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Research Article

Competitiveness of the Agro-Industrial Complex in Ensuring National Food Security

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Abstract

Ensuring national food security has become increasingly challenging amid global economic instability, climate change, and disruptions in agri-food supply chains. Under these conditions, the competitiveness of the agro-industrial complex plays a decisive role in maintaining stable food availability, accessibility, and resilience of national food systems. The relevance of this research lies in the need to move beyond traditional production-oriented approaches to food security and to assess competitiveness as a systemic economic factor influencing food security outcomes.

The purpose of this article is to analyze the impact of agro-industrial competitiveness on ensuring national food security and to identify key economic and technological determinants that strengthen this relationship. The study is empirical in nature and is based on panel data for 28 countries over the period 2010–2023. The leading research method is econometric panel regression analysis, complemented by descriptive and comparative statistical techniques.

The results demonstrate a statistically significant positive relationship between agro-industrial competitiveness and national food security. In particular, total factor productivity, agricultural value added per worker, and investment in agricultural research and development were found to have the strongest influence on food security indicators. The study substantiates that competitive agro-industrial systems are better equipped to ensure stable food supply and reduce vulnerability to external shocks.

The theoretical significance of the research lies in advancing the understanding of the competitiveness–food security nexus, while the practical significance consists in providing an empirical basis for policy measures aimed at strengthening food security through enhanced agro-industrial competitiveness.

Keywords: *agro-industrial complex; competitiveness; agricultural productivity; innovation; panel data analysis.*

INTRODUCTION

In the context of increasing global economic uncertainty, climate change, geopolitical tensions, and disruptions in international supply chains, ensuring national food security has become one of the most pressing challenges facing modern states. Recent years have demonstrated that food systems are highly vulnerable to external shocks, including pandemics, trade restrictions, price volatility, and environmental degradation. As a result, governments worldwide are reassessing their approaches to agricultural development and food system resilience, placing greater emphasis on domestic production capacity, sustainability, and economic efficiency.

At the same time, the agro-industrial complex is undergoing profound structural and technological transformations. Digitalization, innovation in agricultural technologies, the development of value-added processing, and the integration of agricultural production with logistics and marketing systems are reshaping traditional models of agro-industrial development. These trends intensify competition both within national markets and at the global level, making competitiveness a decisive factor in the ability of agro-industrial systems to adapt, grow, and remain resilient under changing conditions.

In this context, food security can no longer be viewed solely as a matter of production volume or self-sufficiency. It increasingly depends on the competitiveness of the agro-industrial complex, which determines productivity levels, cost efficiency, product quality, market accessibility, and the capacity to innovate. A competitive agro-industrial complex is better positioned to ensure stable food supplies, mitigate risks associated with external shocks, and support sustainable economic development. Conversely, low competitiveness can exacerbate food shortages, increase dependence on imports, and weaken national economic security.

Despite the growing recognition of this interdependence, the relationship between the competitiveness of the agro-industrial complex and national food security remains insufficiently explored in an integrated manner, particularly in terms of identifying key economic, institutional, and technological factors that enhance this linkage. This gap underscores the relevance of the present study and highlights the need for a comprehensive analysis of how competitiveness mechanisms contribute to strengthening food security at the national level.

Research Hypothesis

The study is based on the hypothesis that enhancing the competitiveness of the agro-industrial complex—through increased productivity, innovation, efficient resource utilization, and institutional support—has a direct and positive impact on ensuring national food security, improving both the stability of food supply and the accessibility of food for the population.

Purpose and Objectives of the Study

The purpose of this study is to analyze the role of the competitiveness of the agro-industrial complex in ensuring national food security and to identify key factors and policy directions that enhance this relationship.

To achieve this purpose, the study sets out the following objectives:

1. To examine current trends and challenges affecting national food security in the context of global economic and environmental changes;
2. To analyze the conceptual and economic foundations of competitiveness within the agro-industrial complex;
3. To identify key indicators and determinants of agro-industrial competitiveness influencing food security;
4. To assess the impact of competitiveness factors on the stability, availability, and accessibility of food;
5. To formulate recommendations aimed at strengthening national food security through improved competitiveness of the agro-industrial complex.

LITERATURE REVIEW

Food security and the competitiveness of the agro-industrial complex (AIC) have emerged as central themes in economic, agricultural, and development research over the past two decades. The increasing frequency of food crises, climate-related shocks, geopolitical instability, and disruptions in global supply chains has intensified scholarly interest in the capacity of national agro-industrial systems to ensure stable, affordable, and sufficient food supplies. Within this discourse, competitiveness is increasingly viewed not merely as an economic attribute but as a systemic condition that underpins resilience, productivity, and sustainability in food systems.

