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Exploring the Impact of Agricultural Biotechnology on Green Investment and Economic Growth: A Comparative Study Under the RCEP Framework

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These days, countries are increasingly recognising the need for economic growth and green investment in response to significant environmental degradation. This aspect requires recent studies and policymakers' attention. This paper examines the effects of agricultural biotechnology on green investment and economic growth in China, specifically within the framework of the Regional Comprehensive Economic Partnership (RCEP). The study collected secondary data on China from 2003 to 2022 from the World Development Indicators (WDI). The study examines the relationship between agricultural biotechnology, green investment, and economic growth using an autoregressive distributed lag model (ARDL). It then conducts empirical analysis and verification to support its findings. The findings suggest a strong correlation between agricultural biotechnology, green investment, and economic growth in China. The study assists policymakers in formulating policies that promote green investment and economic growth by utilizing efficient agricultural biotechnology.

Keywords: Agricultural Biotechnology, Green Investment, RCEP, Economic Growth.

Introduction

Currently, thanks to advancements in statistics and communication technologies, the digital service industry is currently driving the progress of global trade in a novel manner. In addition to their efficiency in facilitating trade, e-commerce platforms also contribute to reducing transaction costs. However, the rise of digital service trade is slowly challenging the existing global labour division and distribution of benefits. Simultaneously, countries have begun to showcase variations in cooperation rules, content, and forms of digital service trade due to disparities in the comparative advantages of the digital economy. Regional integration has emerged as a crucial aspect of the current digital marketing landscape, highlighting the profound new features of economic globalisation (Zhang, Shao, Han, & Chang, 2022). The emergence of digital service trade is revolutionising the creation of global value, serving as a catalyst for the growth of global trade, and expediting the transformation of international trade patterns. According to the Ministry of Commerce's White Paper on Digital Trade Development, there was a significant increase in international digital carrier exchange export quantity in 2019, reaching a staggering 3,192.59 billion US dollars. This growth significantly exceeded the surge in trade in goods (Zhang & Lis, 2020). With a diverse population of 2.3 billion, a GDP of 23 trillion US dollars, and an additional value of 10.4 trillion US dollars, RCEP member countries form the world's largest free trade community. They have a significant influence and potential for improving quality (Koondhar et al., 2021). The signing of the RCEP will enhance the monetary integration system in the Asia-Pacific region, establish a digital alternative financial network, and collectively address the downward pressure on the global economy. The total exports of digital service trade among RCEP member states in 2019 amounted to 511.52 billion US dollars, showing a year-on-year growth rate of nearly 8%, surpassing the global average (Chen, Shuai, Zhang, & Wu, 2020). The global competitiveness of digital providers is constantly improving. However, there is still a significant disparity compared to developed nations. The e-commerce chapter of the RCEP agreement includes provisions for cross-border e-commerce, restrictions on laptop computer localization, and economic services. These provisions aim to promote industrial development and protect the sovereignty of developing countries (Zhu & Huo, 2022).

In recent years, the three major advancements in agriculture have provided significant momentum for our nation's agricultural progress. China's agricultural technological innovation has experienced a decline in its role in the financial growth of the farming sector (Liu, Zhu, & Wang, 2021). Due to its poor quality, agricultural technology innovation has historically lacked effective and sustainable input mechanisms. Currently, China's investment in agricultural research is significantly lower compared to other industries. The investment intensity is only 0.56% compared to 2.87% in other sectors. Additionally, when compared to developed countries, China's agricultural research investment is only equivalent to 20% of what developed countries invest. However, agriculture is a demanding industry that requires a significant amount of labour and capital. It also has noticeable effects on the surrounding environment, unlike other industries.

Compared to other sectors, scientific research activities have a more pronounced social aspect (Munawar, ul Qamar, Mustafa, Khan, & Joyia, 2020). The primary factor contributing to this situation is the difficulty in attaining exclusivity in the implementation of agricultural technology. The lack of a robust intellectual property protection system hampers investment in agricultural technology innovation. In order to foster agricultural technology innovation and drive technological progress in China, it is essential to address the shortcomings in the intellectual property protection system and the agricultural scientific research system. This calls for a collaborative effort between the government, national public scientific research units, and social enterprises and institutions to increase research and development in agricultural technology innovation. It is essential to consider how to incorporate technology into the agricultural production process, secure funding for rural technology innovation research and development, and efficiently allocate resources to enhance agricultural science and technology and agricultural productivity (Fu et al., 2021).

