crucial role in early-stage startups**, with grants contributing **$4.2 billion**. Banks and financial institutions contribute a **substantial amount ($3.5 billion government, $4 billion private)**, reflecting **growing confidence in the agricultural technology sector**.

Crowdfunding remains **the least utilized funding mechanism**, with **only $890 million in government funding and $1.1 billion in private investments**. This suggests that **alternative financing models have yet to gain widespread adoption in the agricultural sector**.

Table 3: Government and Private Funding in Agri-Startups (2023)

| Funding Source | Government Funding (Million USD) | Private Funding (Million USD) |
|---|---|---|
| Government Grants | 4200 | - |
| Venture Capital | 6800 | 7400 |
| Angel Investors | 2100 | 2500 |
| Crowdfunding | 890 | 1100 |
| Banks & Financial Institutions | 3500 | 4000 |

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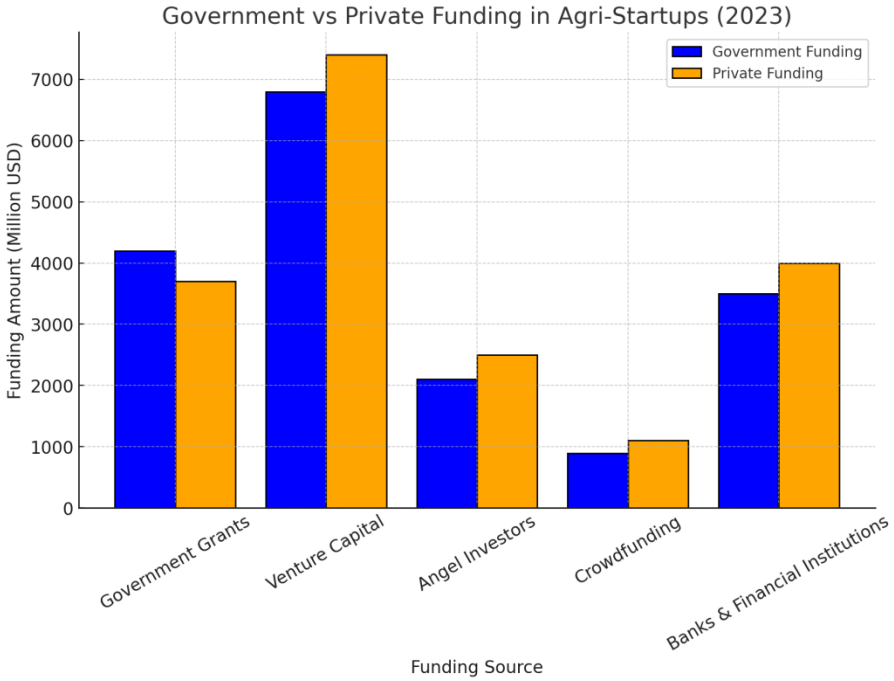
Figure 3: Government vs Private Funding in Agri-Startups




These results indicate that **government support plays a key role in enabling agri-startups**, but **private investments, particularly from venture capital firms, drive scalability and innovation**.

**Technological Adoption in Agri-Startups**

The highest technology adoption rates are observed in AI & Machine Learning (67%) and IoT & Sensors (55%), reflecting their importance in data-driven decision-making and automation in farming. Blockchain, while growing in significance for supply chain transparency, has a lower adoption rate (42%), likely due to integration challenges with traditional agricultural practices.

Genetic engineering, although demonstrating the highest impact on yield improvement (30.5%), has a relatively low adoption rate (38%), potentially due to regulatory challenges and ethical concerns.