The selection of this topic is driven by the growing recognition that traditional approaches to food security—focused primarily on production volumes and self-sufficiency—are insufficient in an era of globalized markets and technological transformation. Recent literature emphasizes the importance of efficiency, innovation, institutional quality, and value-chain integration as determinants of both agro-industrial competitiveness and food security outcomes. Consequently, the literature review focuses on emerging trends, conceptual frameworks, and empirical findings that link competitiveness of the agro-industrial complex with national food security.

The modern understanding of food security is largely grounded in the framework proposed by the Food and Agriculture Organization (FAO), which defines food security through four dimensions: availability, access, utilization, and stability (FAO, 2008). This multidimensional approach has been widely adopted and expanded in academic research. Barrett (2010) argues that food security must be analyzed dynamically, considering vulnerability and risk rather than static supply indicators.

Further refinement of the concept is provided by Pinstrup-Andersen (2009), who emphasizes the interaction between food systems and broader economic development processes. These studies collectively shift the focus from agricultural

output alone toward systemic efficiency and governance, laying the groundwork for linking food security with competitiveness.

Competitiveness in the agro-industrial context is commonly examined through productivity, cost efficiency, technological advancement, and integration into value chains. Porter's theory of competitive advantage (Porter, 1990) provides a foundational analytical lens, emphasizing factor conditions, demand conditions, firm strategy, and institutional support.

Applied to agriculture, Latruffe (2010) defines competitiveness as the ability of farms and agro-industrial entities to survive and grow in domestic and international markets while maintaining profitability. Similarly, Fuglie et al. (2012) highlight total factor productivity as a core indicator of agro-industrial competitiveness, particularly in ensuring long-term food supply growth.

A growing body of literature explicitly connects agro-industrial competitiveness with food security outcomes. Headey and Fan (2010) demonstrate that productivity-driven agricultural growth significantly reduces food insecurity, especially in low- and middle-income countries. Their findings underscore the role of competitiveness-enhancing investments in infrastructure and technology.

Reardon et al. (2019) analyze the transformation of agri-food systems, emphasizing how competitive value chains improve food availability and affordability. At the national level, Clapp (2017) highlights the risks of weak competitiveness, including import dependency and exposure to global price shocks.

Innovation is increasingly identified as a critical driver linking competitiveness to food security. Alston et al. (2010) demonstrate that agricultural R&D investments generate long-term productivity gains essential for sustaining food security. In parallel, sustainability considerations have become central, with Pretty et al. (2018) arguing that competitive agro-industrial systems must also be environmentally sustainable to ensure long-term food security.

Institutional quality and governance also play a decisive role. North (1990) emphasizes that institutions shape economic performance by influencing incentives and transaction costs (ISBN: 978-0521397346, Cambridge University Press). In the agro-industrial context, Anderson and Swinnen (2008) show that policy distortions reduce competitiveness and undermine food security.

Methodologically, the literature employs a mix of qualitative conceptual analyses and quantitative empirical models. Econometric studies often rely on panel data to assess productivity-food security linkages (e.g., Fuglie et al., 2012), while composite indices are used to measure competitiveness and food security simultaneously.

However, several studies rely heavily on aggregate national indicators, which may obscure sectoral and regional disparities. Others focus narrowly on production metrics, neglecting access and stability dimensions of food security.

The reviewed literature demonstrates a broad consensus that the competitiveness of the agro-industrial complex is a key determinant of national food security. Seminal works by FAO, Porter, and Barrett establish the conceptual foundation, while empirical studies by Latruffe, Fuglie, Headey, and Reardon provide strong evidence of positive linkages between competitiveness, productivity, and food security outcomes.

At the same time, the current state of research reveals several methodological shortcomings and gaps. First, there is a lack of integrated frameworks that simultaneously capture competitiveness, sustainability, and food security dimensions. Second, many empirical studies focus on global or cross-country analyses, offering limited insights into national institutional and structural specificities. Third, contradictions remain regarding the role of trade openness, with some studies emphasizing its benefits for food availability and others highlighting increased vulnerability to external shocks.

These gaps indicate the need for further research that combines quantitative and qualitative methods, incorporates institutional and technological factors, and focuses on country-specific agro-industrial systems. Future studies should aim to develop comprehensive models that explain how competitiveness mechanisms can be strategically leveraged to ensure sustainable national food security.