Investing in green initiatives serves multiple purposes. It helps combat environmental pollution, preserves the balance of ecosystems, conserves resources, and promotes sustainable economic and social development. Additionally, it aligns with the national policy of safeguarding environmental resources and fostering the harmonious growth of the economy (Gatto, Daniotti, & Re, 2021). Currently, the significance of green investment in the realm of modern investment and financing lies in its crucial contribution to the preservation of long-term interests and the sustainable development of human society. China's digital trade governance efforts will give the country a competitive edge and foster a positive external environment for the growth of its digital economy. Simultaneously, it offers valuable references to bolster research and development of agricultural technology across different disciplines in our nation. This will enhance the vigour of technological innovation and facilitate the widespread adoption of agricultural technology in the coming years.

The Regional Comprehensive Economic Partnership (RCEP) Agreement is a free-exchange settlement involving 15 countries. ASEAN international locations initiated and led it in 2012, with participation from China, South Korea, Australia, Japan, and New Zealand. The 10 ASEAN global places consist of Indonesia, Singapore, Brunei, Vietnam, Malaysia, the Philippines, Thailand, Cambodia, Laos, and Myanmar. Formally established in November 2020, the RCEP encompasses a population of approximately 3.5 billion individuals and boasts a combined GDP of $23 trillion. This accounts for roughly one-third of the global total and solidifies its position as the largest free trade zone in the world (Khan, Murshed, Dong, & Yang, 2021). In the field of digital exchange in services, the RCEP has important objectives. Firstly, it aims to strengthen political trust among the parties involved and provide new momentum in the fight against the global economic downturn. Secondly, it seeks to enhance cooperation to achieve mutual recognition of digital trade regulations in the Asia-Pacific region and establish institutional guarantees for the movement of digital products and services in the area. Thirdly, it is important to lower the cost of enhancing digital company trade within the region and establish a conducive environment for the growth of digital enterprises (Bashir et al., 2022).

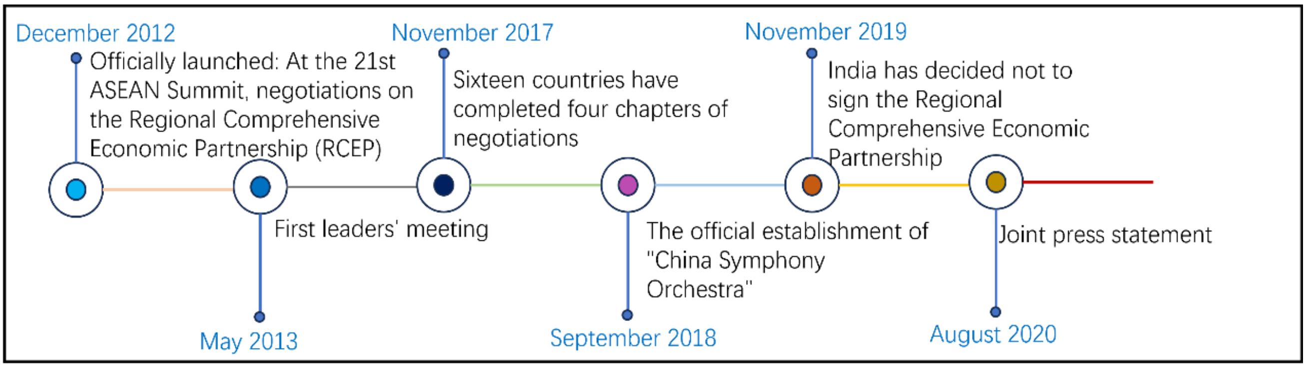

Figure 1: RECP Development.

