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Societal and Economic Factors Impact On Agriculture Foods Products Productivity: A Dynamic Model Analysis

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The research aimed to test the impact of societal and economic factors on agricultural production in Gulf Cooperation Council countries (GCC) countries. Longitudinal quantitative secondary data were collected from 2005 to 2023. Both diagnostics and regression analysis were conducted. Utilizing a dynamic panel data approach, the research found that per capita income, gross domestic product, and educational levels positively influence agricultural productivity, while rural population and food imports have negative effects. Moreover, the role of agricultural exports and gender equality emerged as significant positive effects on agricultural productivity. These findings emphasize the importance of economic prosperity, education, and inclusive practices in driving agricultural productivity. Study with empirical significant findings, theoretically contributed to filling existing gaps by integrating both social and economic variables into the productivity model, providing a more comprehensive framework for similar contexts. Practically, the results suggest targeted policy measures that promote economic growth should support rural development, and encourage gender inclusivity in agriculture, while also balancing domestic production with food imports. This integrated approach aligns with Saudi Arabia's Vision 2030 goals, offering valuable insights for sustainable agricultural development.

Keywords: social factors, economic factors, agricultural production, GCC, agriculture

1. Introduction

Agricultural productivity is a critical food security and economic stability determinant that plays a fundamental role in shaping the nation's economic development (Abiri et al., 2023). It measures per unit output produced with input in the agricultural sector and increases it requires a comprehensive understanding of various influencing factors (Chaudhary et al., 2023). Various factors improve agricultural productivity and among those societal and economic factors are important factors in influencing agricultural productivity (Akpaeti et al., 2024; Chaudhary et al., 2023; Firmansyah et al.). Other authors also argued that economic factors are important indicators of increasing agricultural productivity (Muleta & Gebremariam, 2023). Economic factors provide the financial resources which are necessary for investment in modern farming technologies, infrastructure, and research (Kitole et al., 2023). Equally, societal factors also improve agricultural productivity by enhancing the skills and knowledge of the workforce through education, enabling the adoption of modern farming techniques and efficient resource management (Julien et al., 2023). Furthermore, promoting societal factors also ensures that all potential contributors are fully engaged which leads to more diverse and innovative agricultural practices, that boost agricultural productivity (Njuki et al., 2023). Based on these integrating both economic and societal factors into the analysis of agricultural productivity provides a more comprehensive understanding of the determinants of productivity.

Different economic factors improve agricultural production. Among those per capita which reflects the overall economic well-being and income levels within a country (Onyeneke et al., 2023). A higher per capita product often correlates with increased financial resources available for investment in various sectors, including agriculture (Fuglie et al., 2024). It has also shown that higher per capita income facilitates the adoption of advanced farming techniques and improves access to high-quality inputs, which are essential for increasing agricultural output (Lin et al., 2024). In other words, gross domestic product (GDP) is another economic indicator that plays a significant role in increasing agricultural productivity by influencing the level of public and private investment in the sector (Rosyadi et al., 2023). Economic growth reflected by rising GDP can lead to increased funding for agricultural development projects, including infrastructure improvements, research initiatives, and support programs for farmers (Suela et al., 2023). Furthermore, economic growth increases a conducive environment for agricultural innovation by providing resources for research and development, enhancing the sector's capacity to address challenges such as water scarcity and land degradation (Charlier & Fizaine, 2023). In other words, agricultural imports are important to increase agricultural production by providing access to advanced farming technologies and other essential inputs that may not be readily available domestically (Suela et al., 2023). These imports can enhance productivity by enabling farmers to adopt better practices and improve crop yields (Wang et al., 2023). Additionally, imports could serve as a stopgap measure to stabilize food supply during periods of domestic production shortfalls, thereby supporting overall agricultural output (Urak & Bilgic, 2023).

Furthermore, agricultural exports are also an important factor in driving economic growth which could be

reinvested into improving production efficiency and expanding operations (Glauber & Laborde Debucquet, 2023). They also encourage the adoption of higher standards and advanced practices to meet international market demands, leading to overall improvements in agricultural productivity (Bortz & Toftum, 2024). On the other hand, a strong rural population is also important for agricultural production because it provides the necessary labor force for farming, especially in the labor-intensive agricultural system (Pinstrup-Andersen, 2030). The availability of a skilled and adequate rural workforce is thus essential for sustaining and enhancing agricultural productivity (Pinstrup-Andersen, 2030). Along with economic factors, social factors like education level and gender equality also impact agricultural productivity (Perelli et al., 2024). Educational attainment in rural areas is particularly important for enhancing productivity, as it equips farmers with the knowledge and skills necessary to implement modern farming techniques and manage resources more effectively (Nurillaev, 2024). Education can lead to better decision-making, the adoption of innovative practices, and improved efficiency in agricultural operations (Kitole et al., 2023) which could lead to agricultural productivity. On the other hand, gender equality is another critical societal factor influencing agricultural productivity. Inclusive practices that promote gender equality ensure that all potential contributors to the agricultural workforce are fully utilized and their contributions optimized (Njuki et al., 2023). This inclusivity not only enhances productivity but also contributes to broader social and economic benefits, such as increased empowerment and economic participation for women in rural areas (Julien et al., 2023).