MATERIALS AND METHODS

This study employs a quantitative analytical research design combined with elements of comparative and structural analysis to examine the relationship between the competitiveness of the agro-industrial complex and national food security. The research is based on secondary data obtained from internationally recognized and publicly available sources, ensuring reliability and comparability of indicators.

The empirical sample consists of panel data for selected countries representing different levels of economic development and agro-industrial performance over the period 2010–2023. Countries were selected based on data availability and relevance to agro-industrial competitiveness analysis. The main data sources include the Food and Agriculture

Organization (FAO), the World Bank, OECD statistics, and the Global Food Security Index (GFSI) published by Economist Impact. These sources are widely used in peer-reviewed research and provide standardized indicators essential for cross-country analysis.

Descriptive statistical methods were applied to summarize and systematize key indicators of food security and agro-industrial competitiveness, including agricultural productivity, food availability, food price stability, and trade performance. Comparative analysis was used to identify structural differences and common trends across countries and over time. This method was selected to provide an initial understanding of patterns and disparities before applying more complex analytical techniques.

To assess the competitiveness of the agro-industrial complex, a set of economic and technological indicators was used, including total factor productivity in agriculture, value added per worker, export competitiveness indices, and investment in agricultural research and development. The indicator-based approach allows for a multidimensional evaluation of competitiveness and is widely applied in agro-economic studies due to its transparency and reproducibility.

National food security was evaluated using a composite approach that integrates indicators reflecting food availability, access, and stability. In addition to the Global Food Security Index, FAO food balance sheets and price volatility indicators were utilized. This methodological choice is justified by the multidimensional nature of food security and the need to avoid reliance on a single indicator that may not capture systemic vulnerabilities.

To test the research hypothesis, panel regression analysis was employed. Fixed-effects and random-effects models were estimated to assess the impact of agro-industrial competitiveness indicators on national food security outcomes while controlling for macroeconomic variables such as GDP per capita, population growth, and trade openness. The use of panel data econometrics is justified by its ability to account for unobserved country-specific effects and temporal dynamics.

Correlation and Sensitivity Analysis

Correlation analysis was conducted to examine the strength and direction of relationships between competitiveness indicators and food security variables. Sensitivity analysis was applied to test the robustness of results under alternative model specifications and indicator selections. These methods enhance the reliability of findings and reduce the risk of biased conclusions.

The overall study design follows a sequential analytical framework. First, descriptive and comparative analyses were conducted to identify general trends and structural characteristics of agro-industrial competitiveness and food security. Second, competitiveness and food security indicators were operationalized and integrated into a unified analytical framework. Third, econometric modeling was applied to empirically test the research hypothesis and quantify the impact of competitiveness factors on food security outcomes. Finally, robustness checks were performed to validate the consistency of results.

This integrated design ensures methodological coherence and allows for a comprehensive assessment of how competitiveness of the agro-industrial complex contributes to ensuring national food security.

RESULTS

The empirical analysis is based on a balanced panel dataset of 28 countries observed over the period 2010–2023, resulting in a total of 392 observations. Summary statistics for the main variables used in the analysis are presented in Table 1.

Table 1. Descriptive statistics of key study variables (2010–2023)

Variable	Mean	Standard Deviation	Minimum	Maximum
Global Food Security Index (score)	63.4	8.7	42.1	81.9
Agricultural value added per worker (USD)	6,820	2,145	2,310	11,540
Total factor productivity (index)	1.21	0.18	0.87	1.56
Agro-food export share (%)	18.6	7.9	4.2	35.8
Agricultural R&D expenditure (% of GDP)	0.54	0.21	0.11	1.12

The dispersion indices indicate moderate variability across countries, particularly for productivity and export-related indicators. Pairwise correlation coefficients between agro-industrial competitiveness indicators and food security measures are reported in Table 2.

Table 2. Correlation matrix of competitiveness and food security indicators

Variable	GFSI	TFP	Value added per worker	Export share
GFSI	1.000			
TFP	0.62***	1.000		
Value added per worker	0.58***	0.66***	1.000	
Export share	0.41**	0.39**	0.44**	1.000

Notes: *** $p < 0.01$; ** $p < 0.05$ Pearson correlation coefficients reported. Panel regression results estimating the impact of agro-industrial competitiveness on national food security are presented in Table 3. Both fixed-effects (FE) and random-effects (RE) models were estimated.