This paper examines the current state of agricultural biotechnology research in relation to RECP. It investigates the influence of agricultural biotechnology on green investment and analyses economic data from China between 2003 and 2022. Additionally, it develops a quality index for China's economic growth and explores the effects of agricultural biotechnology on the quality of economic growth. The current chapter delves into the study background, while the second chapter provides a comprehensive review of past literature. The third chapter outlines the research methodology employed, while the fourth chapter presents the findings of the study. Finally, the last chapter engages in discussions regarding the results, study implications, and future directions.

Literature Review

During the past four decades of reform and opening up, China's agricultural scientific research system has experienced significant growth. The development of China's agricultural scientific research system is closely linked to the reform of its extensive framework, which can be broadly categorised into four distinct stages. The initial stage involves the process of healing and making progress. During this period, there was a significant increase in the number of agricultural scientific research institutions in China, and the number of personnel involved in agricultural scientific research grew from 22,000 in 1979 to 102,000 in 1985. Next, we have the industrial aspect of agricultural research (Yaqoob et al., 2023). Nowadays, agricultural research departments and institutions have become more self-sufficient by engaging in income-generating activities, rather than relying solely on government funding. Due to the intense competition in the market, there has been a decline in the number of scientific researchers. Nevertheless, the market-oriented mechanism has significantly enhanced the efficiency of agricultural scientific research. Following 1997, there was a significant shift in rural research tools and a surge in technological advancements in the agricultural sector. At this stage, it was necessary to transform agricultural research institutions into centres focused on social welfare, scientific advancements, and technological development. The goal was to establish a modern scientific research system with a well-defined classification, efficient operations, and a flexible mechanism. The emergence of agricultural firms as the central entity of scientific research provided a strong impetus for the commercialization of agricultural research (Khan, Nouman, & Ullah, 2023).

Since entering the twenty-first century, China's agricultural development has gradually shifted from labour-intensive production to the application of advanced agricultural technology in manufacturing. Throughout the years, China's central report No. 1 has emphasised the need to strongly promote the advancement of agricultural science and technology. In 2007, the No. 1 Central report proposed for the first time to "promote agricultural scientific and technological innovation and give a boost to the scientific and technological guide for the development of present-day agriculture." The report suggests that there is a need for significant improvement in funding for agricultural research. It also emphasises the importance of strengthening the innovation capacity of national and regional agricultural research facilities (Naseem, Hu, Shi, Mohsin, & Jamil, 2023). With a focus on enhancing the innovation capability of agricultural science and technology, the No.1 Central Report 2010 emphasised the need to improve the popularisation capability of agricultural technological know-how and accelerate the development of farm popularisation and software systems. Furthermore, it is important to prioritise teaching fundamental skills in agricultural science and technology, establish a variety of key laboratories and foundational platforms in the field of agriculture, and effectively distribute advanced manufacturing technologies to support agricultural production at the grassroots level (Raihan, Ibrahim, & Muhtasim, 2023).

In 2018, the No. 1 Central file introduced the "Rural revitalization strategy" which emphasised the need to focus on enhancing the manufacturing of high-end agricultural equipment and gear to modernise China's agriculture. It also advocated for the adoption of "digital agriculture" to promote the application of Internet of Things technology in the agricultural sector (Raihan, 2023). China currently promotes the establishment of contemporary agricultural industrial parks to facilitate agricultural modernization. The establishment of modern agricultural industrial parks is seen as a crucial step in addressing the imbalance and inadequacy in China's rural development. It serves as a key initiative in effectively addressing the needs of the "three rural areas" in the new era, starting from the national to local government levels. The Sichuan provincial authorities have put forward a plan to build over 1,000 demonstration parks for agricultural enterprise integration at various levels within the province by 2022. They are also actively working towards establishing several national modern agricultural industrial parks. Hebei Province has put forward a plan to build and enhance 36 modern agricultural parks at the provincial level (Shao, 2024).