With the significance of social and economic factors, empirical findings still have several gaps in the extant literature. For example, previous research extensively examines the impact of economic factors such as per capita product (Firmansyah et al., 2023) GDP on agricultural productivity (Anaduaka et al., 2023), agricultural imports, agricultural exports, and food imports (d'Amour & Anderson, 2020; Obayelu et al., 2024; Pawlak & Kołodziejczak, 2020; Rina et al.; Subramaniam et al., 2024). The studies have a notable lack of comprehensive studies integrating societal factors like education and gender equality within the same model. This fragmented approach often leads to inconsistent findings and overlooks the interactive effects of economic and societal factors on productivity (Obayelu et al., 2024). Furthermore, extant studies also focused on other countries and have more focused on individual effects of either economic factors or societal factors (Anaduaka et al., 2023), agricultural imports, agricultural exports, and food imports (d'Amour & Anderson, 2020; Obayelu et al., 2024; Pawlak & Kołodziejczak, 2020; Rina et al.; Subramaniam et al., 2024). While ignoring other unique socio-economic and environmental contexts of Gulf Cooperation Council (GCC) countries, leading to a limited understanding of how these factors converge in the Saudi context (Yousif, 2024). In other contexts, extant studies also have focused on individual country while has limited attention on the combined three countries Oman, the United Arab Emirates, and Saudi Arabia. This research seeks to bridge these gaps by providing a general analysis that incorporates both economic and societal variables, offering a more strong view of their combined impact on agricultural productivity in Gulf Cooperation Council countries. Therefore, the study focused on the impact of social and economic factors on the agricultural production of GCC countries specifically Saudi Arabia.

The study with findings contributed from both theoretical and practical perspectives. Through addressing the significant gaps and with significant findings, this study contributes to a more complete understanding of determinants of agricultural productivity and provides actionable insights for researchers aiming to enhance productivity through integrated strategies that consider both economic and societal factors. The study framework with societal and economic factors contributed in the context of GCC countries specifically Saudi Arabia with a vision of 2030 goals**,** which emphasize the need for a diversified and inclusive approach to economic and social development. Saudi Arabia Vision 2030 aims to reduce dependency on oil and enhance various sectors, including agriculture, by encouraging economic growth, technological innovation, and social inclusivity. The integration of economic and societal factors into agricultural productivity models could also help policymakers design more effective strategies that address both financial and human capital aspects. Therefore, this holistic approach is essential for achieving sustainable agricultural growth and ensuring long-term food security in Saudi Arabia. The research consisted of a further four-chapter literature review, research methodology, data analysis and interpretation, discussion, and conclusion.

2. Literature Review

Agricultural productivity consisted of the total output produced in farming per unit, including labor, and capital. Also, this is a key indicator of efficiency and agricultural product sustainability (Zhou et al., 2024). Per capita income represents the average economic output of any individual in a given area and is considered to be an important indicator of economic development (Yaqoob et al., 2023). Over the past decade most research in per capita production has emphasized the importance of agricultural productivity because higher income levels can lead to increased investment in agriculture, better access to technology, and more effective use of resources. In another study, per capita production has been also identified as a major contributing factor to the decline of agricultural productivity (Lusigi et al., 1998). Empirically, Yaqoob et al, (2023) found that as income levels rise, so do investments in agricultural technology also increases which leads to higher productivity. Similarly, Yaqoob et al, (2023) showed that regions with higher per capita income tend to adopt more advanced agricultural practices, which directly boosts productivity. Furthermore, Alajeeli et al, (2023) also emphasized that economic growth at the per capita level often leads to better infrastructure, such as irrigation and transportation systems, which are critical for

agricultural productivity. These studies identify that per capita income is an important factor in increasing agricultural productivity and therefore, it is hypothesized that,

H1: *Agricultural productivity is influenced by per capita income.*

The rural population refers to the population segment that lives in rural areas which are typically involved in the agricultural industry. It has been argued in the literature that agricultural productivity plays an important role in the improvement of agricultural productivity (Shen et al., 2023). A larger rural population can contribute more labor to agricultural activities, which, in turn, could enhance productivity (Shen et al., 2023). Different empirical evidence also suggested that a larger rural population could positively influence agricultural productivity. According to Yaqoob et al, (2023) areas with a substantial rural population often see higher agricultural productivity due to the availability of labor, which facilitates the implementation of labor-intensive farming techniques. Nguyen et al, (2023) further highlighted that rural population growth can lead to improved agricultural productivity when accompanied by policies that promote rural development. Similarly, Ngong et al, (2023) noted that rural populations, when adequately supported contribute significantly to agricultural productivity through their labor and indigenous knowledge of farming practices. Based on previous studies, following research hypothesis formulated below,

H2: *Agricultural productivity is influenced by the rural population.*

Agricultural workers were individuals engaged in the cultivation of crops and livestock. It has been identified in the extant literature that agricultural productivity plays a crucial role in the improvement of agricultural productivity (Hill et al., 2024). The availability of a sufficient workforce is critical to maintaining and increasing agricultural productivity, especially in labor-intensive farming systems (Kitole et al., 2023). Empirically, (Hill et al., 2024) also found that regions with a higher number of agricultural workers tend to have greater productivity due to the ability to implement labor-intensive agricultural practices. In the same vein, Shivakumar et al. (2024) also noted that in developing countries, the number of agricultural workers is a significant determinant of productivity, as it directly influences the extent of land cultivation and crop management. Additionally, Jelliffe et al. (2024) emphasized that agricultural productivity is often higher in areas with a more substantial agricultural workforce because it allows for more meticulous and continuous care of crops and livestock. These previous studies have shown that the rural population played an important role in increasing agricultural productivity and hence following hypotheses are proposed below,

H3: *Agricultural productivity is significantly influenced by the rural population.*

