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Strategic Entrepreneurship: From Science Laboratory to Commercialization of Disruptive Agri-biotechnology Crop Innovations in Kenya

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Abstract

Commercialization of Agri-biotechnology research outputs has remained low. The government of Kenya has implemented multiple policy frameworks to support the growth of the Agri-biotechnology industry. It has developed an elaborate approval process for Agri-biotechnology innovations. However, despite the huge potential of Agri-biotechnology crop innovations, *Bt* cotton remains the only product approved in Kenya for commercial cultivation and human use since 2019. This represents a paltry 2.5% of the approved in-house research projects. The industry has not been able to translate its Agri-biotechnology crop research and development into marketed products. Therefore, this study investigated the effect of strategic entrepreneurial mindset, entrepreneurial culture, strategic entrepreneurial leadership, and strategic resource management on the commercialization of Agri-biotechnology crop innovations.

The study was founded on four theories: Technology Commercialization Theory, Strategic Entrepreneurship Theory, Knowledge Spillover Theory, and Theory of Traditional Agriculture.

A descriptive survey research design was employed. Primary data was collected from 46 scientists from 15 organizations involved in Agribiotechnology research and development in Kenya. The data was analyzed through descriptive statistics, correlation analysis, and multiple linear regression using SPSS version 30. Strategic entrepreneurial practices had a positive and statistically significant effect on the commercialization of Agri-biotechnology crop innovations.

This study underscores the critical role of strategic entrepreneurship in the commercialization of Agri-biotechnology crop innovations in Kenya. By fostering an entrepreneurial mindset, cultivating an entrepreneurial culture, and optimizing resource management, organizations can effectively turn their innovations into market-responsive products.

Keywords: Strategic entrepreneurship, Commercialization, Agri-biotechnology, Disruptive innovations, Entrepreneurial ecosystem

1. Introduction

1.1 Background

The agricultural sector remains the backbone of most developing countries' economies as they grapple with poverty. However, Africa has the lowest agricultural productivity, with predominantly subsistence farming (Aragie et al., 2016). Climate change has accelerated biodiversity loss, undermining global food security (Otieno et al., 2022). This has prompted research aimed at developing ways of overcoming these challenges. Innovation has emerged as one way of enhancing advancements in the agricultural sector to solve these modern-day global challenges. One of the areas that has emerged from this is biotechnology.

Biotechnology is a field of technology that utilizes living organisms or their by-products to either make new products or improve existing ones (Kivuva et al., 2017). Biotechnology has evolved significantly since the early 20th Century, beginning with the discovery of antibiotic penicillin and continuing to the present day, where biotechnology innovations played a key role in combating the COVID-19 pandemic. The global biotechnology industry is rapidly expanding. According to Precedence Research (2023), the industry was valued at $1,224.31 billion in 2022 and was expected to surpass $3,200 billion within this decade, with an exponential growth rate of 12.8%. Agribiotechnology has revitalized hopes for sustainably producing food for the rising global population. There has been an increase in genetically modified (GM) crops that are resistant to various environmental stresses (Masehela & Barros, 2023).

The Cartagena Protocol on Biosafety (CPB) set the stage for proper regulation of biotechnology to promote its adoption, innovation, and trade in living modified organisms. The United States (US), Canada, Argentina, Brazil, and India are among the leading countries in Agri-biotechnology (ISAAA, 2019; Smyth et al., 2016). Agri-biotechnology continues to grow as new crop and seed varieties are developed. It has led to the introduction of improved crops with better traits like drought-resistance, pest and disease-resistance, as well as improved yields. With crops of such traits, the world can increase food security and build resilient and sustainable agricultural practices (Otieno et al., 2022).

In Africa, the adoption of Agri-biotechnology was initially slow, with adoptions only in South Africa, Burkina Faso, and Sudan. However, it has picked up with a rapid increase in GM crops and an active pipeline of Agri-biotechnology products. Nigeria, Ethiopia, Malawi, and Kenya have joined the list of countries that have approved the production of insect-resistant GM cotton varieties for commercial use. Ghana, Uganda, and Kenya are already evolving beyond small-scale field experiments to the general release of GM varieties (Komen et al., 2020). As of 2019, 29 African countries had adopted Agri-biotechnology, representing double the number of countries from 2009 (ISAAA, 2019).

Beyond developing technology to improve agriculture, an organization must be able to put the resulting products into the market sustainably and effectively. Commercialization is a key aspect of transforming the agricultural sector. It positively impacts agricultural productivity and the nutritional status of the population (Jiang et al., 2023; Minot et al., 2021). The ability to commercialize Agri-biotechnology innovations in time and efficiently encourages investment in R&D in the sector (Smyth et al., 2016). It enhances the contribution of

agriculture toward economic sustainability and can transform the agricultural sector to improve food sufficiency and nutrition (Jiang et al., 2023).

Commercialization has been defined as the process of translating ideas into product development using technology to release the products into the market (Gatignon & Xuereb, 1997). Commercialization is also a means of leveraging outcomes from an R&D process and making them available for public use (Maurset, 2020). This emphasizes the vital role of technology commercialization in product R&D and competitive advantage (Kim et al., 2020). Ludmila & Denys (2016) argue that commercialization in scientific research and technology-based industries is best measured using scientific and technology output indicators such as patents and research publications.

