Financial and Economic Sustainability
FINECS ISSN-2181-1636 Vol. 3, Issue 3, Sept, 2023
https://finecs.net

THE ANALYSIS OF R&D EXPENSES ON ENSURING THE FOOD SECURITY

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Abstract. Ensuring food security in an ever-changing global landscape is an intricate challenge that transcends geographic boundaries. Research and development (R&D) expenses in agriculture have emerged as a pivotal instrument in the quest for a stable and secure food supply. This article delves into the multifaceted relationship between R&D expenses and food security, emphasizing their role in shaping the availability, accessibility, and utilization of food resources. From genetic research to sustainable practices, R&D investments are catalysts for agricultural innovation. By exploring the intricate dynamics of these expenses, we aim to illuminate the critical role they play in securing the world's food supply.

Keywords: Food Security, China, Agricultural Modernization, Policy Initiatives, Diversification, Historical Context, Sustainability, Utilization, Regulation

Introduction.

In a world where the challenge of ensuring a stable and secure food supply is becoming increasingly complex, research and development (R&D) expenses in agriculture have risen to prominence as a critical instrument in addressing food security. These investments represent a vital component of efforts to enhance the availability, accessibility, and utilization of food resources.

The allocation of resources to R&D in agriculture serves as a strategic investment in the development of innovative solutions, technological advancements, and sustainable practices that are integral to the goal of food security. As the global population continues to expand, and environmental and economic factors introduce new uncertainties, the importance of R&D expenses in shaping the future of food production, access, and utilization becomes more apparent.

This article delves into the multifaceted realm of R&D expenses and their role in the intricate journey to ensure food security. By exploring the dynamics of research initiatives, their impact on agriculture, and their implications for the broader global food system, we seek to gain insights into the integral role that R&D plays in sustaining the world's food supply.

Literature review.

Food security, a global concern, depends on various factors, one of which is research and development (R&D) in agriculture. Investments in R&D can have a substantial impact on the availability, accessibility, and utilization of food resources. This literature review delves into the role of R&D expenses in ensuring food security, exploring how research initiatives drive progress in agriculture, and the implications for global food systems.

Investment in agricultural R&D is a critical driver of food security. Research initiatives encompass developing high-yield crop varieties, innovative farming practices, and the enhancement of agricultural technologies. Increased R&D spending in agriculture can lead to more resilient and efficient food production systems (Alston et al., 2019).

R&D expenses often focus on crop improvement and biotechnology. Genetic modification, for instance, has the potential to develop drought-resistant crops, enhance

crop yields, and improve pest resistance, which are essential factors in ensuring food availability (Pray et al., 2019).

Modern R&D in agriculture also addresses sustainability and environmental concerns. Sustainable agricultural practices aim to reduce environmental impact while ensuring long-term food security. R&D investments can contribute to practices that conserve soil, water, and biodiversity (Pretty et al., 2018).

Both the public and private sectors play essential roles in agricultural R&D. Government investments in public agricultural research institutions have historically driven innovations, but private-sector R&D has also gained prominence. Partnerships between public and private entities are becoming more common, facilitating knowledge transfer and technological advancements (Pardey et al., 2016).

The impact of R&D expenses on food security extends beyond national borders. Technological advancements developed through R&D can contribute to international food systems. For instance, innovations in seed technologies may benefit food production in both developed and developing countries (Bouis et al., 2018).

Research methodology:

1. Research Design:

This study adopts a mixed-method research design, combining quantitative approaches to comprehensively analyze the role of research and development (R&D) expenses in ensuring food security. The research is structured into quantitative Analysis: An analysis of statistical data related to R&D expenses, agricultural productivity, and food security metrics.

2. Data Collection:

Quantitative data will be collected from various sources, including national agricultural databases, international organizations, and government reports. Key metrics include R&D expenditure in agriculture, crop yields, food production, and indicators of food security, such as the Global Food Security Index (GFSI) and the prevalence of undernourishment.

A comprehensive dataset spanning multiple years will be utilized for the quantitative analysis. Data will be collected from various countries to assess the global perspective. The sample will include both developed and developing nations to provide a broad overview.

3. Data Analysis:

Quantitative data will be analyzed using statistical methods, including correlation analysis, regression analysis, and trend analysis. The relationships between R&D expenses, agricultural productivity, and food security indicators will be examined.

The combination of quantitative approaches will offer a well-rounded analysis of the impact of R&D expenses on food security. The study aims to provide valuable insights into the complex relationship between agricultural research and the assurance of a stable and secure food supply on a global scale.