Green investment encompasses various aspects of environmental pollution treatment, including investment in facilities, equipment, and expenses related to environmental protection. This includes investments in sewage discharge and solid waste treatment, as well as efficient resource development and economic utilization. Such investments involve measures such as energy saving, material saving, water saving, and land saving (Li et al., 2023b). Green investment refers to promoting increased investment in environmentally friendly initiatives. The deduction will be made from the total amount of existing social investment, specifically targeting ineffective or negative investment that is not "green," as well as investment that is not beneficial or even detrimental to human survival and development. Green investment is a type of investment that reflects people-oriented and sustainable economic and social development, as well as the scientific concept of development. The concept of the "Green vote" refers to the voting behaviour and preferences of individuals who prioritise environmental issues.

A higher proportion of "capital" in total social investment leads to increased effective and beneficial investment, resulting in greater contributions to human social development and healthy economic growth (Fang, 2023). The term "green" refers to the consideration of environmental pollution control, ecological protection, and the promotion of sustainable economic and social development in investment and financing behaviour. It plays a guiding role in the management of social and economic resources. Green investment stands out from traditional investment and financing due to its strong focus on the benefits of the human society's living environment. The implementation of this measure will contribute to the preservation and conservation of the environment. The effectiveness of an organization's activities is determined by how efficiently it utilises its resources. Economic entities should prioritise the balance of natural ecology, minimise environmental pollution, conserve natural resources, and protect the long-term interests of human society and its development. The concept emphasises the integration of economic activities, environmental protection, and ecological balance to achieve sustainable economic and social development (Lei, Yang, & Qin, 2023).

China's agricultural technological know-how innovation has historically lagged behind industrial science innovation and urbanisation. This lag can be attributed to historical and cultural factors. In the past, the shift in agricultural employment has been slower compared to changes in the industrial structure (Yang & Solangi, 2024). For a long time, the proportion of China's rural output price in GDP has been lower than the percentage of the agricultural workforce in the total population, which is about 20%. Additionally, the transformation of employment structure has been slower than the change in industrial structure. As a result, there is a significant amount of surplus labour idle in agricultural production. This situation has led to a lack of motivation for

China's scientific research institutions to carry out research and development of agricultural innovation technology. There should be a greater openness in the nation-state to adopt advanced agricultural techniques. In this scenario, the rural population was predominantly preserved, which hindered the advancement of agricultural technology (Li, Nanseki, Chomei, & Kuang, 2023a). The rapid development of agricultural technology is not only a driving force for agricultural growth, but also a crucial guarantee for advancing China's national economy. Since its establishment over 70 years ago, China's agriculture has undergone a significant transformation, shifting from a reliance on valuable resources and labour to a more scientific and capital-intensive approach. Over the years, China has made significant progress in the agricultural sector, transitioning from a state of scarcity to becoming a dominant player in the production of food (Tang, Cao, Guo, & Li, 2023).

In recent years, China has experienced a significant increase in urbanisation. The rate of urbanisation has steadily risen, with the percentage of city residents reaching 49.7% in 2010 and 63.89% in 2020. The rapid increase in urban population has resulted in a significant decrease in the number of people living in rural areas (Li et al., 2023b). In light of these circumstances, finding ways to improve agricultural manufacturing effectiveness by advancing agricultural technology and reducing the labour force has become a crucial focus for our agricultural development. However, in 2019, the contribution fee of agrarian science and science development in China reached 59.2%, indicating the impact of rural modernization on agricultural production. Additionally, there was a comprehensive mechanisation fee for crop cultivation and harvest (Jin, Xu, Zhu, & Li, 2023). In 2020, the US has witnessed a remarkable increase in the contribution of agricultural scientific and technological growth. This increase has reached a new stage of 60%, which is a significant improvement compared to the 15.5% recorded in 1996. The development of agricultural science and the adoption of recent applied sciences have played a crucial role in maintaining a steady growth in grain output, despite the relatively unchanged grain sown output (Raihan, 2023).