Low- and middle-income countries have struggled to commercialize their Agri-biotechnology innovations. This has been attributed to several factors, including stringent regulatory requirements (Komen et al., 2020; Smyth et al., 2016), low prices for cash crops (Niguse & Mebratu, 2023), and market inaccessibility (Gachuhi, 2021). The tedious regulatory approval process leads to increased costs of developing GM crops. The stringent regulatory requirements also create uncertainty, making innovations risky. The process is also resource-intensive and expensive (Ongu et al., 2023). These negatively impact the willingness of investors to invest in Agri-biotechnology innovations. Varying regulatory requirements have led to disparities between states. Low prices of staple food commodities have also discouraged huge investments in technology to improve these foods, as investors are not able to meet their expected return on investment (Smyth et al., 2016).

Strategic entrepreneurship is the synergistic integration of exploiting current competitive advantages while simultaneously exploring novel possibilities to expand those advantages in the future (Hitt et al., 2001; Ireland et al., 2001). This is the nexus between recognizing new possibilities and seeking to gain a competitive edge. In other words, strategic entrepreneurship explains how firms create and sustain competitive advantage. Simsek et al. (2017) identified three dimensions that characterize strategy and entrepreneurship: actions taken, cognitive processes underlying the actions, and a specific set of capabilities.

Withers et al. (2018) identified four dimensions in defining strategic entrepreneurship. These are an entrepreneurial mindset, entrepreneurial culture, entrepreneurial leadership, and strategic management of resources. While an entrepreneurial mindset promotes growth, creativity, and flexibility, entrepreneurial culture sets the organization's common values, and strategic leadership leads the organization towards the desired position. The authors posit that effective strategic management implementation requires a firm to combine these dimensions in its operations. The current study adopted these variables to measure strategic entrepreneurial behavior.

1.2 Statement of the Problem

The Agri-Biotechnology industry in Kenya has seen minimal commercialization of crop innovations. This is despite agriculture being the dominant sector in the economy, contributing 33% of the gross domestic product (GDP), with the potential to grow further. It ranks as the second-largest private-sector employer in the country (KNBS, 2023b). With the

poverty rate in Kenya standing at 36.15% in 2021, coupled with a rising population and climate change, Kenya has experienced a decline in agricultural productivity (KNBS, 2023a; Otieno et al., 2022). Consequently, Agri-biotechnology innovations remain vital in ensuring food security (Ahmed et al., 2021; Jiang et al., 2023; Ozor, 2015). However, there is very little commercial output to this effect.

Kenya has put in place an elaborate approval process for genetically modified innovations. There is also an active pipeline of GM crops under various stages of the approval process. Forty (40) GMO varieties have been approved for contained-use research activities (lab and greenhouse research) (NBA, 2023). Despite all these efforts, the only commercially cultivated GM crop in Kenya is the insect-resistant *Bt* cotton, which was approved in 2019 (Snyder & Kamau, 2022). This represents a paltry 2.5% of the approved in-house research projects. The players in the Agri-biotechnology industry have not been able to translate the active Agri-biotechnology innovations pipeline into marketed products to meet the population's needs.

1.3 Describe Relevant Scholarship

a) 1.3.1 Theoretical Review

The Technology Commercialization theory, also known as the Technology Commercialization Strategy (TCS), explains why firms fail to commercialize their technological innovations successfully. It also highlights the important role played by business strategy in the sustainable commercialization of innovations. It proposes that sustainable commercialization and profitability require firms to focus their resources on developing innovations that they can commercialize more efficiently than existing and potential competitors.

According to Teece (1986), firms that develop innovative products and improved processes may sometimes fail to commercialize or even sustain the profitability of their innovations. Despite having the best innovations that are most responsive to customers' needs, these firms may still lose out to imitators or competitors. He attributes this to a lack of appropriate business strategies and requisite capabilities. He argues that successful commercialization is based on three factors. First, the firm must have appropriate environmental factors outside the firm and market structure that allow it to recoup the R&D costs and make a profit. Such factors may include strong intellectual property rights protection and unique technology. Secondly, the firm must have a dominant innovation design. Finally, the firm must be able to utilize specialized and co-specialized complementary assets for the successful commercialization of its innovation. These assets include competitive manufacturing, complementary technology, marketing, and after-sales service.

This theory assumes that commercialization strategies are static and are made at the beginning of the commercialization process. This assumption has been disputed by Marx et al. (2014), who argued that a firm may switch from its initial strategy during the lifecycle of the product in the market. They also propose that commercialization strategies can change based on the type of innovative product and the industry in which the innovation has been made. This theory underpins the concept of the commercialization of innovations and highlights the importance of strategy and entrepreneurship for successful and sustainable

commercialization.

Jolly (1997) improved on this theory by arguing that commercialization is a dynamic process. He argues that technology-based innovations do not automatically have commercial potential. Efforts have to go into making commercial sense out of them, and this involves a lot of back and forth; hence, it is not a linear process. He further argues that the time-to-market varies for each technological innovation. He proposes that firms can engage in collaborative research and assign more researchers to the R&D process. He argues that market orientation should be incorporated early in the R&D process by engaging the responsible teams through collaborative efforts.

The theory of Strategic Entrepreneurship is still a relatively new concept. It sought to integrate the areas of entrepreneurship and strategic management, which had until then developed independently. Ireland et al. (2001) built on the argument that the primary goal of any organization is wealth creation and that both entrepreneurship and strategic management are actions of top managers with responsibility over the business. The theory argues that while both entrepreneurial and strategic actions are independently instrumental in organizational growth and success, integration of the two has a synergistic effect that enhances their wealth-creation effects. Entrepreneurial actions are defined as steps taken to exploit new opportunities in a fast-changing world, while strategic actions involve choosing and implementing specific strategies. Strategic actions are developed to pursue entrepreneurial opportunities.