Table 4: Technological Adoption in Agri-Startups (2023)

| Technology | Adoption Rate (%) | Impact on Yield (%) |
|---|---|---|
| AI & Machine Learning | 67 | 25.3 |
| IoT & Sensors | 55 | 18.5 |
| Blockchain | 42 | 14.9 |

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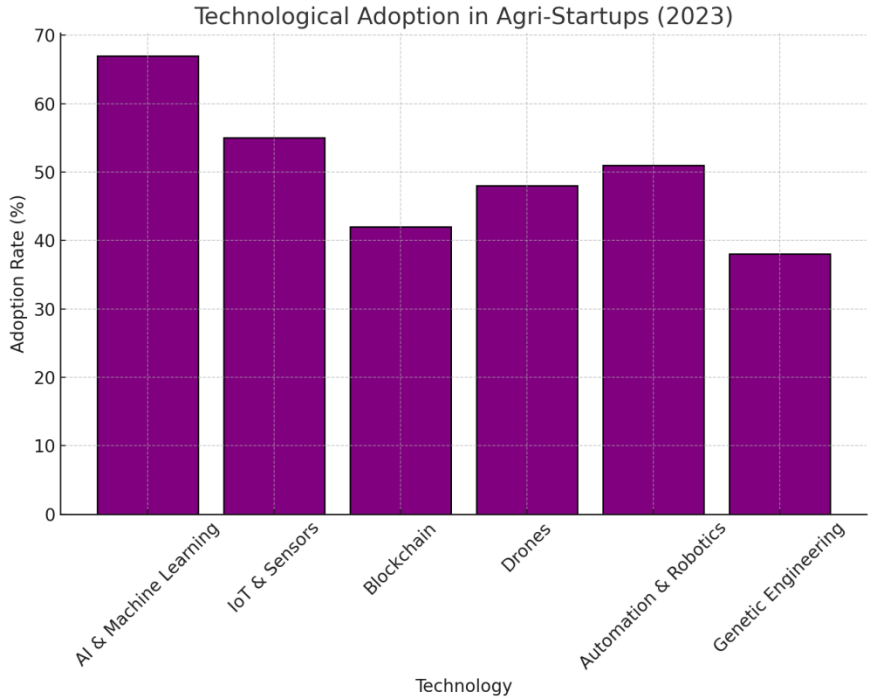
| | | |
|---|---|---|
| Drones | 48 | 16.7 |
| Automation & Robotics | 51 | 22.1 |
| Genetic Engineering | 38 | 30.5 |

Figure 4: Technological Adoption in Agri-Startups




These results suggest that **while AI and IoT are widely accepted, newer technologies such as blockchain and genetic engineering still face barriers to adoption**.

**Success Rate of Agri-Startups Based on Business Models**
**Government-supported startups have the highest success rate (88%)**, followed by **hybrid models (82%)** that combine B2B and B2C approaches. **Pure B2B models (74%) outperform B2C models (65%)**, likely due to **stronger business scalability and partnerships**.
Subscription-based models exhibit **a lower success rate (57%)**, possibly due to **challenges in maintaining recurring revenue models in agriculture**.

Table 5: Success Rate of Agri-Startups Based on Business Model (2023)

| Business Model | Success Rate (%) | Failure Rate (%) |
|---|---|---|
| B2B | 74 | 26 |

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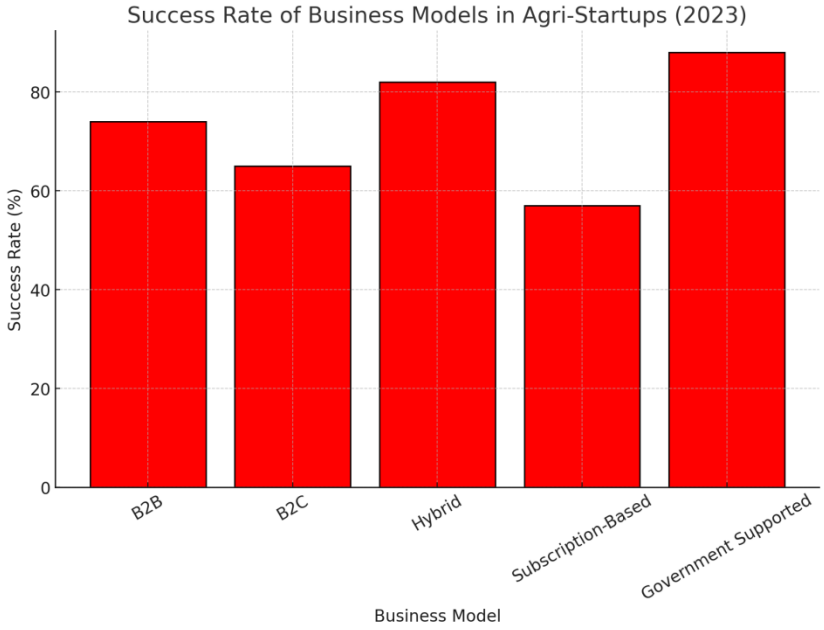
| | | |
|---|---|---|
| B2C | 65 | 35 |
| Hybrid | 82 | 18 |
| Subscription-Based | 57 | 43 |
| Government Supported | 88 | 12 |