Research Methods

The paper examines the effects of agricultural biotechnology on green investment and economic growth in China, specifically within the framework of RCEP. The researchers have utilised secondary sources of data collection, specifically the WDI, to extract data spanning from 2003 to 2022. The equation is given as under:

$$QEG_t = \alpha_0 + \beta_1 USTI_t + \beta_2 EUA_t + e_t \quad \textbf{(1)}$$

$$UIA_t = \alpha_0 + \beta_1 USTI_t + \beta_2 EUA_t + e_t \quad \textbf{(2)}$$

Where,

QEG = Quality of Economic Growth

UIA = Urban Innovation Ability

t = Time Period

USTI = Urban Science and Technology Importance

EUA = Proportion of Employees in Urban Agriculture

The primary factors in the study were green investment and economic growth, which were expressed as GDP growth (annual percentage) and technology access (percentage of urban population), respectively. Furthermore, agricultural biotechnology was employed as a predictor in the study, with high technology exports (as a percentage of manufactured exports) and employment in agriculture (as a percentage of total employment) being measured. Table 1 displays these factors.

Table 1: Variables.

Variable Category	Variable Symbol	Variable Definition		Data Source
dependent variable	QEG	The quality of economic growth	GDP growth (Annual percentage)	WDI
independent variable	UIA	Urban innovation ability	Access of technologies (% of Urban population)	WDI
	USTI	Urban science and technology importance	High technology exports (% of manufactured exports)	WDI
	EUA	Proportion of employees in urban agriculture	Employment in agriculture (% of total employment)	WDI

The study presents the descriptive statistics that reveal the details of the variables, including measures such as mean, standard deviation, and minimum and maximum values. Furthermore, the study also highlights the importance of conducting a unit root test as a crucial step in selecting the appropriate model. The equation for the ADF tests is given below:

$$d(Y_t) = \alpha_0 + \beta t + \Upsilon Y_{t-1} + d(Y_t(-1)) + \mathcal{E}_t \quad \textbf{(3)}$$

The unit root among variables has been investigated individually, and the separate equations for each variable are given below:

Quality of Economic Growth

$$d(QEG_t) = \alpha_0 + \beta t + \Upsilon QEG_{t-1} + d(QEG_t(-1)) + \mathcal{E}_t \quad \textbf{(4)}$$

Urban Innovation Ability

$$d(\mathrm{UIA}_t) = \alpha_0 + \beta t + \Upsilon \mathrm{UIA}_{t-1} + d(\mathrm{UIA}_t(-1)) + \mathcal{E}_t \quad \textbf{(5)}$$

Urban Science and Technology Importance

$$d(\mathrm{USTI}_t) = \alpha_0 + \beta t + \Upsilon \mathrm{USTI}_{t-1} + d(\mathrm{USTI}_t(-1)) + \mathcal{E}_t \quad \textbf{(6)}$$

Proportion of Employees in Urban Agriculture

$$d(\mathrm{EUA}_t) = \alpha_0 + \beta t + \Upsilon \mathrm{EUA}_{t-1} + d(\mathrm{EUA}(-1)) + \mathcal{E}_t \quad \textbf{(7)}$$

Finally, the ARDL model was utilised to examine the relationship between variables. It is considered the best approach when certain constructs remain constant at a certain level, while others remain constant after undergoing a first difference (Sharif, Baris-Tuzemen, Uzuner, Ozturk, & Sinha, 2020). Furthermore, the ARDL model examines the relationship between constructs in both the short and long term. Equations (8) and (9) contain the "short-run coefficients" represented by δ1, δ2, δ3, δ4, and δ5. On the other hand, the "long-run coefficients" and the error term are denoted by φ1, φ2, φ3, φ4, φ5, and Ɛ1. The ARDL model equation is given as under:

$$\Delta QEG_t = \alpha_0 + \sum\delta_1\Delta QEG_{t-1} + \sum\delta_2\Delta USTI_{t-1} + \sum\delta_3\Delta EUA_{t-1} + \varphi_1 QEG_{t-1} + \varphi_2 USTI_{t-1} + \varphi_3 EUA_{t-1} + \varepsilon_1 \quad \textbf{(8)}$$

$$\Delta UIA_t = \alpha_0 + \sum\delta_1\Delta UIA_{t-1} + \sum\delta_2\Delta USTI_{t-1} + \sum\delta_3\Delta EUA_{t-1} + \varphi_1 UIA_{t-1} + \varphi_2 USTI_{t-1} + \varphi_3 EUA_{t-1} + \varepsilon_1 \quad \textbf{(9)}$$

Research Findings

An analysis was conducted on the original data series of each variable using descriptive statistics. The descriptive statistics revealed the intricate details of the variables, including measures like the mean, standard deviation, and the range of values. The results are displayed in Table 2.