They conclude that for an organization to be successful, it must build its strategic management process on entrepreneurial actions. For a firm to grow successfully and create wealth, it must first be profitable and then maintain a higher growth rate than its competitors in the industry. The theory proposes that "the focus of entrepreneurship is growth and innovation, while that of strategic management is gaining competitive advantage". Turning entrepreneurial opportunities into financial gain requires strategic actions (Luke et al., 2010). Therefore, the two have one thing in common: they both aim to increase wealth creation and lead to economic growth.

Hitt et al. (2001) later attribute the emergence of this concept to the digital era associated with the emergence of new technologies and increased globalization. They argue that modern-day change causes high levels of uncertainty and that with uncertainty come opportunities. Firms must be ready to spot and take advantage of these opportunities. Therefore, strategic entrepreneurship helps organizations to adapt to the dynamic industry environments and exploit these emerging opportunities. According to Hitt et al. (2011), strategic entrepreneurship involves exploiting current competitive advantages while also seeking new opportunities to sustain the competitive advantage or create new ones.

The Theory of Transformation of Traditional Agriculture classifies agricultural practices into 3 categories: traditional, modern, and transitional. It then focuses on how traditional agriculture in developing countries can transition into modern agriculture to become more productive. Schultz (1964) sought to clarify misconceptions about what traditional agriculture is. He argued that traditional agriculture has nothing to do with either the traditions of a society or the arrangement of institutions in a country. Traditional agriculture can exist in any country, whether developed or developing, and can exist in both large- and small-scale

farming. He then defines traditional agriculture as a state of economic equilibrium reached when technology in agriculture remains the same for a long time, people fully comprehend the inputs under the technology, and the cost of the inputs remains the same.

Schultz hypothesized two characteristics of traditional agriculture: allocative efficiency ('poor but efficient' hypothesis) and the doctrine of zero-value labor. He also argued that all factors of production are unemployed, hence there is no disguised unemployment. However, these have come under criticism by various scholars (Dandelar, 1966; Schultz, 1966). One of the arguments was that decisions on the allocation of resources are complex and influenced by many factors, leading to imperfect allocation.

The Knowledge Spillover theory can be traced to the scholarly works of Audretsch (1995). However, the theory was fully developed in 2009 in collaboration with other authors. It aimed to refine the endogenous growth model, which argues that economic growth stems directly from internal processes.

According to Acs et al. (2009), knowledge is a factor of production input into the research and development process to generate new technology opportunities. Consequently, a firm invests in new knowledge to grow economically. New knowledge in one firm can also inform opportunities for other firms. This is what Audretsch and co-authors call knowledge spillover. The primary firm where the new knowledge is first developed is termed the incumbent. These firms utilize the flow of knowledge to improve existing products. However, new start-up firms may use knowledge spillovers to cause radical innovations that create new products or industries. Therefore, startups are better placed to advance innovation in industries and even create new industries, as has been witnessed in the biotechnology and the information, communication, and technology (ICT) industry. The theory, therefore, assumes that new startup firms are responsible for radical innovations.

While Audretsch and co concur with contemporary theories of entrepreneurship that entrepreneurship is about recognizing and deciding to exploit opportunities, they add a new concept to this definition. The scholars advance the idea that entrepreneurship encompasses both the creation and marketing of new products and the exploitation of prospects identified by the incumbent firms that they have not commercialized. Theoretically speaking, entrepreneurship involves exploiting such opportunities, too.

The theory argues that new knowledge creates new entrepreneurial opportunities. However, these opportunities must be converted into 'economic knowledge' for commercialization. Failure to do this creates spillovers that startup firms can exploit and develop radical innovations. As a result, the scholars argue that entrepreneurship becomes a link through which knowledge spills over from incumbents, leading to the formation of new startups to exploit the knowledge.

Public institutions dominate the Agri-biotechnology industry in Kenya. Knowledge spillovers from these institutions drive Agri-biotechnology startup formation. These startups may commercialize innovations that the public institutions abandon midway. They may also utilize such innovations to develop completely new products. This study sought to explore such entrepreneurial strategies and the commercialization of Agri-biotechnology innovations. This study adopted knowledge management as a measure of the strategic resource

management variable. It embraced some of the concepts of this theory to measure knowledge management, including the qualification of research personnel.

b) 1.3.2 Empirical Review

Gupta et al. (2018) investigated how an entrepreneurial mindset affects fundamental research funding based on their value proposition. This was undertaken through a bimodal transformation that involved comparing basic and agile research, where technology commercialization is part of the research. Commercialization outcomes were measured through two key indicators: the volume of patent applications and the number of start-up ventures established. However, funding is not an end goal but rather part of the R&D exploitation process, hence, it may not be the best outcome measure.

Hayter et al. (2022) investigated how scientists develop an entrepreneurial identity to become entrepreneurs. They advanced the concept of liminal identity to explain how academic scientists can embrace entrepreneurship and commercialize their technological innovations. The study identified several factors that promote liminality, including motivation, experience, and support from social circles. It identifies intrinsic and extrinsic motivations that impact the ability to develop an entrepreneurial identity.