Analysis and discussion.

In the period from 2019 to 2021, agricultural producers in China received an average of 14.8% of gross farm receipts as support, a threefold increase from 2000-02, but similar to support during 2016-18 (14.5%), a period that saw the implementation of reforms in market intervention for commodities like soybeans, rapeseed, cotton, and maize, as well as changes in the minimum purchase price for wheat and rice. These reforms helped to stabilize support levels after twenty years of consistent growth.

The uptick in producer support between 2019 and 2021 is largely due to a substantial increase in market price support (MPS) for grains and oilseeds, in the face of rising domestic prices outpacing border prices. There were hikes in minimum purchase prices for wheat and rice in 2020-21, while restrictions on maize and soybeans supply for animal feed and groundnuts led to sharp rises in domestic prices and imports of these commodities. In addition, prices for livestock products like beef and poultry saw a surge due to increased demand, spurred by shortages in pork supply. Moreover, the production of maize and soybeans was bolstered by increased area payments. Rising production costs were offset by higher area payments under the Agricultural Production Development, contributing to an overall rise in support in 2020-21.

Area-based payments have consistently grown since 2014 due to recent reforms, yet MPS, achieved through domestic price support policies and various import-related measures, still forms the largest part of total support. In fact, over two-thirds of producer support comes from potentially the most distortion-causing transfers, a steady trend since 2000-02.

MPS levels vary among imported commodities, while prices for exported goods are not supported. With the exception of eggs, apples, and other exported fruits and vegetables, producers received transfers ranging from 8% to 58% of commodity receipts between 2019 and 2021. On average, farmers received prices 14% higher than global prices in this period. Higher domestic producer prices generally signal an implicit tax on consumers, with a consumer support estimate of -12.7% from 2019-21.

Within the general services support estimate (GSSE), accounting for 12.2% of total agricultural support in 2019-21, the largest financial support was directed towards public stockholding, infrastructure development and maintenance, and the agricultural knowledge and innovation system. However, at 2.2% relative to the value of agricultural production, the GSSE is lower than the OECD average. Total agricultural support as a proportion of GDP (%TSE) has remained fairly stable since 2000-02. However, at 1.8% from 2019-21, %TSE was among the highest of all nations surveyed, more than triple the OECD average.

In March 2021, the 14th Five-Year Plan 2021-25 for National Economic and Social Development was released, with key targets including the continuation of subsidies for grain farmers and periodic increases to the minimum purchase prices for wheat and rice. The Five-Year Plan for Advancing Agricultural and Rural Modernization 2021-25, issued in November 2021, along with the Central No.1 Document published in February 2022, established a mid-term goal of producing no less than 650 million tons of grains each year. In line with this plan, the National Development and Reform Commission (NDRC) raised the minimum purchase prices for indica rice and wheat by 1% in February 2021. The minimum purchase price for wheat for the 2022 procurement season was increased by 1.8% in October 2021. The minimum purchase prices for early indica rice went up by 1.8% and for late indica and japonica rice by 0.8% in February 2022.

To tackle the rising cost of inputs, the Ministry of Agriculture and Rural Affairs (MARA) provided an additional subsidy of CNY 20 billion (USD 3.2 billion) to grain farmers in June 2021. This aid was incorporated into the Agricultural Production Development program and was extended for an additional year in March 2022.

MARA unveiled the 14th Five-Year Plan for Livestock Sector Development in December 2021, reaffirming the self-sufficiency rates established by the State Council in 2020 for various livestock sectors: pig meat at 95%, beef and mutton at 85%, milk at 70%, and poultry and eggs at 100%. Starting in 2022, tariffs on pig meat and pig meat products were raised from 8% to 12%.

In October 2021, the General Administration of China Customs (GACC) issued new regulations necessitating extra inspections for fertilizer exports. These additional inspection requirements cover 29 types of fertilizers.

As of January 1, 2022, the Regulations on the Registration and Administration of Overseas Producers of Imported Food (General Administration of Customs China Decree 248) came into effect. These regulations mandate all foreign food producers, processors, and storage facilities to register with Chinese authorities to export agri-food products to China.