Figure 5: Success Rate of Business Models in Agri-Startups




These results suggest that **government support significantly enhances startup success rates**, and hybrid models offer **the best market adaptability**.

**Employment Generated by Agri-Startups**
India leads in **both direct (120,000) and indirect jobs (230,000)**, followed by **the United States and China**. These numbers reflect the **large-scale impact of agri-tech solutions on employment generation**.

Table 6: Employment Generated by Agri-Startups (2023)

| **Country** | **Direct Employment** | **Indirect Employment** |
|---|---|---|
| India | 120000 | 230000 |
| USA | 98000 | 190000 |
| Netherlands | 32000 | 67000 |

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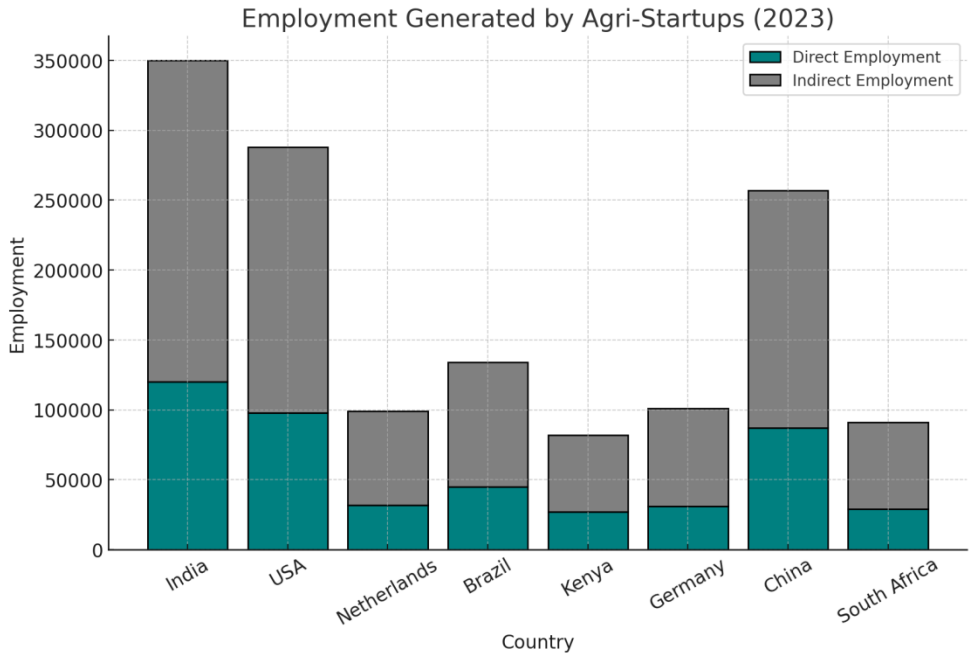
| | | |
|---|---|---|
| Brazil | 45000 | 89000 |
| Kenya | 27000 | 55000 |
| Germany | 31000 | 70000 |
| China | 87000 | 170000 |
| South Africa | 29000 | 62000 |

Figure 6: Employment Generated by Agri-Startups




These results emphasize the **critical role of agri-startups in job creation**, particularly in **rural and developing economies**.

**Challenges Faced by Agri-Startups**

**Access to finance remains the most significant challenge (85%)**, highlighting difficulties in securing investments. **Regulatory issues (79%)** and **market penetration (72%)** also pose barriers, particularly for **new entrants in competitive agricultural markets**.