NawzadSabir et al. (2019) conducted a descriptive study to investigate the effect of various entrepreneurship characteristics on the attitudes toward knowledge commercialization among academic researchers. Two hundred and thirty faculty members of the University of Technology Malaysia were randomly sampled, and data were collected through a cross-sectional survey. Various measures of entrepreneurs' traits were used, including leadership, the need for achievement, risk-taking, and commitment. These were shown to have a statistically significant positive effect on one's attitude towards commercialization. While the study employed measures such as the need for achievement, commitment, and dedication to measure researchers' attitudes, this current study went ahead to investigate whether this attitude translates into actual commercialization.

Roundy et al. (2018) examined the influence of entrepreneurial alertness on the direction and performance of organizations in North Arlington, Texas, in the United States. Entrepreneurial alertness was conceptualized as the cognitive capability to sense entrepreneurial opportunities, threats, and uncertainties. This is what has been conceptualized in this study as opportunity recognition. The study had a challenge in measuring firm performance due to the reluctance of respondents, and it relied on self-reported measures, which are unreliable. Jemal (2021) analyzed how entrepreneurial mindset and capabilities influence firm performance through a systematic literature review. The entrepreneurial mindset was measured using innovativeness, creativity, opportunity recognition, proactiveness, and alertness, while commitment was one of the measures for entrepreneurial competence. While the study viewed these two as different but related factors, this current study takes the view that their measures are similar, hence, it will measure them as one variable.

Yermachenko et al. (2023) conducted a study examining the commercialization of scientific research in universities in Ukraine and Slovakia. It aimed to understand the attitude of scientists towards entrepreneurship and to identify the steps and strategies used in implementation. The study employed a meta-synthesis of past scholarly works. The study

identifies various factors that can be used to measure commercialization, including direct industry partnerships, patents, out-licensing, and creating spin-offs. It also highlights entrepreneurial strategies to promote commercialization, which are relevant to this study. Within this study's theoretical framework, internal policies, procedures, and entrepreneurial intention were operationalized as constitutive dimensions of entrepreneurial culture.

In Cubero et al. (2021), a study of the commercialization of disruptive innovations was undertaken through a systematic literature review. Sixty-four pieces of literature from peer-reviewed journals were sampled and analyzed through content analysis to identify the factors affecting commercialization and the process adopted for commercialization. Market orientation and stakeholder involvement emerged among the key constructs affecting commercialization. This current study also adopted the use of these measures of commercialization. However, the study gathered firsthand data directly from the scientists instead of relying on secondary data, as this allowed for relationship testing.

Fini et al. (2018) proposed a shift in the measurement of commercialization from entrepreneurial outcomes to the social impact of the innovations. They argue that the purpose of innovations is to impact the final consumers and that R&D processes and marketing of the innovations target these consumers' needs. They also propose the use of longitudinal and multi-level research designs in investigating the social impact of scientific innovations. While this study agrees with the assessment of different stakeholders, it took a different view on how to measure commercialization. The field of modern Agri-biotechnology crop innovations is still relatively new, with few local studies on the R&D. With the limited number of products approved for commercial cultivation (NBA, 2023), it was not plausible to assess social impacts at this point.

Maurset (2020) investigated the role of role models in commercialization through a single case study in the technology research sector. Semi-structured interviews were conducted among six academic researchers with a history of commercialization to understand their personal experiences with role models. Commercialization was measured through patenting, licensing, and university spin-offs. The data analysis also involved identifying keywords on commercialization, such as entrepreneurial education, motivation, intentions, and self-efficacy. Being a case study, the study only considered a few scientists and was limited to the university setting.

Johnson et al. (2022) investigated science commercialization by individual agents in universities across the US, the UK, and Russia through the university-centered entrepreneurial ecosystem. Forty-seven respondents engaged in the commercialization of regenerative medicine were purposively selected for a narrative interview. Commercialization support mechanisms, such as training programs, were found to be key. The study was conducted in countries considered to be developed, hence having well-developed entrepreneurial ecosystems. This current study sought to explore the existence of such ecosystems and assess their impact on commercialization in a developing country.

Kim et al. (2020) studied how technology commercialization and sustainability initiatives collectively influence firm performance. It involved a survey of 409 international firms, with the unit of observation being team leaders and executives within the R&D department. Knowledge management was estimated through learning activities and inter-departmental

collaboration, while commercialization was measured through new or improved products. However, using knowledge management alone is limited and cannot exhaustively describe the concept of strategic management. It was also the view of this study that knowledge management alone cannot fully represent management capabilities.

Gachuhi (2021) investigated the intensity of the commercialization of soybeans and its determinants among smallholder farmers in Butere, Kenya. An exploratory research design was utilized, and 201 farmers were interviewed face-to-face using a semi-structured questionnaire. Some of the variables studied included age, gender, experience in farming, income level, and education level. However, this study was limited to small-scale agriculture consumption. Ndeisieh (2018) studied the strategies for the sustainability of small businesses in Cameroon through an exploratory multiple case study design. Five small food enterprises were purposefully sampled for face-to-face, semi-structured interviews. The factors explored include education, previous experience, leadership experience, access to external support, and entrepreneurship training. The study explored a wide range of strategies, some of which are not relevant to the field of strategic entrepreneurship. The population studied was also not innovation-intensive.

Falconi (1999) surveyed agricultural biotechnology research indicators in Kenya by investigating how various resources are used. The study was conducted at one agricultural research institute, selected university departments involved in Agri-biotechnology research activities, and two crop research foundations. Among the variables measured were the number of personnel, research expenditure, source of funding, level of donor assistance, research focus areas, and purpose of donor funding. While Falconi (1999) investigated variables relevant to this study, the present study introduced a new focus on commercialization and intended to investigate how these variables relate to commercialization.