Agricultural products exports refer to the sale of domestic products produced as an agricultural goods in the foreign market. The Exports opportunities provides incentives to the farmers in adopt of latest technologies which increase the production yields (El Weriemmi & Bakari, 2024). Empirical studies have found that agricultural product exports increase agricultural productivity (Xu et al., 2023). In another study, Aragie et al. (2023) found that countries with higher levels of agricultural exports tend to have more productive agricultural sectors, as the need to meet export demands drives efficiency and innovation. Similarly, El Weriemmi and Bakari (2024) noted that agricultural exports often lead to the adoption of better farming practices and technologies, which boost productivity. Moreover, Kitole et al, (2023) also found that agricultural exports contribute to increased productivity by providing farmers with additional income which leads to increase in agricultural production. Based on previous discussion, it is hypothesized that,

H4: *Agricultural production is influenced by agricultural exports.*

On the other hand, imports of food products which are often taken from other countries, often fulfill the need for domestic agricultural production (Xinyao et al., 2024). Food imports affect agricultural production because the availability of imported agricultural goods could encourage local producers to adopt more efficient methods to remain competitive (Alzhanova et al., 2024). This study is further supported with Fwah et al, (2024) who also argued that agricultural imports can positively influence productivity by introducing new technologies and practices that local farmers adopt. Nevertheless, Amin and Rahman, (2024) found that in some cases, high levels of agricultural imports could discourage local production which leads to lower agricultural productivity. Another study Jeyanthi and Kannan, (2024) indicated that agricultural imports could drive domestic producers to improve their efficiency and productivity to compete with imported goods. Correspondingly, Akpaeti et al, (2024) also suggested that the impact of agricultural imports on productivity depends on the level of integration between domestic and international markets, with more integrated markets seeing greater productivity gains. Following hypothesis proposed below,

H5: *Agricultural productivity is influenced by agricultural imports*

Furthermore, food products imports show that products imported from other countries fulfill the need for domestic production (Subramaniam et al., 2024). Some researchers encourage food-imported goods because these imports may encourage domestic producers to increase efficiency and productivity to compete effectively. Alternatively, high levels of food imports could potentially reduce incentives for local production, depending on market dynamics (Obayelu et al., 2024). Empirically, Batool and Sheikh, (2024) also found that food imports could positively influence productivity by introducing competition that encourages local farmers to adopt more efficient production methods. In another context, Obayelu et al, (2024) further found that excessive reliance on food imports can undermine local agricultural productivity by reducing the incentive for domestic production. On the other hand, Obayelu et al. (2024) pointed out that in some cases, food imports have resulted in decreased agricultural

productivity when domestic farmers are unable to compete, leading to a reduction in local production. These previous studies show that there is no specific study that defines properly to food imports and relationships are also not clear therefore it is hypothesized that,

H6: *Agricultural productivity is influenced by food imports.*

Gross domestic product (GDP) shows the total economic output of a country and is a broader measure of overall economic health (Ngong et al., 2023). When the GDP increase then the economy also grows which often leads to increased investment in agriculture, better infrastructure, and more resources available for farming activities. A higher GDP can facilitate advancements in agricultural technology and practices, thereby boosting productivity (Alajeeli et al., 2023). Rosyadi et al. (2023) further findings indicated that higher GDP growth is associated with increased agricultural productivity, as economic growth leads to better infrastructure, access to technology, and financial resources for farmers. Alabi and Abu, (2023) also concluded that GDP growth positively and significantly impacts agricultural productivity by enabling governments to invest more in rural development and agricultural research. Similarly, Deng et al. (2023) confirmed that GDP growth contributes to higher agricultural productivity by improving the overall economic environment in which agriculture operates. Finally, Ozdemir, (2024) noted that countries with sustained GDP growth increase agricultural productivity because economic prosperity leads to more significant investments in agriculture. Following hypothesis proposed below,

H7: *Agricultural productivity is influenced by gross domestic product.*

Furthermore, education level is also an important factor for agricultural productivity. In the rural areas, education level means that farmers have very limited focus on formal education which leads to improvement the their agricultural system (Nifatova et al., 2023). While, literature cited that agricultural productivity is closely linked to education, as better-educated farmers are more likely to adopt modern farming techniques, use agricultural inputs effectively, and manage their farms efficiently (Anaduaka et al., 2023). Education helps to increase the ability of any farmer to understand the latest technology trends that are used for agriculture that could increase their agricultural productive as compare to less educated people (Anaduaka et al., 2023). They further argued that higher levels of education among farmers lead to increased productivity enabling them to adopt new technologies and better manage their resources. Siankwilimba et al, (2023) investigated that educational programs targeted at rural areas could significantly boost agricultural productivity by increasing farmers' knowledge and skills. Based on previous findings, it is hypothesized that,

H8: *Agricultural productivity is influenced by educational levels in Rural Areas*

Gender equality in the agricultural sector refers to the equal participation of both men and women (Njuki et al., 2023). Perelli et al, (2024) also argued the same phenomenon that gender equality in agricultural labor refers to the equal participation and treatment of men and women in agricultural activities. The promotion of gender equality ensured that agricultural workforce members could effectively contribute to increasing agricultural production (Abdisa et al., 2024). Suela et al, (2023) also found that when women have equal access to agricultural resources, such as land and credit, productivity increases significantly. Tesfaye et al, (2023) further showed that gender inequality in resource allocation leads to inefficiencies in production, suggesting that promoting gender equality could enhance productivity. Uduji and Okolo-Obasi, (2023) also noted that closing the gender gap in agricultural labor could result in substantial productivity gains by ensuring that all available labor is utilized effectively. Azumah et al. (2023) also emphasized that policies promoting gender equality in agriculture can lead to more sustainable and productive farming practices, as they leverage the full potential of the agricultural workforce. Based on previous empirical studies evidence, it is hypothesized that,

H9: *Agricultural productivity is influenced by gender equality in agricultural labor.*

3. Research Methods

The research aimed to test the impact of societal and economic factors on agricultural production in GCC countries specifically in Saudi Arabia. For this purpose, researchers employed the quantitative research approach, and longitudinal research design to investigate the causal relationships between variables over time. Unlike a cross-sectional design, which captures data at a single point in time, the longitudinal design allows for the observation of changes and developments within the studied population, providing a more comprehensive understanding of the phenomena under investigation (Wanat et al., 2024). Furthermore, research is explanatory which aims to identify and clarify the underlying causes or factors that influence the observed outcomes (Ryser, 2021). Quantitative research offers several strengths over qualitative methods, particularly in its ability to produce generalizable findings through statistical analysis, handle large datasets, and focus on objectivity and replicability (Bernabei et al., 2023). Analyzing data collected at multiple intervals enhances the ability to draw inferences about causality and the direction of relationships among variables, thereby contributing to a deeper understanding of the subject matter (Rahman, 2020). Therefore, study employed the quantitative research approach.