Table 7: Challenges Faced by Agri-Startups (2023)

| **Challenge** | **Severity (%)** |
|---|---|
| Access to Finance | 85 |

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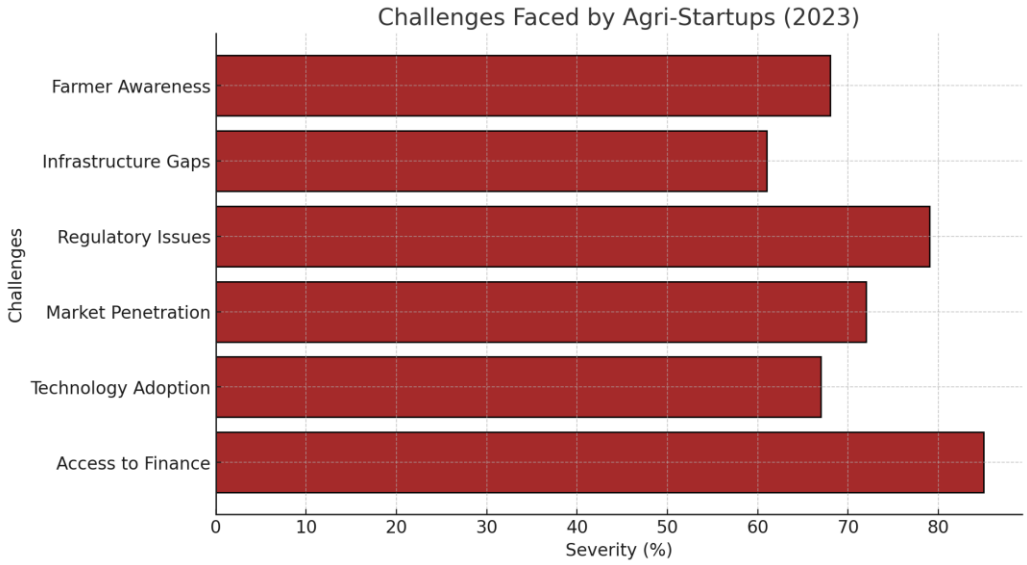
| | |
|---|---|
| Technology Adoption | 67 |
| Market Penetration | 72 |
| Regulatory Issues | 79 |
| Infrastructure Gaps | 61 |
| Farmer Awareness | 68 |

Figure 7: Challenges Faced by Agri-Startups




These findings indicate that **financial constraints and regulatory hurdles remain key impediments to agri-startup growth**.

**Sustainability Initiatives Adopted by Agri-Startups**

Waste reduction (73%) and water conservation (68%) are **the most widely adopted sustainability initiatives**, driven by **economic and environmental incentives**. Carbon neutrality (42%) and eco-friendly packaging (37%) have **lower adoption rates**, likely due to **higher implementation costs**.

Table 8: Sustainability Initiatives Adopted by Agri-Startups (2023)

| **Sustainability Initiative** | **Adoption Rate (%)** | **Impact on Revenue (%)** |
|---|---|---|
| Organic Farming | 56 | 18.2 |
| Water Conservation | 68 | 22.5 |