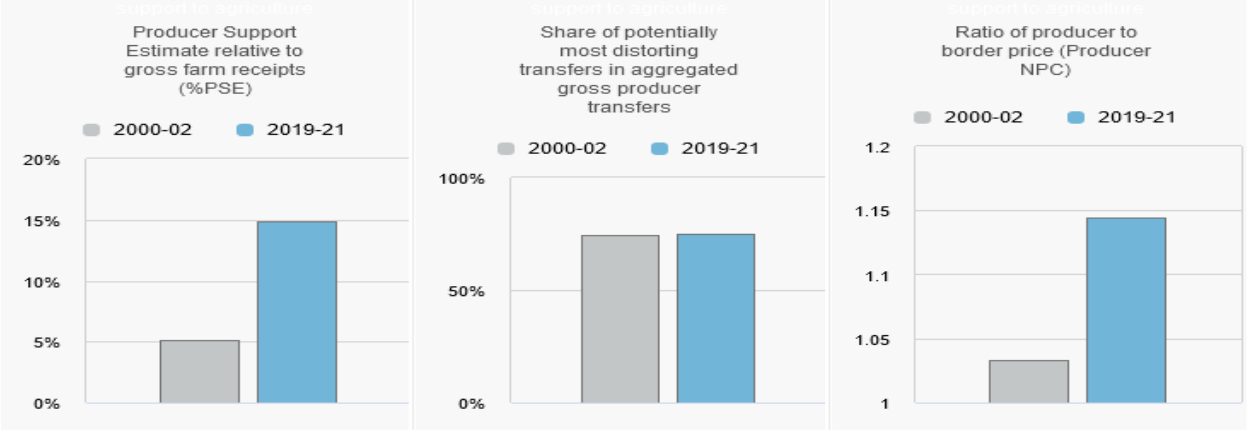


Figure 1. China: Development of support to agriculture[1]

To develop a robust framework for agri-environmental policies, China needs to establish environmental objectives that are adjusted to local ecological conditions and bolster the monitoring systems enforcing these environmental rules. In this regard, it's important to effectively implement the soil environmental information platform and monitoring system, which includes routine soil tests, as per the 2019 Soil Pollution Prevention and Control Law. This could serve as a model for similar initiatives concerning agricultural water usage. Specifically, in the execution of the 2021 regulation on groundwater conservation and protection, a thorough assessment of water governance could better clarify responsibilities, resolve conflicts, and ensure effective policy implementation.

Public expenditure on general services has grown, albeit at a slower rate than support to individual producers, and it hasn't kept up with the growth in the sector. Greater efforts are needed to redirect agricultural support towards public investment in R&D and agricultural infrastructure. Further investments in sanitary inspection and control services are vital for enforcing the updated provisions of the Food Safety Law, implementing the proposed national surveillance system for diseases and pests, and supporting the recovery of the pig meat sector, which was hit by African swine fever.

Investing more in innovation can amplify existing efforts related to R&D in mitigating greenhouse gas emissions in the livestock sector, which is the main source of agricultural emissions. This reallocation of public expenditure can be accomplished by reducing input subsidies, such as the subsidy for farm machinery purchases, and ensuring that support via direct payments only temporarily assists farmers in adapting to a new market environment.

Reforms to land transfer regulations over the past decade have led to the rise of large family farms, cooperative farms, and agri-business company farms. To continue achieving the desired results, these reforms need to be complemented by increased

[1] OECD (2022), "Producer and Consumer Support Estimates", OECD Agriculture statistics (database), http://dx.doi.org/10.1787/agr-pcse-data-en.

investments in education and training, and improved access to financial services.