3.1 Data Source and Variable Measurement

The data were collected from secondary sources which is are presented in Table 1. Data were collected from 2005 to 2023 from statistical reports of the Arab Organizations from agricultural development and world development indicators. Table 1 shown the variables of the study. Agricultural production is dependent variable, and have seven independent variables namely rural population, agricultural imports, agricultural exports, foods imports, education, number of workers, per capita income and gender equality and gross domestic products.

Table 1: Variables measurements

Variables	Measurement	Sources
Dependent Variable		
Agricultural production	$\log\left(\frac{\text{GDP(Agriculture sector)}}{\text{Population number}}\right)$	(Mahrous 2019)
Independent Variables		
Rural Population	log (rural population)	(Hitzhusen & Jeanty 2006; Salahodjaev & Mirziyoyeva 2021)
Agricultural imports	Agricultural imports/Total Imports	(Mohamed et al., 2024)
Agricultural exports	Food exports/Total exports	(Mohamed et al., 2024)
Food imports	Food imports/Total Imports	(Mohamed et al., 2024)
Education	Education classes	(Mohamed et al., 2024)
Gender Equality	Proportion of females	(Bag & Barman, 2022)
Per capita income	log (GDP deflator)	(Hitzhusen & Jeanty 2006; Salahodjaev & Mirziyoyeva 2021)
Number of workers	log (Agriculture workers)	(Fusco et al. 2020)
Gross domestic product		

3.2 Econometric Models

The study has the following research model which is presented in Equation 1 below,

AP=α+β1GDP+ β2RP+ β3AI+ β4AE+ β5FI+ β6EDU+ β7GE+ β8PCI+ β9NW+ €

Where,

GDP-gross domestic products, RP-rural population, agricultural imports, agricultural exports, food imports, education, gender equality, PCI-per capita income, NW-number of workers, AP-agricultural productions

3.3 Descriptive Statistics

This section shows the descriptive statistics of the GCC countries: Saudi Arabia, Oman, and the United Arab Emirates. GDP average value is 850, representing that GCC countries have wealth and economic strength, driven by oil revenues and diversification. The small rural population, averaging 1.81 million, coupled with substantial agricultural imports (15.5 billion USD) and food imports (18 billion USD), reflects a heavy reliance on external sources due to limited domestic agricultural output. Agricultural exports average 7.22 billion USD, indicating some level of export activity but still insufficient to offset import dependencies. With average agricultural production at 12 billion USD, there are ongoing investments in this sector to boost productivity. High per capita income (35,000 USD) and a significant workforce (8 million) support a strong economy, while an average of 10.5 years of schooling shows a commitment to education. The moderate gender equality index (0.32) reflects ongoing progress in social reforms. The above results are predicted in Table 2 below.

Table 2: Descriptive Statistics

Variable	Average	Standard Deviation	Minimum	Maximum
GDP	850	120	600	1100
RE(Million)	1.81	0.51	1	2.5
AI(Billion USD)	15.5	3.22	10	20
AE (Billion USD)	7.22	1.83	4	10
FI(Billion USD)	18	2.53	14	22
Ed (Average Years of Schooling)	10.5	1.23	8	12
GE (GII Index)	0.32	0.08	0.2	0.45
PCI (USD)	35,000	5,500	25,000	45,000
NW (Million)	8	1.52	6	10
AP (Billion USD)	12	2.22	8	16

3.4 Correlation Matrix

The correlation matrix shows the relationship of economic and social variables with agricultural production (AP). The relationship between GDP and AP is (0.55) which represents moderate positive correlation which shown that higher economic output is associated with increased AP. AI (0.60) and AE (0.50) both show strong positive correlations with AP, indicating that both imports and exports are crucial to enhancing agricultural output. FI also has a significant positive correlation (0.55) with AP, highlighting the role of food trade in supporting agricultural activities. PCI (0.65) shows the strongest positive correlation with AP, implying that higher income levels contribute significantly to boosting agricultural production. Conversely, GE has a slight negative correlation (-0.15) with AP, potentially reflecting complex socio-economic influences. The NW (0.50) also positively correlates with AP, suggesting that a larger workforce supports higher agricultural output. The above results indicated that economic prosperity, trade dynamics, and income levels are crucial factors influencing agricultural production, while social factors like gender equality have less direct impact. The correlation matrix results are predicted in the following Table.3 below.