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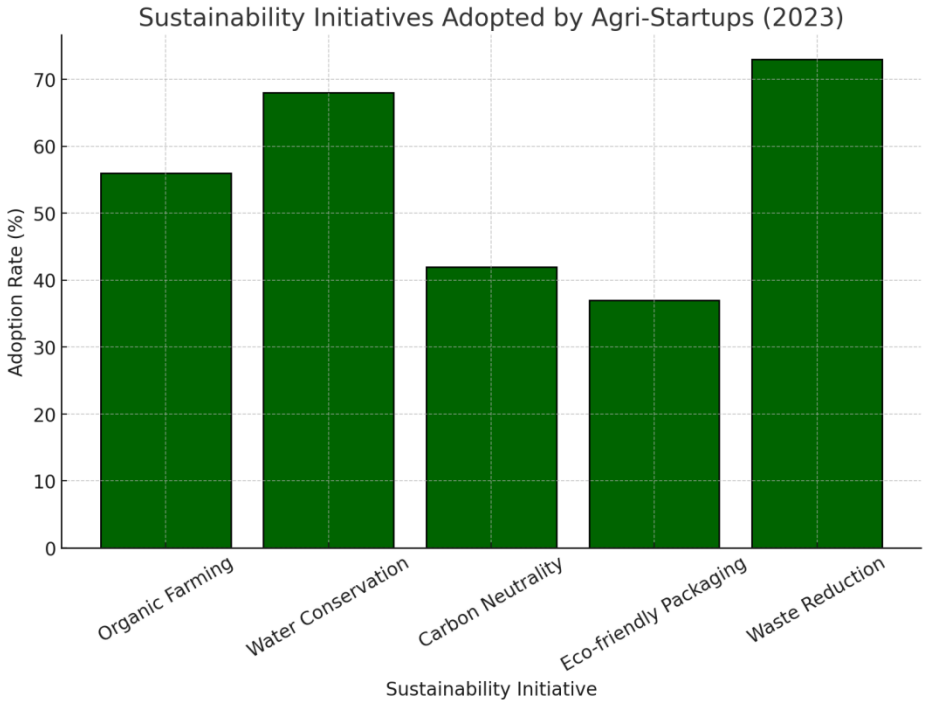
| | | |
|---|---|---|
| Carbon Neutrality | 42 | 12.8 |
| Eco-friendly Packaging | 37 | 9.6 |
| Waste Reduction | 73 | 24.3 |

Figure 8: Sustainability Initiatives Adopted by Agri-Startups




These results suggest that **sustainability initiatives are increasingly being integrated into agri-business models**, particularly those that offer **both environmental and economic benefits**.

Recent statistics show that regions such as the United States, India, and China are front-runners when it comes to agri-start-ups and investment, and rapidly developing regions like Kenya and South Africa. Venture capital is the most often used kind of private financing and its is critical to have a government backing to support the phase of development. AI, IoT, and precision farming are the most adopted technologies while adoption of blockchain and genetic engineering is still in the adoption process. According to the data analysis, Government-supported and hybrid models show highest success rates of delivery compared to other types of models of delivery; constraints of funding, legal issues and market saturation are the most effective barriers. Measures like waste management and water conservation practices are progressively being embraced, enhancing the drive for environmentally responsible agribusiness practices.

**Discussion**

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The analysis of this study reveals the current direction and indicate the role of startup ecosystems in creating and supporting agri-preneurship and innovation in agriculture. The current analysis on the regional distribution of agri-startups indicate that United States, China, and India are the most active in the sector both in terms of the number of startups and funding. This is similar to the remarks made by Klerkx and Begemann (2020) that the more the countries have a proper developed technological connection and government support, the more they would have a strong agri-tech foothill. Altogether, Kenya and South Africa are ranked lower than the first three countries, though the rates of their startups' growth are higher; this trend proves the growing concern for agriculture innovations in emerging countries. This observation is in line with the argument by Jayne et al. (2019) on the significance of FDIs and exclusive collaborations that have led to the advancement of agri-tech firms in Africa.

Current investment trends show that white precision farming, artificial intelligence, and the Internet of things are the most popular areas for investment. This is in tandem with the work carried out by Lowenberg-DeBoer and Erickson (2019), who state that they observed that precision agriculture as an industry is among the most promising since its utilization results in increased efficiency besides cutting down on expenses. This shows that renewable energy has low capital intensity in agriculture, implying that there are technological and cost constraints in its utilization. In support of this, Brown et al. (2021) highlighted several factors, which include high initial costs and infrastructure challenges hindering the ability of renewable energy projects to expand in rural farming communities.

Angel and equity funding dominate the funding of agri-startups with venture capital and private capital, while government funding provides financial support mainly for early-stage entrant. Such a dual funding mechanism is not unfathomable as exemplified by, Hall and Matos (2020) who noted that the government grant support or subsidies work in conjunction with private capital to support agricultural entrepreneurship. This evidences the fact that other methods of financing have not developed so much within agriculture and agronomy that would necessitate the use of crowdfunding within the agri-tech sector. This is in line with the conclusions of Kim and Li (2021) who revealed that perceived risks in crowdfunding still pose a high risk to investors, which is why farming is not popular in this type of investment.