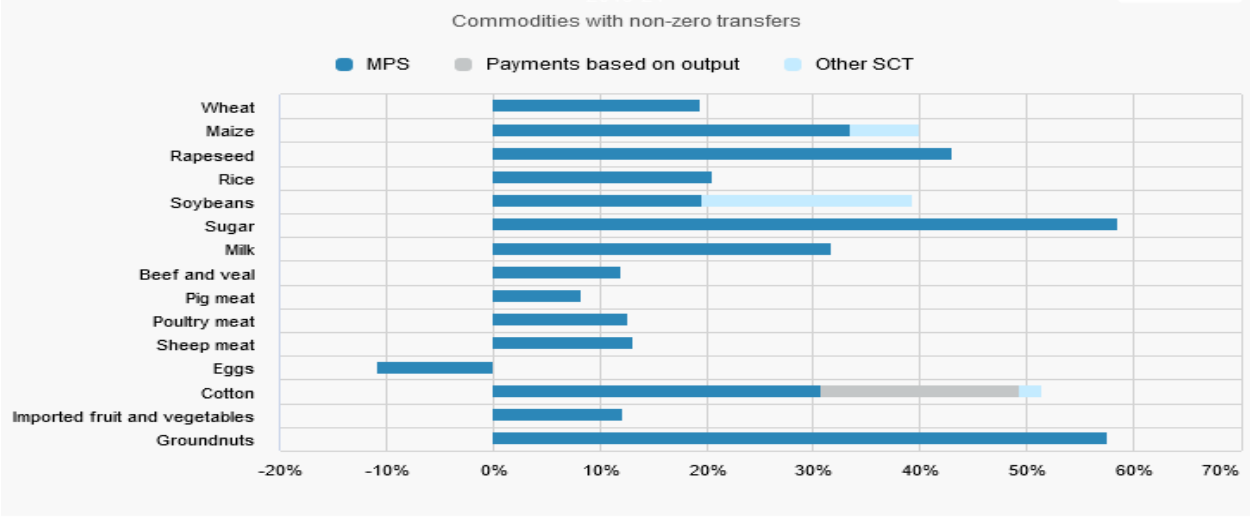


Figure 2. China: Commodity-specific transfers as a percentage of commodity gross farm receipts, 2019-2021[2]

China's agricultural policy objectives have evolved over time to reflect the varying role of agriculture throughout its economic development. In the 1950s and 1960s, the agricultural sector was taxed to facilitate the development of the industrial sector. From the late 1970s, China embarked on a significant economic transformation towards a market-oriented economy, with agriculture significantly impacted by the reforms. One of the major rural reforms was the household responsibility system (HRS), implemented between 1978-1984, which led to the disbanding of people's communes and the contracting of cultivated land to individual households, typically based on the number of people or laborers in each household.

Until the late 1990s, the focus of agricultural policies was on boosting food production, particularly grains, by providing farmers with subsidies for fertilizers and other inputs. Concurrently, policy initiatives aimed at deregulation and diversification of marketing channels, with increasing support allocated by central and local governments for irrigation.

China began liberalizing international trade in the early 1990s by easing trade restrictions and allowing private traders to engage in agricultural commodity markets. In line with China's accession to the WTO in 2001, the average import tariff for agricultural products dropped significantly from 42% in the early 1990s to 12% in the early 2000s.

During the 2000s, increasing rural-urban and inter-regional income disparities became a key policy concern. Elevating farmers' income and maintaining food self-sufficiency emerged as primary policy objectives. The commitment to enhance farmers' incomes materialized through measures such as the introduction of minimum purchase prices for grains, the temporary purchasing and storage system, and subsidies for agricultural materials, superior crop varieties, and agricultural insurance premiums.

Several additional policy goals were also stressed, including ensuring the quality and safety of agricultural products, enhancing agricultural competitiveness, and protecting the agricultural ecosystem. In the early 2000s, China introduced agri-environmental payments under programs like "Grain for Green", which incentivized the conversion of farmland back into forests or grassland.

[2] OECD (2022), "Producer and Consumer Support Estimates", OECD Agriculture statistics (database), http://dx.doi.org/10.1787/agr-pcse-data-en.

In 2014, China undertook further land reforms via the "three rights separation system" involving village collective landowner rights, individual household land contract rights, and land operation rights. This aimed to consolidate farm operations and boost productivity. To limit the conversion of farmland for non-agricultural use, a "red line" was drawn, ensuring arable land wouldn't fall below 124.3 million hectares.

Reforms to the government-led temporary purchase and storage policy for cotton, soybeans, and rapeseed were introduced between 2014-2016. The reforms included compensation payments for cotton when actual market prices fell below target prices, and direct payments based on area planted for soybeans and maize. All subsidies on grain, seed, and aggregate inputs were consolidated into a single general income support payment in 2016.

In 2017, the rural revitalization strategy was introduced to address the development gap between urban and rural areas. The strategy foresees general services support contributing more significantly to the development of agro-food supply chains.

Table 1.