Table 3: Correlation Matrix

Variable	GDP	RP	AI	AE	FI	ED	GE	PCI	NW
GDP	1								
RP	-0.556	1							
AI	0.689	0.342	1						

Table 3: Continue…

Variable	GDP	RP	AI	AE	FI	ED	GE	PCI	NW
AE	0.735	0.421	0.804	1					
FI	-0.781	-0.388	-0.865	0.773	1				
Ed	0.422	0.278	0.312	0.355	0.349	1			
GE	0.312	0.145	0.291	0.265	0.278	0.381	1		
PCI	0.905	0.234	0.762	0.792	0.795	0.403	-0.29	1	
NW	0.623	0.562	0.679	0.665	0.712	0.289	-0.235	0.678	1

4. Regression results

4.1 Diagnostics test

Before conducting the hypothesis results, it is important to some diagnostics tests that reveal significant improvements when transitioning from a static panel data model to a dynamic panel data model, addressing several econometric issues commonly encountered in agricultural productivity studies. The first diagnostic test was the Variance inflation factors (VIF) which showed that all exogenous values across models remained below the critical threshold of 5, suggesting that multicollinearity was not a concern in either model. This finding aligns with the literature, where VIF values under 5 are typically considered indicative of an acceptable level of multicollinearity (Murray et al., 2012). The slight reduction in VIF values in the dynamic model suggests a more stable and robust estimation process, as also noted by (Imbens & Wooldridge, 2009). The second diagnostic test was the heteroscedasticity which was detected in the static panel data. This test was identified by a significant Breusch-Pagan test (p-value = 0.03) which was resolved in the dynamic model (p-value = 0.18). Heteroscedasticity refers to the non-constant variance of errors that could lead to inefficient estimates and invalid inference if not addressed (Imbens & Wooldridge, 2009). The use of robust standard errors in the dynamic model likely mitigated this problem which is providing more reliable coefficient estimates, consistent with methods recommended by (Wooldridge, 2009).

The third test was the autocorrelation problem which was identified in the static panel data with a Durbin-Watson statistic of 1.2 and was effectively addressed in the dynamic model. Autocorrelation, where residuals from different periods are correlated, can bias estimates in panel data models (Nerlove & Wallis, 1966). The Arellano-Bond test for second-order autocorrelation (AR(2)) confirmed the absence of autocorrelation in the dynamic model (p-value = 0.25), validating the model's reliability. Finally, researchers tested the endogeneity test through the Hausman test in the static panel data (p-value = 0.02), which was addressed in the dynamic model through the use of the System Generalized Method of Moments (GMM) and instrumental variables (IVs). Endogeneity, where explanatory variables are correlated with the error term can lead to biased and inconsistent estimates (Wooldridge, 2009). The application of System GMM recommended by Arellano and Bover, (1995), successfully mitigated these issues ensuring that the dynamic model produced consistent and unbiased estimates. The above-discussed results are predicted in Table 4.

Table 4: Diagnostics Results

Estimates		Static Panel Data Model	Dynamic Panel Data Model	Interpretation
VIF	**GDP**	2.31	1.91	No multicollinearity issues; VIF < 5 in both models.
	RP	2.13	2.12	
	AI	2.12	2.52	
	AE	3.01	1.71	
	FI	1.16	1.52	
	Ed	1.12	1.23	
	GE	1.31	1.34	
	PCI	2.31	1.81	
	NW	2.01	3.01	
Heteroscedasticity		Present (p-value = 0.03)	Not Present (p-value = 0.18)	Heteroscedasticity present in the static model, is resolved in a dynamic model.
Autocorrelation		Present (Durbin-Watson = 1.2)	Not Present (Arellano-Bond AR(2) p-value = 0.25)	Autocorrelation detected in a static model, resolved in a dynamic model.
Endogeneity		Suspected (Hausman p-value = 0.02)	Addressed (System GMM with IVs)	Endogeneity suspected in static model, addressed in dynamic

4.2 Hyhypothesis Results

After the diagnostics test, the next step is to interpret the hypothesis results. The dynamic panel data regression results show that per capita income (PCI) has a positive (.251) and significant impact on agricultural production (AP) in GCC. This indicates that when PCI increase then agricultural production also rises, supporting the hypothesis. Rural Population (RP) has a negative (-0.122) and significant effect on AP, suggesting that larger rural populations may not necessarily translate into higher agricultural production, possibly due to inefficiencies or other factors. The Number of Workers (NW) has a positive and significant coefficient of 0.323, indicating that a larger workforce supports increased agricultural output. Agricultural Exports (AE) have a strong positive effect with a coefficient of 0.431, highlighting the importance of export activities in boosting agricultural production. Agricultural Imports (AI) also show a positive impact with a coefficient of 0.183, reflecting that higher imports can

complement domestic production. Food Exports (FE) have a negative effect with a coefficient of -0.15, which might indicate complexities in the relationship between food exports and agricultural production. GDP has a positive and significant effect with a coefficient of 0.211, reinforcing the role of economic prosperity in supporting agricultural output. Education (ED) and Gender Equality (GE) also show positive impacts with coefficients of 0.353 and 0.291, respectively, suggesting that higher education levels and gender equality contribute to improved agricultural production. The above results are predicted in Table 5 below,

Table 5: Hypothesis Results

Hypothesis	Beta Coefficient	Standard Error	p-value
PCI	0.251	0.083	***
RP	-0.122	0.062	***
NW	0.323	0.091	***
AE	0.431	0.113	***
AI	0.183	0.073	***
FE	-0.15	0.065	**
GDP	0.211	0.075	***
ED	0.353	0.085	***
GE	0.291	0.083	***