Table 2: Descriptive Statistics of Variables

	Observed Value	Minimum	Maximum	Mean	Standard Deviation
QEG	20	-4.439	3.570	-6.384	2.994
UIA	20	0.004	0.082	0.026	0.024
USTI	20	0.037	0.298	0.144	0.067
EUA	20	0.062	0.120	0.094	0.016

Considering the available economic data, there are a couple of challenges when it comes to developing a model that analyses the effects of green investment on economic growth in China. Every variable is distinct based on whether it follows the sequence of I (0) or I (1). The ARDL is capable of effectively addressing the aforementioned modelling issues. (1) In the case of estimating small samples, the ARDL model demonstrates increased stability. Moreover, when the explanatory variable is endogenous, the ARDL model can also provide independent and high-quality estimates; (2) The ARDL model is capable of conducting a boundary co-integration check to assess the long-term relationship between variables. Unlike the EG two-step approach and JJ method, the ARDL model does not necessitate variables to have the same order of unified home integration. This holds true regardless of whether the variables are I (1) or I (0). The ARDL model can be utilised in the ARDL boundary co-integration test. Consequently, this paper employs the ARDL model to examine the influence of the leverage ratio on the quality of economic growth in China. The process of modelling requires three steps. The ARDL model employs Bound Testing to assess the presence of a long-term stable relationship between variables. Bound testing is applicable in three specific scenarios: when the variables are of the same order I (0) single integer, when the variables are of the same order I (1) single integer, and when the variables are of mixed type I (0) and I (1). Hence, it is imperative to perform a stationarity test for each variable initially in order to assess whether they fulfil the prerequisites of the ARDL boundary co-integration test. Equation (2) can be used to analyse the long-term relationship between variables, if there exists a co-integration relationship between them. It is important to highlight that the coefficient estimation in equation (1) is used exclusively to determine the presence of a long-term relationship, whereas the coefficient in equation (2) is utilised to estimate the magnitude of the long-term effect.

This study employs the ADF and KPSS tests to conduct unit root tests for each variable. The ADF test method, introduced by Dickey and Fuller in 1979, assumes that the data generation process follows a P-order autoregressive process with unit roots. Its initial assumption is that the sequence possesses a unit root. The principles of intercept, trend, intercept-free, trend-free, and no-intercept are applied during the test until the null hypothesis is rejected. Eviews10 software selects the optimal lag time based on SIC criteria. The KPSS test, proposed by Kwiatkowski in 1992, distinguishes between two types of errors in hypothesis testing: α errors (rejecting true hypotheses) and β errors (accepting false hypotheses). When the sample size is small, greater emphasis is placed on rejecting the null hypothesis rather than accepting an incorrect null hypothesis. This paper employs the KPSS test method in addition to the ADF test method to enhance and strengthen the results. This approach ensures a more comprehensive and persuasive analysis. The results of the ADF and KPSS tests in Table 3 indicate that all variables are either I(0) or I(1) sequences. There is no second-order stationary sequence, and the variables satisfy the conditions for the ARDL boundary co-integration test.

Table 3: Unit Root Test Results.

variable	ADF	ADF test results	KPSS	KPSS stationarity
QEG	-1.928*	smooth and steady	0.146	smooth and steady
LGUIA	0.297	Nonstationary	0.119	smooth and steady
LGUSTI	-2.131**	smooth and steady	0.097	smooth and steady
LGEUA	-2.267**	smooth and steady	0.310	smooth and steady

The null and alternative hypotheses for equation (8) aim to determine the presence of a long-term steady relationship among the four variables. The null hypothesis (H0) states that δ1, δ2, δ3, and δ4 are all equal to zero. The alternative hypothesis (H1) states that at least one of δ1, δ2, δ3, and δ4 is not equal to zero. The statistical test employed is the F statistic, which follows a non-standard asymptotic distribution. If the price of the F statistic exceeds the critical value, the null hypothesis is rejected. If the calculated F value is significantly smaller than the critical value, the null hypothesis is accepted. If the estimated F price falls within the range of the higher and lower critical values, it cannot be immediately determined and must be assessed based on the result of the unit root test. Table 4 demonstrates that when the satisfactory monetary increase (QEG) is used as the dependent variable, the calculated F cost of 17.44062 exceeds the upper limits of the integral values of 10%, 5%, 2.5%, and 1%. Therefore, we reject the null hypothesis that there is no co-integration relationship between variables. Thus, the aforementioned conclusion is derived. There exists a long-term and stable co-integration relationship.