In a preliminary study exploring emerging opportunities and resources for research in Agribiotechnology research and commercialization, Nyende et al. (2013) surveyed 23 scientists drawn from selected universities and public research organizations in Kenya. The scientists were asked to describe their experience and observations on Agri-biotechnology research. Content analysis was then employed to determine challenges affecting the commercialization of Agribiotechnology research. These factors were then categorized into five resource categories.

Loganathan and Subrahmanya (2022) investigated the commercialization of agricultural biotechnology to entrepreneurial ventures through a case study of the Indian Institute of Horticultural Research (IIHR). Four startup founders, principal scientists, and the incubator managers were sampled purposively to undergo in-depth interviews. The study investigated entrepreneurship development programs as part of the variables for measuring networking. The study was limited to just one entrepreneurial opportunity, networking activities.

In a study examining the determinants of agricultural technology innovation commercialization in universities across Kenya, Ateka (2021) randomly sampled seventy-seven researchers from JKUAT's College of Agriculture. The study considered commercialization training as one of the independent variables, while spin-offs, university-industry collaboration, and commercialization strategy were used to measure the

dependent variable. The study was, however, limited to just one institution. This current study expanded on this scope to include different academic institutions and other research institutions dealing with agricultural innovations.

In summary, limited studies are focusing on agricultural innovations in Kenya. The available studies have explored different factors that affect commercialization. However, these factors are general. This study grouped these factors into strategic entrepreneurship to better conceptualize the factors. The studies also focus mainly on institutions of higher learning; hence, these results may not be directly transferable to other firms dealing with agricultural innovations. This study incorporated other firms, including the private sector and public research institutes. This ensured a comprehensive representation of players in the Agri-biotechnology industry in the study.

1.4 Study Objectives

i. To establish the effect of strategic entrepreneurial mindset on the commercialization among organizations involved in Agri-biotechnology crop innovations in Kenya.
ii. To determine the effect of entrepreneurial culture on the commercialization among organizations involved in Agri-biotechnology crop innovations in Kenya.
iii. To find out the effect of strategic entrepreneurial leadership on the commercialization among organizations involved in Agri-biotechnology crop innovations in Kenya.
iv. To examine the effect of strategic resource management on the commercialization among organizations involved in Agri-biotechnology crop innovations in Kenya.

2. Method

The Method section describes in detail how the study was conducted, including conceptual and operational definitions of the variables used in the study, Different types of studies will rely on different methodologies; however, a complete description of the methods used enables the reader to evaluate the appropriateness of your methods and the reliability and the validity of your results, It also permits experienced investigators to replicate the study, If your manuscript is an update of an ongoing or earlier study and the method has been published in detail elsewhere, you may refer the reader to that source and simply give a brief synopsis of the method in this section.

2.1 Study Design

This study adopted a descriptive survey research design. This enabled the exhaustive collection of accurate information on the characteristics of Agribiotechnology crop innovations and described relationships with other phenomena under study (Kothari, 2004). Muathe (2010) and Musau (2018) noted that descriptive research design helps avoid bias as the variables cannot be manipulated by the researcher. Since this study sought to accurately detail the commercialization of Agribiotechnology innovations and test the association between strategic entrepreneurship and commercialization, a descriptive research design was deemed appropriate.

2.2 Target Population and Sampling

The target population was 15 organizations involved in Agri-biotechnology crop research and development, as adopted and updated from the NBA (2024). The study adopted a proportionate stratified and random sampling technique, dividing the study population into three strata: academic institutions, public research institutes, and private organizations. There was a total of eighty-eight (88) scientists within the target population. These included forty-four (44) in academic institutions, twenty-five (25) in public research institutes, and nineteen (19) in private organizations. A sample size of 72 was calculated using the Yamane (1973) formula at a 95% confidence level.

2.3 Data Collection

Questionnaires were distributed using the drop-off/pick-up method to collect primary data directly from the study participants. This enabled the respondents to complete the data collection tool conveniently, resulting in favorable response rates (Wanjohi, 2023). The questionnaire demonstrated high internal consistency, with a Cronbach's alpha value of 0.898. This was acceptable since different scholars consider a minimum Cronbach's alpha value of 0.7 satisfactory (Kiprono, 2021; Ndegwa, 2022; Oduor, 2022).

2.3 Data Analysis

The data collected was analyzed through descriptive statistics, such as mean and standard deviation to summarize the properties of the data (Mugenda & Mugenda, 2019). Inferential statistics was employed to test the relationships between the variables. Correlation was used to establish the linearity of the relationship between the predictors and the outcome variable. Regression analysis was carried out to estimate the effect of the independent variables on the dependent variable (Musau, 2018). The analysis was done using SPSS version 30.0, and data visualization techniques such as tables, charts, and graphs were used to present the results.

3. Results and Discussions

The researcher distributed 72 questionnaires to scientists within the available target institutions involved in Agri-biotechnology crop innovation R&D. Only 46 responses were used in this study for data analysis. This translated to a response rate of 64%, meeting the adequacy thresholds according to Mugenda and Mugenda (2019). The respondents consisted of 31 (67.4%) males and 15 (32.6%) females (N=46). Most participants (71.7%) were associated with academic institutions, while respondents from national research institutes comprised 17.4%. Eleven percent (11%) of the respondents were from private commercial and non-commercial organizations. The study participants maintained different organizational positions. Most respondents were postgraduate students, representing 17.4% of the total, while lecturers and technicians comprised 8.7% of the participant base each. Research assistants and research scientists comprised 4.3% of the workforce among several different industry roles they studied.