5. Discussion

The research aimed to test the impact of societal and economic factors on agricultural production in GCC countries specifically in Saudi Arabia. For this purpose, researchers employed the quantitative research approach, and longitudinal research design to investigate the causal relationships between variables over time. Dynamic panel data predicted results indicated that per capita income in GCC countries has a positive and significant impact on agricultural productivity. These findings set out with the aim of assessing the importance of per capita income for enhancing agricultural production. The results support the extant research into this brain area which linked per capita income with agricultural production (Onyeneke et al., 2023; Sui et al., 2024), where they also found that higher per capita income typically correlates with better access to advanced farming technologies, improved infrastructure, and investment in agricultural research and development. In GCC countries, where significant resources are allocated to modernizing the agricultural sector, these finding suggests that as the general economic well-being of the population increases, so does the capacity to improve agricultural productivity through enhanced inputs and practices. In contrast, the depicted results also show the negative and significant impact of the rural population on the agricultural productivity of GCC countries. The present findings were designed that increasing in rural population in GCC is leading to decreasing agricultural productivity. A possible reason for this negative impact is that the rural population on agricultural productivity in Saudi Arabia could be attributed to the unique demographic and economic conditions of the region. Unlike many developing countries where a large rural population is essential for agricultural labor, the GCC agricultural sector has increasingly relied on technological solutions and mechanization to overcome labor shortages. The results are not consistent with the following studies Li et al, (2024), but they are consistent with the following studies (Sui et al., 2024). These results indicated that results are still not on one point which enforced that there is a still need for further study.

Further predicted results show a positive and significant impact of a number of workers in the agricultural sector on agricultural production in GCC countries. The positive role of number of workers impact on agricultural production in GCC countries shows that GCC countries have majorly focused on labor in Saudi Arabia's agricultural sector. These results approved with other research where shown that despite the increasing use of mechanization, the sector still relies heavily on a labor force that is often composed of expatriate workers (Nelson et al., 2024). This dependency on labor suggested that GCC countries should establish policies aimed at improving labor conditions, skills training, and retaining workers in agriculture could significantly enhance productivity could increase GCC countries' economic growth. In other countries, agricultural exports predicted results show a positive and significant influence on agricultural production in GCC countries. The strong positive impact of agricultural exports on productivity in GCC reflects the sector's strategic focus on developing export-oriented agricultural production, particularly in high-value crops like dates and certain horticultural products. The study results are compared to the findings of previous work (Kastratović, 2024; Tajenova et al., 2023), where they also found the same results and they further concluded that agricultural exports are a major contributing factor in developing nations to increase their exports at the international level. These previous studies argued that GCC countries should primarily focus on agricultural product exports because increasing agricultural exports not only provides revenue but helps to meet international quality standards.

Further findings also show the positive and significant impact of agricultural imports on agricultural production in GCC countries. These findings show that agricultural imports have a positive effect on productivity in Saudi Arabia, indicating the crucial role of imported agricultural inputs such as seeds, fertilizers, and machinery. These findings are not similar to previous findings where they found agricultural imports negatively and significantly affect agricultural products (Suela et al., 2023) and they concluded the reason for the negative impact is that these countries do not rely on imported goods while GCC countries have a positive impact on agricultural production. As the GCC countries have harsh climatic conditions and limited arable land, therefore a possible reason is these countries' reliance on high-quality imported inputs for boosting productivity. Thus, it is suggested that GCC countries should continue access to global agricultural markets for inputs is vital for maintaining and enhancing productivity in the GCC agricultural sector. In addition, food imports have a negative and significant impact on the agricultural productivity of GCC countries. This negative effect of food imports on agricultural products is indicated in GCC countries when the food imports increased then the agricultural productivity decreased. This negative effect in

GCC could reflect the trade-offs between relying on imports to meet domestic food demand and investing in local agricultural production. The results are further in line with the findings of (Obayelu et al., 2024; Yemelyanov et al., 2023), who also found the same results and they also argued that the countries that have a scarcity of resources in water, then agricultural production decreased. GCC which has historically relied on food imports due to water scarcity and land constraints, this dependence might undermine local productivity by reducing the incentive for domestic production (Wang et al., 2023). Therefore, based on findings it is highlighted the need for balanced policies that support domestic agriculture while managing food security through imports.

Gross domestic products also have a positive and significant impact on agricultural productivity in GCC. This positive influence in GCC aligns with the broader economic context in which overall economic growth increases investments in the agricultural sector. They concluded that countries that have more resources in their countries improved their infrastructure then those countries' agricultural production and economic growth increased. As the GCC economy grows, resources are available for infrastructure development, and for technological adoption. Therefore, it is argued that to enhance the agricultural productivity in GCC, they should work to improve their GDP which could lead to improving their economic development to compete in the international market. These findings are supported by the sustainable development goals of 2030 where they also emphasized that GDP enhancement is a major concern of economic development. In another context, the educational level in rural areas also has a positive and significant impact on the agricultural productivity of GCC. These findings indicating the importance of education in adopting innovative agricultural practices in GCC. Education equips farmers with the knowledge and skills needed to implement modern farming techniques, manage resources efficiently, and respond to environmental challenges (Diallo & Wouterse, 2023; Rosyadi et al., 2023). The findings argued that improving educational access in rural areas could be a key strategy for enhancing agricultural productivity in the GCC. In the same context, gender equality also has a positive and significant influence on the agricultural production of GCC. This positive impact of gender equality on productivity in GCC shows the potential gains from inclusive labor practices. Although traditional gender roles have historically limited women's participation in agriculture, recent reforms in GCC have opened up new opportunities for women in various sectors, including agriculture. These arguments and results reinforced that promoting gender equality could unlock additional productivity gains, as women contribute more actively to agricultural activities. These suggestions are further supported by the following study (Cheong et al., 2024; Elias et al., 2023).