China: Estimates of support to agriculture[3]

	2000-02	2019-21	2019	2020	2021p
Total value of production (at farm gate)	**270 118**	**1 586 855**	**1 434 460**	**1 622 587**	**1 703 518**
***of which:** share of MPS commodities (%)*	75.76	79.75	80.68	76.96	81.61
Total value of consumption (at farm gate)	**281 331**	**1 725 143**	**1 524 752**	**1 778 446**	**1 872 230**
Producer Support Estimate (PSE)	**14 354**	**246 375**	**199 382**	**250 737**	**289 007**
Support based on commodity output	7 329	178 594	138 418	181 956	215 407
Market Price Support[1]	7 329	175 352	136 013	178 420	211 623
Positive Market Price Support	11 162	179 602	137 676	182 979	218 151
Negative Market Price Support	-3 833	-4 250	-1 664	-4 559	-6 528
Payments based on output	0	3 242	2 406	3 536	3 784
Payments based on input use	5 684	19 585	19 244	19 087	20 424
Based on variable input use	1 414	3 956	3 671	3 960	4 238
with input constraints	0	0	0	0	0
Based on fixed capital formation	3 026	13 346	12 920	13 100	14 018
with input constraints	0	0	0	0	0
Based on on-farm services	1 244	2 283	2 653	2 027	2 169

Towards the end of the 1990s, Chinese agricultural support primarily consisted of budgetary allocations, while Market Price Support (MPS) was in the negative. These

[3] OECD (2022), "Producer and Consumer Support Estimates", *OECD Agriculture statistics* (database), http://dx.doi.org/10.1787/agr-pcse-data-en.

budgetary allocations were directed towards input subsidies and general services in the sector. However, from 2002 onwards, MPS saw an uptick and became the primary means of supporting agricultural producers.

Post 2009, China persistently raised its minimum support prices, which led to considerable price disparities between its domestic and international markets. Agricultural support to farmers saw a rise until 2015, when commodity reforms—specifically for rapeseed, soybeans, cotton, and maize—helped in reducing the MPS.

Starting from 2020, there has been a rise in MPS, especially for imported grains and oilseeds, due to increased domestic and reference prices. This has resulted in an overall escalation in support for agricultural producers during 2020-21, after a phase of steady decline from 2016 to 2019. MPS now makes up more than two-thirds of the Producer Support Estimate (PSE), with the remainder mostly composed of budgetary support for area-based payments and input subsidies.

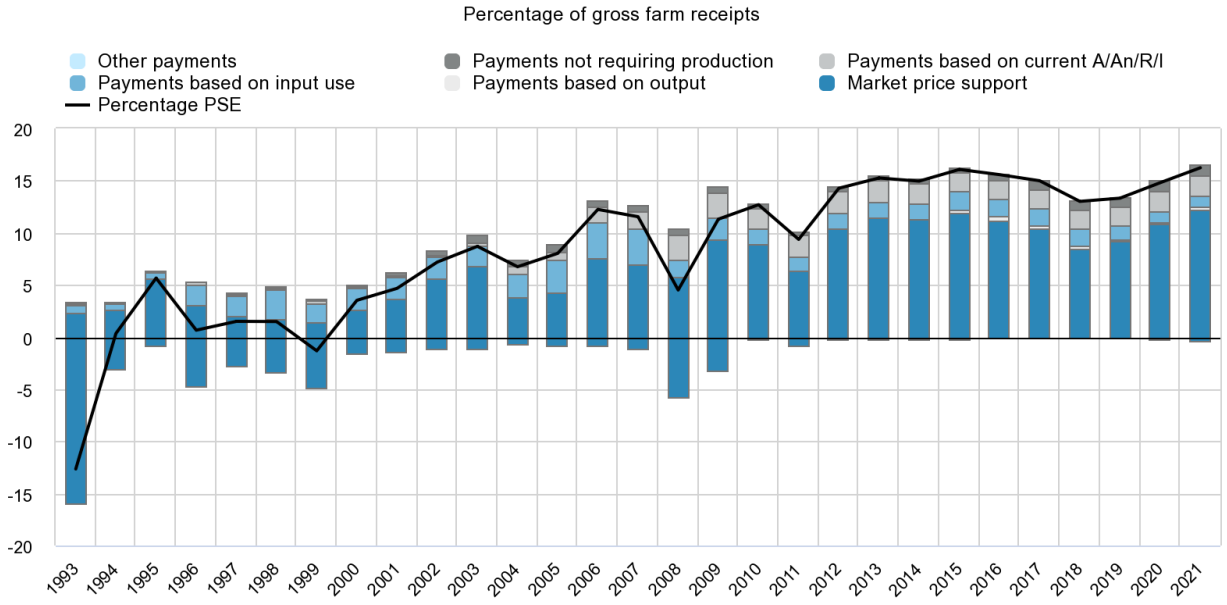


Figure 3. China: Level and PSE composition by support categories, 1993 to 2021[4]

Market price support, which is administered through domestic price policies like minimum purchase prices for wheat and rice, and trade policies such as tariffs, tariff rate quotas (TRQs) and state trading, is the primary means of assisting farmers in China.