The research participants showed diverse experience levels. Most (31.1%) had worked in the industry for 4-7 years. Experienced professionals with over 12 years of experience constituted a significant portion (28.9%) of the respondents.

The data revealed that approximately 84.9% of Agri-biotechnology crop innovations focused

on food crops, like maize, sorghum, millet, rice, beans, and tomatoes, highlighting the global priority of enhancing food security. In contrast, only 15.1% targeted cash crops. Specifically, cereal crops accounted for 44.0% of the Agri-biotechnology crop research, followed by 12.0% for vegetable crops, 10.8% for fruits, and 9.0% each for root and tuber crops, legumes, and beverage crops. The wide variety of crops can explain the high focus on crop innovations (75%) compared to livestock, as noted in some previous studies (Falconi, 1999).

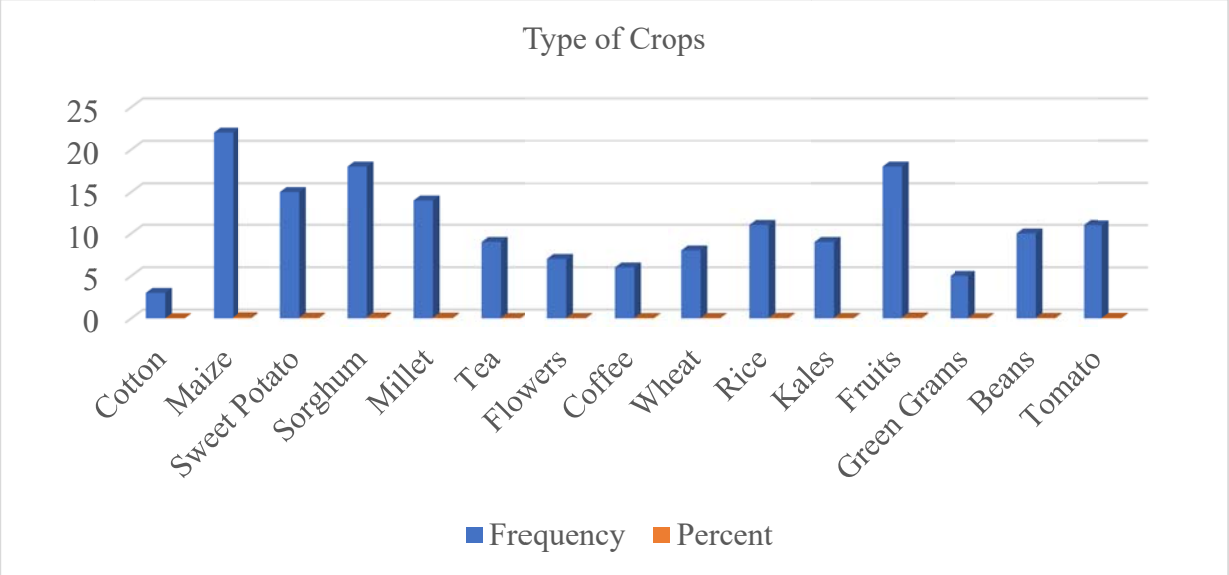

Figure 1. Types of Crops

Source: Research Data (2025)

Table 1. Sources of Funding

Source of Funding	Mean	Std. Deviation
Internal Organizational Sources	1.56	1.150
Collaboration with other Agri-biotechnology firms	1.67	1.220
Government Funding	1.63	1.127
Donor Funding	2.25	1.149
Overall	**1.78**	

Source: Research Data, 2025

Overall, the study findings revealed inadequate funding for Agri-biotechnology crop research and development, consistent with reports by Falconi (1999) and Ozor (2015). The findings also revealed an overreliance on donor funding and inadequate funding by the individual organizations. Respondents indicated that their crop innovation activities were frequently financed through donor funding (Mean = 2.25). Other funding sources were less common, including collaboration with other Agri-biotechnology firms (Mean = 1.67), government funding (Mean = 1.63), and internal organizational sources (Mean = 1.56). Ateka (2021) found almost similar results, with donor funding being the predominant source of financing.

Table 2. Correlation Analysis

Variables	Commercialization	Strategic Entrepreneurial Mindset	Entrepreneurial Culture	Strategic Entrepreneurial Leadership	Resource Management
Commercialization	1				
Strategic Entrepreneurial Mindset	.443**	1			
Entrepreneurial Culture	.543**	-.018	1		
Strategic Entrepreneurial Leadership	.321*	.103	.072	1	
Strategic Resource Management	.512**	.018	.152	.024	1

**. Correlation is significant at the 0.05 level.*

***. Correlation is significant at the 0.01 level.*

Source: Research Data, 2025

The correlation analysis showed that commercialization was positively correlated with all the variables: strategic entrepreneurial mindset, entrepreneurial culture, strategic entrepreneurial leadership, and strategic resource management. A clear linear relationship existed between commercialization and the variables entrepreneurial culture and strategic resource management ($r = .543$, $p < .01$, and $r = .512$, $p < .01$, respectively). Strategic entrepreneurial mindset and strategic entrepreneurial leadership had a moderate correlation with commercialization ($r = .443$, $p < .01$ and $r = .321$, $p < .05$, respectively). These results align with the findings of Farida et al. (2022), who found that strategic entrepreneurship mindset and strategic entrepreneurship leadership had a positive correlation with entrepreneurial value creation (p-value = 0.000 < 0.05 or sig 5%). NawzadSabir et al. (2019) also found a clear relationship between leadership and the attitude towards commercialization ($r = 0.161$, $p < .022$).