Table 4: ARDL Boundary Co-Integration Test Results.

Test Statistic	Value	k
F-statistic	17.44062***	3
	Critical Value Bounds	
Significance	I (0) Bound	I (1) Bound
10%	2.72	3.77
5%	3.23	4.35
2.50%	3.69	4.89
1%	4.29	5.61

Note: ***, ** and * represent the significance level of 1%, 5% and 10% respectively

The study employed the ARDL approach to examine the relationship between the variables. The study found a positive correlation between agricultural biotechnology and economic growth in China. The outcomes are presented in Table 5.

Table 5: ARDL Model (Economic Growth).

Variable	Coefficient	Standard Error	T-statistics	P-value
C	0.683***	0.084	8.131	0.000
QEG (-1)	1.388 ***	0.230	6 035	0.000
LGUSTI (-1)	0.767***	0.141	5.439	0.000
LGEUA (-1)	0.321***	0.060	5.350	0.000
D (QEG (-1))	0.261**	0.112	2.330	0.032
D(LGUSTI)	0.853***	0.165	5.169	0.000
D (LGUSTI (-1))	1.071***	0.234	4.577	0.000
D(LGEUA)	0.481***	0.109	4.413	0.000
D (LGEUA (-1))	0.545***	0.088	6.193	0.000

The study employed the ARDL approach to examine the relationship between the variables. The study found a positive correlation between agricultural biotechnology and green investment in China. The outcomes are presented in Table 6.

Table 6: ARDL Model (Green Investment).

Variable	Coefficient	Standard Error	T-statistics	P-value
C	0.784***	0.091	8.615	0.000
UIA (-1)	1.765***	0.455	3.879	0.000
LGUSTI (-1)	0.729**	0.314	2.321	0.029
LGEUA (-1)	0.894**	0.398	2.246	0.031
D (UIA (-1))	3.158***	0.987	3.199	0.001
D(LGUSTI)	0.201**	0.091	2.209	0.035
D (LGUSTI (-1))	0.882***	0.236	3.737	0.000
D(LGEUA)	3.361***	0.471	7.135	0.000
D (LGEUA (-1))	0.489***	0.118	4.414	0.000

Discussions

This study examines the impact of agricultural biotechnology on green investment and economic growth by investigating two research questions and corresponding hypotheses. The first hypothesis proposes that advancements in agricultural biotechnology can stimulate increased investment in sustainable green practices in China. Prior research by Hesham et al. (2021) has demonstrated that agro-biotechnology, specifically genetic modification, reduces the release of harmful chemicals like fertilisers and pesticides, thereby benefiting the environment. Furthermore, it is worth mentioning that biotechnology has a positive influence on the environment, which is particularly appealing to environmentally conscious investors. These investors are increasingly engaged and actively seeking investment opportunities that align with sustainable development goals (Pandey, de Coninck, & Sagar, 2022). Genetically modified crops, created through biotechnology, serve as a prime example of crops that are ideal for green investment. These crops contribute to an eco-friendlier environment by reducing soil and water pollution and promoting the overall health of ecosystems. Munaweera, Jayawardana, Rajaratnam, and Dissanayake (2022). further supports the hypothesis. Their research underscores the potential of biotechnology advancements to enhance the nutritional content of crops. This has the potential to address the issue of malnutrition, particularly in developing societies, thereby adding both environmental and social value to these plants. According to Aguilar, Twardowski, and Wohlgemuth (2019), investors who prioritise environmentalism and societal welfare often choose to invest in agricultural biotechnology. This allows them to contribute to both causes while also supporting biotechnological innovations through increased investment. Investments of this nature are crucial for advancing the field, supporting important research and development, and ultimately bringing new biotechnological products to market. In addition, they play a crucial role in addressing the fundamental requirements of sustainable agriculture. This includes ensuring the availability of adequate water resources for agricultural purposes and promoting the adoption of renewable energy in agricultural operations and on the fields. The study highlights a strong feedback loop in the relationship between investment in Green and agricultural biotechnology. This investment not only stimulates the development of more biotechnological innovation but also encourages additional investment.