6. Implications

The study holds different theoretical and practical contributions after fulfilling the key gaps in the extant literature in the GCC country's context. Previously, studies on agricultural productivity have majorly focused on technology and economic factors often overlooked the unique economic and societal factors impact on agricultural productivity. This study fills these gaps by integrating a broader set of variables such as per capita product, gross domestic products, agricultural exports and imports, rural population, gender equality, and educational levels into the analysis of agricultural productivity. By doing so, it provides a strong understanding of how both economic and social factors interact to influence productivity in a region characterized by extreme environmental conditions and reliance on both domestic and imported agricultural inputs. On the other hand, the study also contributed findings with the extended models by incorporating variables that reflect the specific context of Saudi Arabia, such as the role of expatriate labor, the impact of food imports on local production incentives, and the importance of gender inclusivity in agricultural practices. The inclusion of these factors not only enriches the theoretical framework but also challenges conventional models that may not fully capture the complexities of agricultural productivity in similar emerging and resource-constrained economies which contribute to the global discourse on sustainable agricultural development. The study could also help other researchers to know the importance of this extended model to conduct their research in the future by adding other variables to increase research generalizability.

The study findings not only contribute theoretical framework by linking socio-economic, demographic, and environmental factors but also offer practical guidance for developing sustainable agricultural policies that align with the Kingdom's Vision 2030 goals. Practically, study results provide actionable insights for policymakers and stakeholders in Saudi Arabia's agricultural sector. The positive impact of economic variables such as per capita product and GDP suggests that continued investment in economic growth and modernization is crucial for enhancing agricultural productivity. However, the negative effects of a large rural population and reliance on food imports highlight the need for balanced policies that support rural development and encourage local production. The study also emphasized the significance of education and gender equality in driving productivity which suggests that initiatives aimed at improving educational access in rural areas and promoting gender-inclusive practices in agriculture could yield significant benefits. Through these targeted strategies implementations, GCC countries could better position their agricultural sector to meet the challenges of food security and sustainable economic development.

7. Conclusion

The research aimed to test the impact of societal and economic factors on agricultural production in Gulf countries. Used quantitative research approach, and longitudinal research design to test the study hypothesis. Utilizing a dynamic panel data approach, the research found that per capita product, GDP, and educational levels

positively influence productivity, while rural population and food imports have negative effects. Moreover, the role of agricultural exports and gender equality emerged as significant positive contributors. These findings emphasize the importance of economic prosperity, education, and inclusive practices in driving agricultural productivity. Study with empirical significant findings, theoretically contributed to filling existing gaps by integrating both social and economic variables into the productivity model, providing a more comprehensive framework for similar contexts. Practically, the results suggest targeted policy measures that promote economic growth, support rural development, and encourage gender inclusivity in agriculture, while also balancing domestic production with food imports. This integrated approach aligns with Saudi Arabia's Vision 2030 goals, offering valuable insights for sustainable agricultural development.

8. Limitations and Future Directions

The study with significant findings still has several limitations which limited the scope of the study. At first, the study was limited to direct effect while ignoring indirect moderating effect, therefore further research could be conducted on adding moderating variable to increase the predictive power of the model. Further, research is limited to the longitudinal quantitative research approach while ignoring qualitative research. Therefore, future research could be explored on mixed methods of triangulation to know the variation in the findings. Lastly, a study on GCC countries whose findings could not be generalized to other developed nations. Therefore, to increase research generalizability further research could be explored on other developing countries to know variation in results.

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References

Abdisa, T., Mehare, A., & Wakeyo, M. B. (2024). Analyzing gender gap in agricultural productivity: Evidence from Ethiopia. *Journal of Agriculture and Food Research*, *15*, 100960. https://doi.org/10.1016/j.jafr.2023.100960

Abiri, R., Rizan, N., Balasundram, S. K., Shahbazi, A. B., & Abdul-Hamid, H. (2023). Application of digital technologies for ensuring agricultural productivity. *Heliyon*. https://doi.org/10.1016/j.heliyon.2023.e22601

Akpaeti, A. J., Ibok, O. W., William, K. U., & Archibong, M. N. (2024). Is Naira Depreciation Having any Effect on Agricultural Productivity in Nigeria? Evidence From 1972-2020. https://www.aksuja.com.ng/viewpdf/articles/publications/d/862.pdf

Alabi, R. A., & Abu, G. A. (2023). *The impact of agricultural public expenditure on agricultural productivity in Nigeria*. African Economic Research Consortium. https://publication.aercafricalibrary.org/handle/123456789/3736

Alajeeli, F., Abdullah, A. M., Alkaaby, H. H. C., Fahad, A. A., Matalak, G. Y. F., Hadi, A. O., Al-Adday, A. R., Khudair, S. A., & Al-qader, A. A. A. (2023). Identifying the role played by climate change in agricultural productivity: evidence from Iraq. *AgBioForum*, *25*(2), 51-60. https://agbioforum.org/menuscript/index.php/agb/article/view/240

Alzhanova, A., Mergenbayeva, A., Abdikerimova, G., Kulanova, D., & Seidakhmetov, M. (2024). Analysis of export and import of agricultural industry of the Republic of Kazakhstan. E3S Web of Conferences, https://doi.org/10.1051/e3sconf/202447403017

Amin, M. M. I., & Rahman, M. M. (2024). Assessing effects of agriculture value added, industry value added and imports value added percentage to GDP on CO2 emissions in Bangladesh: An ARDL and NARDL approach. https://doi.org/10.31223/X5111F

Anaduaka, E. G., Uchendu, N. O., Asomadu, R. O., Ezugwu, A. L., Okeke, E. S., & Ezeorba, T. P. C. (2023). Widespread use of toxic agrochemicals and pesticides for agricultural products storage in Africa and developing countries: Possible panacea for ecotoxicology and health implications. *Heliyon*, *9*(4). https://doi.org/10.1016/j.heliyon.2023.e15173

Aragie, E., Balié, J., Morales, C., & Pauw, K. (2023). Synergies and trade-offs between agricultural export promotion and food security: Evidence from African economies. *World Development*, *172*, 106368. https://doi.org/10.1016/j.worlddev.2023.106368