Table 3. Regression Model Summary

Model	R	R^2	Adjusted R^2	Std. Error of the Estimate
1	0.857	0.735	0.709	1.041

Source: Research Data, 2025

The regression test revealed that approximately 70.9% of the variance in the commercialization of Agri-biotechnology crop innovations in Kenya can be explained by the four independent variables of strategic entrepreneurship. The relatively small residual errors (Standard Error of the Estimate = 1.041) suggest that, on average, the predicted values are close to the actual observed values. Tijani et al. (2020) found that 44.1% of the variance in business sustainability was attributed to strategic entrepreneurship ($R^2 = 0.441$, $p<0.0$), which corroborates the findings of this study.

Table 4. ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	123.272	4	30.818	28.415	.000[b]
	Residual	44.468	41	1.085		
	Total	167.740	45			

Source: Research Data, 2025

The F-statistic of 28.415 and a p-value less than 0.001 confirm that the regression equation is statistically significant overall. The p-values for all coefficients were less than 0.05, meaning that the predictor variables significantly predicted the dependent variable. The findings confirmed that strategic entrepreneurship is a critical determinant in the successful commercialization of Agri-biotechnology crop innovations.

Table 5. Regression Coefficients

Variable	Unstandardized Coefficients (B)	Standardized Coefficients (β)	t-value	p-value
Constant (β_0)	-0.326	_	-0.456	0.651
Strategic Entrepreneurial Mindset (X_1)	0.681	0.420	5.191	0.000
Entrepreneurial Culture (X_2)	0.739	0.469	5.743	0.000
Strategic Entrepreneurial Leadership (X_3)	0.388	0.234	2.885	0.006
Strategic Resource Management (X_4)	0.699	0.428	5.257	0.000

Source: Research Data (2025)

From the above data, the resultant regression equation is;

$$Y = -0.326 + 0.681X_1 + 0.739X_2 + 0.388X_3 + 0.699X_4 + \varepsilon$$

Entrepreneurial culture had the most significant positive influence on the commercialization of Agri-biotechnology crop innovations ($\beta = 0.739$, $p < 0.05$). Organizations with policies and procedures encouraging creativity and risk-taking achieve greater commercialization of Agri-biotechnology crop innovations. Tijani et al. (2020) and NawzadSabir et al. (2019) found that a firm's performance and research commercialization, respectively, had a linear dependence on strategic entrepreneurship, as measured through innovation and risk-taking. These previous studies align with the current study in demonstrating the beneficial influence of organizational entrepreneurial culture on the commercialization of R&D innovations.

Strategic resource management was the second most influential variable ($\beta = 0.699$, $p < 0.05$). Successful commercialization of Agri-biotechnology crop innovations depends on the ability of organizations to properly manage their resources, such as technical capacity, networks, and knowledge assets. These results reinforce previous conclusions by Nyende et al. (2013) on the influence that human capacity, funding, and modern equipment have on the commercialization of Agri-biotechnology R&D outputs. Ateka (2021) also identified inadequate funding and a lack of industry-university collaboration as factors that lead to low commercialization of agricultural innovations.

Strategic entrepreneurial mindset is one of the factors driving successful commercialization of Agri-biotechnology R&D outputs ($\beta = 0.681$, $p < 0.05$). Scientists' attitudes, perceptions, commitment, and motivation for the commercialization of their innovations enhance the achievement of better results when bringing their innovations to market. Previous studies have shown that having an entrepreneurial mindset increases research funding, which promotes the commercialization of technology innovations (Gupta et al., 2018). Hayter et al. (2022) identified entrepreneurial motivation as one of the factors promoting the development of commercialization-focused entrepreneurial identity among scientists. This study's outcomes mirror those from these previous studies.

Strategic entrepreneurial leadership had the lowest yet meaningful influence on commercialization activities ($\beta = 0.388$, $p < 0.05$). Research achievement occurs under exceptional leadership because these leaders establish entrepreneurship support programs, such as training programs and technology transfer offices. Maurset (2020) determined that role models foster a culture of entrepreneurship, which enhances research commercialization, while Johnson et al. (2022) established the positive impact of training on the commercialization of R&D outputs. All these studies agree with the findings of the current study regarding the positive impact of strategic entrepreneurial activities on the commercialization of crop innovations.

Generally, the research findings demonstrate why organizations should implement strategic approaches combining leadership enhancement with resource management, mindsets, and organizational culture to achieve innovation commercialization.

4. Conclusion

In conclusion, this study underscores the critical role of strategic entrepreneurship in the commercialization of Agri-biotechnology crop innovations in Kenya. By fostering an entrepreneurial mindset, cultivating an entrepreneurial culture, and optimizing resource management, organizations can effectively turn their innovations into market-responsive products. While challenges persist — including regulatory bureaucracies, funding gaps, and poor public perception — targeted interventions can foster a more conducive environment for innovation uptake and scale. Moving forward, a coordinated effort between the government, academic institutions, the private sector, and innovators will be essential in translating Kenya's agricultural potential into sustainable economic growth and food security through Agri-biotechnology research.