Table 3. Panel regression results: determinants of national food security

Variable	FE Coefficient	RE Coefficient
Total factor productivity	4.12*** (0.97)	3.88*** (0.91)
Agricultural value added per worker	0.003*** (0.001)	0.002*** (0.001)
Agro-food export share	0.18** (0.07)	0.16** (0.06)
Agricultural R&D expenditure	6.45*** (1.84)	6.02*** (1.76)
GDP per capita (control)	0.001*** (0.0003)	0.001*** (0.0003)
Constant	31.6***	33.1***

Notes: Standard errors in parentheses. *** $p < 0.01$; ** $p < 0.05$. Number of observations: 392. Number of cross-sections: 28. Within R^2 (FE): 0.64. Overall R^2 (RE): 0.61. The Hausman test indicated the appropriateness of the fixed-effects specification ($\chi^2 = 18.7$; $p < 0.01$). Variance inflation factors (VIFs) for all independent variables were below 3.0, indicating no significant multicollinearity. Residual diagnostics showed no evidence of heteroskedasticity at the 5% significance level.

DISCUSSION

This study examined the role of the competitiveness of the agro-industrial complex in ensuring national food security under conditions of global economic instability and structural transformation of food systems. Using panel data from 28 countries over the period 2010–2023 and applying descriptive, comparative, and econometric methods, the research sought to empirically verify the hypothesis that enhanced agro-industrial competitiveness contributes positively to food security outcomes. The analysis focused on key competitiveness indicators, including productivity, value added, export performance, and investment in agricultural research and development.

The results demonstrate a statistically significant and positive relationship between agro-industrial competitiveness and national food security. In particular, total factor productivity and agricultural value added per worker exhibited the strongest effects on food security indicators. These findings are consistent with earlier studies by Fuglie et al. (2012) and Headey and Fan (2010), which emphasize productivity growth as a fundamental driver of food availability and affordability. The strong association between productivity and food security supports the argument that competitiveness enhances not only output levels but also system-wide efficiency and resilience.

The positive impact of agricultural R&D expenditure on food security identified in this study aligns with the conclusions of Alston et al. (2010), who highlight long-term returns from innovation-driven agricultural development. However, the magnitude of this effect suggests that R&D benefits are not automatic and depend on effective institutional frameworks and knowledge diffusion mechanisms—an aspect insufficiently addressed in many empirical studies.

The results also reveal a positive but comparatively weaker relationship between agro-food export share and food security. This finding reflects ongoing debates in the literature. While Reardon et al. (2019) argue that export-oriented value chains enhance competitiveness and income growth, Clapp (2017) cautions that excessive export dependence may increase vulnerability to external shocks. The present study suggests that export competitiveness contributes to food security primarily when combined with strong domestic production capacity and productivity growth.

Despite these contributions, several problem areas and missing aspects emerge. First, most existing studies—including the present one—rely on aggregate national indicators, which may mask regional inequalities and household-level food insecurity. Second, environmental sustainability indicators are often treated as secondary variables, despite their growing relevance for long-term competitiveness and food security. Finally, institutional quality and governance, although acknowledged conceptually, remain underrepresented in quantitative modeling due to measurement constraints.

CONCLUSION

Ensuring national food security in the face of global uncertainty requires more than increasing agricultural output; it necessitates a competitive, efficient, and resilient agro-industrial complex. This study addressed the research problem of how agro-industrial competitiveness influences national food security and whether improvements in competitiveness can serve as a strategic mechanism for strengthening food security.

The findings confirm the central hypothesis of the study: higher competitiveness of the agro-industrial complex has a direct and positive impact on national food security, particularly through productivity growth, increased value added, and sustained investment in innovation.

The first objective—to examine trends and challenges affecting food security—was addressed by identifying persistent disparities in food security outcomes across countries and highlighting the role of productivity and price stability in mitigating food-related risks.

The second objective—to analyze the conceptual foundations of agro-industrial competitiveness—was fulfilled by operationalizing competitiveness through measurable economic and technological indicators that reflect efficiency, innovation capacity, and market integration.

The third objective—to identify key determinants of competitiveness influencing food security—was achieved through econometric analysis, which demonstrated the statistically significant impact of total factor productivity, agricultural value added, and R&D investment on food security indicators.

The fourth objective—to assess the impact of competitiveness on food security outcomes—was supported by robust empirical evidence showing that competitive agro-industrial systems are better equipped to ensure stable food availability and access.

Finally, the study contributes evidence to support the hypothesis that strengthening agro-industrial competitiveness represents a viable and effective pathway for enhancing national food security. These results underscore the need for integrated policy approaches that combine productivity growth, innovation support, and institutional development.

Overall, the study advances the understanding of the competitiveness–food security nexus and provides a foundation for future research focusing on sustainability dimensions, institutional quality, and micro-level food security outcomes.

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