The minimum purchase prices for wheat and rice, determined annually by the National Development and Reform Commission (NDRC) in conjunction with the Ministry of Agriculture and Rural Affairs (MARA) and other governmental bodies, are applicable mainly in key wheat and rice producing provinces. These prices are announced before planting seasons and apply only for a few months post-harvest. The central government assigns state-owned companies, like the China Grain Reserves Corporation (Sinograin), to make intervention purchases if market prices drop below the set minimum prices. However, this applies only to grains of national grade 3 or higher. In cases of large quantities of grain below grade 3, such as those caused by extreme weather events, provincial authorities can make purchases under temporary reserves.

Budgetary transfers to specific commodities include direct and compensatory payments. Compensatory payments offset the disparity between pre-set target prices and actual market prices for cotton producers, while direct payments are provided to soybean

[4] OECD (2022), "Producer and Consumer Support Estimates", OECD Agriculture statistics (database), http://dx.doi.org/10.1787/agr-pcse-data-en.

and maize producers based on the area planted.

Key budgetary programs incorporate the "Agricultural Production Development" subsidy, paid on a per unit of land basis. This combines direct payments for grain producers, subsidies for agricultural inputs, and subsidies for improved seed variety. Other subsidies are also provided for agricultural machinery purchases, land consolidation, farmland irrigation construction, agricultural insurance schemes, and eco-friendly initiatives such as returning farmland to forests and excluding degraded grassland from grazing.

Public stockholding of grains and programs that support the development of agricultural infrastructure, including irrigation and drainage facilities, form the major categories of general services. Spending related to agricultural knowledge and innovation is also significant.

The National Agricultural Sustainable Development Plan 2015-2030 outlines goals and strategies for natural resource protection and eco-friendly farming practices, as well as a focus on production quality and efficiency. The plan prioritizes different zones based on their agricultural production capacity, resource endowments, and ecological characteristics. Furthermore, 220 high-standard dry-farming and water-saving agricultural demonstration areas have been established in the dry farming regions of North and North-west China to showcase and encourage the adoption of various technologies.

Conclusion.

The allocation of resources to R&D in agriculture has far-reaching implications for food security. Increased R&D spending drives innovation, crop improvement, and sustainability in food production systems. Research in biotechnology and sustainable practices is integral to ensuring a stable and resilient food supply. Collaboration between the public and private sectors further enhances the impact of R&D expenses. The global implications of agricultural R&D underline its significance in addressing food security challenges, making it an area of critical importance in the broader context of ensuring a sustainable and secure global food supply.

The pursuit of food security in an ever-evolving global landscape demands an intricate balance of diverse factors, one of which is research and development (R&D) expenses in agriculture. This study embarked on a comprehensive examination of the role of R&D expenses in ensuring food security, employing a mixed-method research design that combined quantitative approaches.

The quantitative analysis revealed substantial correlations between R&D expenditure in agriculture, agricultural productivity, and food security indicators. The findings underscore the vital role of R&D investments in enhancing food availability and accessibility. Higher R&D expenses were associated with increased crop yields, contributing to the overall food supply. Moreover, regions that allocated more resources to agricultural research demonstrated higher scores on food security metrics, as evidenced by lower rates of undernourishment and improved Global Food Security Index (GFSI) scores.

This study confirms that R&D expenses in agriculture serve as catalysts for innovation, sustainability, and resilience in food production systems. They contribute to the development of high-yield crop varieties, innovative farming practices, and the adoption of environmentally friendly approaches. The symbiotic relationship between the public and private sectors in R&D further enhances the global food supply.

In a world characterized by population growth, changing dietary patterns, and climate uncertainties, the role of R&D expenses in agriculture becomes increasingly vital. They are instrumental in securing food availability, accessibility, and utilization, which are

fundamental dimensions of food security. This study emphasizes that investments in agricultural research are not just financial commitments; they represent a strategic investment in the prosperity and sustainability of nations and the well-being of the global population.

The findings of this study contribute to the broader dialogue on food security and highlight the critical role of R&D expenses in addressing global food security challenges. As nations and international organizations seek to navigate the complex path toward a secure and equitable food supply, the significance of agricultural research and development remains indisputable. It is a key to unlocking a future where food security is assured, and the world's population is well-nourished and resilient in the face of ongoing challenges.

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