The second hypothesis explores the impact of an agricultural biotechnology invention on the overall economic growth of China. A recent study by Schröder et al. (2019) highlights the positive impact of biotechnology on crop production. The research shows that optimising farming activities through the application of biotechnology leads to improved yields and increased returns for farmers. This boost in land productivity contributes to economic growth, particularly in rural areas where farming is the primary focus of activity. The study reveals that the advantages of the agricultural biotechnology industry are primarily seen in the agriculture sector. However, we also recognise a significant external benefit that is introduced by the industry when considering both production and final consumption values.

Essentially, when farmers' incomes rise, it has a ripple effect on the economy by creating a greater demand for goods and services. This serves as a catalyst for economic growth, providing an immediate and effective stimulus (Ibn-Mohammed et al., 2021). The ability to export also contributes to the overall economic growth of a nation by enhancing trade balances and generating foreign exchange revenues. This is particularly evident in the case of biotechnologically advanced crops, as highlighted by Mustafa and Iqbal (2021). Investing in agricultural biotechnology can offer countries the advantage of becoming exporters of high-quality, nutrient-rich crops that have a competitive edge in the market. This could potentially lead to an influx of foreign capital, which has the potential to boost the economic growth of many countries. As a result, there may be an increase in investment in both agricultural and non-agricultural sectors. Furthermore, past research conducted by Lu, Xie, and Yao (2019) has demonstrated that improvements in labour and capital efficiency within the agricultural sector can have positive effects on growth, employment, and output diversification in other sectors.

However, while the study acknowledges certain advantages of agricultural biotechnology, it also highlights a number of disadvantages of this technology. For this reason, we must also take into account the potential negative impacts of biotechnological development on both large agri-business organisations and smallholder farmers. These challenges can be exacerbated by the advancements in biotechnology. Small-scale farmers depend on temporary workers and may not have the necessary funds to invest in biotechnological tools and knowledge. This could widen the gap between different players in the agriculture industry. In order to address these disparities, it is crucial to prioritise the equitable distribution of biotechnological innovations.

Implications of the Study

The practical significance of the current study is evident as it encompasses a wide range of issues, such as policy-making, investment, and farming worldwide. Therefore, policymakers can use this information to develop appropriate regulatory policies that would allow smallholder farmers to benefit from this biotechnological advancement and provide them with the necessary education to navigate it. It can greatly contribute to reducing or at least not exacerbating the current disparities in income distribution in agricultural trade. For investors, it highlights the potential of agricultural biotechnology as a valuable investment. It emphasises that the return on investment in this field will be significant in the future, making it a worthwhile and environmentally sustainable choice for further investment. It raises the question of the ethical procedures that have been implemented and briefly discusses genetically modified organisms and the need to address the public's misunderstandings and fears, in order to promote a more ethical approach. The study guides policymakers in making policies related to enhancing green investment and economic growth through the use of effective agricultural biotechnology.

Limitations

When considering the conclusion, it is important to acknowledge certain limitations that were identified in the study. The analysis primarily relies on the current impact of prevailing biotechnological technologies, potentially overlooking the long-term consequences of genetically modified organisms (GMOs) on both the environment and human health. This limitation may arise from the geographical coverage of the study, as the benefits and drawbacks of agricultural biotechnology can vary significantly in various countries or farming contexts. In addition, although it emphasises the economic advantages for these smallholder farmers, it may not fully address all the challenges these farmers encounter when adopting biotechnological tools and knowledge. Lastly, the ethical concerns and societal implications of GMOs are complex and ever-changing, and the study may not have been able to fully address and incorporate all the perspectives and solutions from around the world.

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