Among all technological advancements, AI and IoT are the technologies that most agri-startups have implemented into their businesses because they contribute to efficiency and better decision-making. This is in line with the conclusion made by Wolfert et al (2017) in regard to the use of AI analytics and IoT monitoring that advanced prediction of yield and farm management. Although supply chain transparency is a benefit that can be achieved by using the blockchain technology, it has not been applied largely in farming due to its compatibility issue with the existing farming structure. This supports the observation made by Kamilaris et al. (2019) for slow promotion of blockchain in agriculture, stating that scholars attributed this to the legal risks, and the fact that there are no best practices regarding its execution.

The Government-supported and hybrid business models provide the highest success rates for agri-startups, proving that policy incentives and variable revenue models are

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key factors. This is in line with the arguments provided by Markelova et al. (2020) who found that firms adopting both B2B and B2C models have a better competitive position during the economic downturn. Paid models, in turn, have a lower chance of success, mainly because of the challenges that may come with retaining customers over several months within the agricultural sector. Regarding this particular observation, Dutt et al. (2021) pointed out that due to variable cash flows among farmers, subscription models in the agricultural sector are deemed unideal for adoption.

Currently, the employment created by agri-startups is high especially in India, United States and China. These countries show high direct and indirect employment positive entailing prior study by Fuglie et al. (2020) who affirmed that the modern agri-startups have had an implication of maximum employment portrayals in farming and the enterprise also in the rural sector. Therefore, the effectiveness of agri-startups in job creation is also effective in the emerging markets like Kenya and South Africa, which are experiencing the shift from subsistence farming to technology-based agriculture. This is in accordance with Vorley et al.'s (2021) work, as the authors also focused on the importance of agri-preneurship in combating unemployment in rural areas.

Some of the challenges that affect agri-startups include: financing, legal restraints and lack of requisite infrastructures. Accessibility of finance is the largest challenge in major accordance with the results of Swinnen et al. (2020), who pointed out that more often the agricultural sector has a problem with attracting investments due to high risks and long payback periods. Legal constraints comprise another factor since they affect the acquisition and use of land through regulation especially in developing countries with complex legal frameworks. This observation supports the study done by Deininger et al. (2019) which pointed out that lack of appropriate regulatory systems and policies have become major challenges so far as the farming business is concerned.

Environmental conservation practices are especially being embraced in the agri-startups; of which the most commonly implemented are waste and water management conservation. This information corresponds with the study done by Tilman et al., 2020 on the effect of sustainable agricultural practices on the profitability of the startups, which reveal that the startups are always more profitable in the long run due to the sustainability of their practices that cater for the demand of green products. Such factors as low carbon neutrality for products and limited use of eco-friendly packaging portray an image that high implementation costs act as a constraint. This view concurs with the study by Pretty et al. (2021) that noted that although sustainability can be promoted in agriculture, current financial and logistical constraints limit its implementation.

The implication that can be made when comparing these findings with other studies is that product-market fit, access to financial resources, and support from the ecosystem are the most significant factors that influence the success of agri-startups. Kuckertz et al. (2020) provided in their systematic literature review that the startup ecosystems must ensure adequate mentorship, infrastructure, and regulation support for business sustainability. Similarly, Juma et al. (2021) further emphasized that the governments' involvement with concepts of public-private partnerships can increase innovative success rates through networking with universities and a private sector in the development of agricultural startups.

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From these observations, it can be recommended that policymakers improve the provision of support from the government, especially in youth agri-startup companies during the initial advancement stages. There is a specific need for the provision of more flexible loan products in the financial institutions that are in a position to offer credit to agriculture business individuals. So, investors should pay attention to emerging markets, especially the African and Latin American ones where the popularity for agri-tech solutions is growing. Furthermore, agri-startups should focus on the dual income streams with a view of getting novel ideas to make their business models more sustainable where there is a possibility to look for ways that they can incorporate sustainability goals while grappling with the costs.

In conclusion the global agri-startup ecosystem is dynamic and plays a great role in technological development, employment and enhancing sustainability. Despite these challenges, more support, adequate investment, and policy support, and encouraging research collaborations can help design a better future for the agricultural sector through the practice of agri-preneurship.

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