References

Aragie, E. A., McDonald, S., Ferrari, E., & Dudu, H. (2016). *Investment in agricultural productivity vs rural commercialization: Which way to rapid poverty reduction in Ethiopia?*

Gachuhi, M. W. (2021). Determinants of Intensity of Soybean Commercialization Among Smallholder Farmers in Butere, Kenya. *Review of Agricultural and Applied Economics*, *24*(2), 101-111. https://doi.org/10.15414/raae.2021.24.02.101-111

Gatignon, H., & Xuereb, J.-M. (1997). Strategic Orientation of the Firm and New Product Performance. *Journal of Marketing Research*, *34*(1), 77–90. https://doi.org/10.2307/3152066

Hitt, M. A., Ireland, R. D., Camp, S. M., & Sexton, D. L. (2001). Strategic Entrepreneurship: Entrepreneurial Strategies for Wealth Creation. *Strategic Management Journal*, *22*(6–7), 479-491. https://doi.org/10.1002/smj.196

Ireland, R. D., Hitt, M. A., Camp, S. M., & Sexton, D. L. (2001). Integrating Entrepreneurship and Strategic Management Actions to Create Firm Wealth. *Academy of Management Perspectives*, *15*(1), 49–63. https://doi.org/10.5465/ame.2001.4251393

ISAAA. (2019). *Seventy Countries Adopted Biotech Crops to Provide Solutions to Hunger, Malnutrition, and Climate Change* [Press Release]. https://www.isaaa.org/resources/publications/briefs/54/

Jiang, Q., Ishdorj, A., Tabares, E., Song, S., & Norton, R. (2023, July). *The Effectiveness of Agricultural Commercialization in Improving Food Security of Rural Population in Development Countries*. 2023 Agricultural & Applied Economics Association Annual Meeting, Washington DC. http://ageconsearch.umn.edu

Kim, J., Seok, B., Choi, H., Jung, S., & Yu, J. (2020). Sustainable Management Activities: A Study on the Relations between Technology Commercialization Capabilities, Sustainable Competitive Advantage, and Business Performance. *Sustainability*, *12*(19), 7913. https://doi.org/10.3390/su12197913

Kivuva, D. M., Yegon, C. K., & Ndue, K. M. (2017). Agricultural biotechnology policy review in Africa: A case study of Kenya. *Columella : Journal of Agricultural and Environmental Sciences*, *4*(2), 47–54. https://doi.org/10.18380/SZIE.COLUM.2017.4.2.47

Komen, J., Tripathi, L., Mkoko, B., Ofosu, D. O., Oloka, H., & Wangari, D. (2020). Biosafety Regulatory Reviews and Leeway to Operate: Case Studies From Sub-Sahara Africa. *Frontiers in Plant Science*, *11*, 130. https://doi.org/10.3389/fpls.2020.00130

Ludmila, L., & Denys, B. (2016). Measuring commercialization success of innovations in the EU. *Marketing and Innovation Management*, *4*, 15–30.

Masehela, T. S., & Barros, E. (2023). The African continent should consider a harmonized consultative and collaborative effort towards coordinated policy and regulatory guidelines across the fields of biotechnology. *Frontiers in Bioengineering and Biotechnology*, *11*, 1211789. https://doi.org/10.3389/fbioe.2023.1211789

Maurset, S. U. (2020). The Influence of Entrepreneurial Role Models on Commercialization of Research from Universities. *Norwegian University of Science and Technology, Master's Thesis*, 118.

Minot, N., Warner, J., Dejene, S., & Zewdie, T. (2021, August). Agricultural commercialization in Ethiopia: Results from the analysis of panel household data. *Organized Symposium on Agricultural Transformation in Ethiopia*. 31st International Conference of Agricultural Economists, New Delhi. http://ageconsearch.umn.edu

Niguse, H., & Mebratu, T. (2023). Determinants of avocado commercialization among smallholder farmers in Shebediono Woreda, Sidama Zone SNNPRS of Ethiopia. *International Journal of Agricultural Research, Innovation and Technology*, *13*(1), 89–95. https://doi.org/10.3329/ijarit.v13i1.68054

Ongu, I., Olayide, P., Alexandersson, E., Mugwanya Zawedde, B., & Eriksson, D. (2023). Biosafety regulatory frameworks in Kenya, Nigeria, Uganda and Sweden and their potential impact on international R&D collaborations. *GM Crops & Food*, *14*(1), 1–17. https://doi.org/10.1080/21645698.2023.2194221

Otieno, G., Ogola, R. J. O., Recha, T., Mohammed, J. N., & Fadda, C. (2022). Climate Change and Seed System Interventions Impact on Food Security and Incomes in East Africa. *Sustainability*, *14*(11), 6519. https://doi.org/10.3390/su14116519

Precedence Research. (2023). *Biotechnology Market* (Global Industry Analysis and Forecast 2023-2030 1450; p. 150+). https://www.precedenceresearch.com/biotechnology-market

Simsek, Z., Heavey, C., & Fox, B. C. (2017). (Meta-)framing strategic entrepreneurship. *Strategic Organization*, *15*(4), 504–518. https://doi.org/10.1177/1476127017711720

Smyth, S. J., Falck-Zepeda, J., & Ludlow, K. (2016). The Costs of Regulatory Delays for Genetically Modified Crops. *Journal of International Law and Trade Policy*, *17*(2), 173–195.

Withers, M. C., Ireland, R. D., Miller, D., Harrison, J. S., & Boss, D. S. (2018). Competitive Landscape Shifts: The Influence of Strategic Entrepreneurship on Shifts in Market Commonality. *Academy of Management Review*, *43*(3), 349–370. https://doi.org/10.5465/amr.2016.0157