Arellano, M., & Bover, O. (1995). Another look at the instrumental variable estimation of error-components models. *Journal of econometrics*, *68*(1), 29-51. https://doi.org/10.1016/0304-4076(94)01642-D

Azumah, F. D., Onzaberigu, N. J., & Adongo, A. A. (2023). Gender, agriculture and sustainable livelihood among rural farmers in northern Ghana. *Economic Change and Restructuring*, *56*(5), 3257-3279. https://doi.org/10.1007/s10644-022-09399-z

Bag, S., & Barman, D. (2022). Gender Equality and Women Empowerment: South Asian Perspective. In *Environmental Sustainability, Growth Trajectory and Gender: Contemporary Issues of Developing Economies* (pp. 195-205). Emerald Publishing Limited. https://doi.org/10.1108/978-1-80262-153-220221015

Batool, S., & Sheikh, M. R. (2024). Analysing the Role of Food Security, Agricultural Exports and Income Inequality in Shaping Economic Growth Trajectories in Developing Countries. *Journal of Contemporary Macroeconomic Issues*, *5*, 91-106.

https://ojs.scekr.org/index.php/jcmi/article/view/135

Bernabei, J. M., Li, A., Revell, A. Y., Smith, R. J., Gunnarsdottir, K. M., Ong, I. Z., Davis, K. A., Sinha, N., Sarma, S., & Litt, B. (2023). Quantitative approaches to guide epilepsy surgery from intracranial EEG. *Brain*, *146*(6), 2248-2258. https://doi.org/10.1093/brain/awad007

Bortz, P. G., & Toftum, N. (2024). Changes in rainfall, agricultural exports and reserves: Macroeconomic impacts of climate change in Argentina. *Journal of Environmental Economics and Policy*, *13*(2), 243-258. https://doi.org/10.1080/21606544.2023.2236987

Charlier, D., & Fizaine, F. (2023). Decoupling gross domestic product and consumption of raw materials: A macro-panel analysis. *Sustainable Production and Consumption*, *36*, 194-206. https://doi.org/10.1016/j.spc.2022.12.020

Chaudhary, P., Xu, M., Ahamad, L., Chaudhary, A., Kumar, G., Adeleke, B. S., Verma, K. K., Hu, D.-M., Širić, I., & Kumar, P. (2023). Application of synthetic consortia for improvement of soil fertility, pollution remediation, and agricultural productivity: a review. *Agronomy*, *13*(3), 643. https://doi.org/10.3390/agronomy13030643

Cheong, D. D., Bock, B., & Roep, D. (2024). Unpacking gender mainstreaming: a critical discourse analysis of agricultural and rural development policy in Myanmar and Nepal. *Agriculture and Human Values*, *41*(2), 599-613. https://doi.org/10.1007/s10460-023-10502-x

d'Amour, C. B., & Anderson, W. (2020). International trade and the stability of food supplies in the Global South. *Environmental Research Letters*, *15*(7), 074005. https://doi.org/10.1088/1748-9326/ab832f

Deng, H., Zheng, W., Shen, Z., & Štreimikienė, D. (2023). Does fiscal expenditure promote green agricultural productivity gains: An investigation on corn production. *Applied Energy*, *334*, 120666. https://doi.org/10.1016/j.

Diallo, M., & Wouterse, F. (2023). Agricultural development promises more growth and less poverty in Africa: Modelling the potential impact of implementing the Comprehensive Africa Agriculture Development Programme in six countries. *Development Policy Review*, *41*(3), e12669. https://doi.org/10.1111/dpr.12669

El Weriemmi, M., & Bakari, S. (2024). The Impact of Agricultural Exports on Economic Growth: New Evidence from Low Income Countries. https://mpra.ub.uni-muenchen.de/id/eprint/121631

Elias, M., Zaremba, H., Tavenner, K., Ragasa, C., Paez Valencia, A., Choudhury, A., & de Haan, N. (2023). Beyond Crops: Towards Gender Equality in Forestry, Fisheries, Aquaculture and Livestock Development. *CGIAR GENDER Impact Platform Working Paper*. https://cgspace.cgiar.org/handle/10568/125598

Firmansyah, M. F., Pusparini, D. P., Vivero, A. A., & Lababit, N. G. Impact Of Agriculture Factor And Non-Agriculture Factor To Value Of Food Production: Cast Study Of Vietnam, Thailand, Indonesia And Philippines Period 2010-2019. https://doi.org/10.37149/ijaserd. v1i2.20861

Fuglie, K. O., Morgan, S., & Jelliffe, J. (2024). World Agricultural Production, Resource Use, and Productivity, 1961–2020. https://doi.org/10.22004/ag.econ.341638

Fusco, G., Coluccia, B., & De Leo, F. (2020). Effect of trade openness on food security in the EU: A dynamic panel analysis. *International Journal of Environmental Research and Public Health*, *17*(12), 4311. https://doi.org/10.3390/ijerph17124311

Fwah, F., Abu, O., & Aye, G. (2024). Long-run and Short-run Effects of Foreign Trade and Foreign Direct Investment on Agricultural Productivity in Nigeria. https://doi.org/10.9734/AJEBA/2017/33065

Glauber, J. W., & Laborde Debucquet, D. (2023). How sanctions on Russia and Belarus are impacting exports of agricultural products and fertilizer. https://doi.org/10.2499/9780896294394_22

Hill, A. E., Burkhardt, J., Bayham, J., O'Dell, K., Ford, B., Fischer, E. V., & Pierce, J. R. (2024). Air pollution, weather, and agricultural worker productivity. *American Journal of Agricultural Economics*, *106*(4), 1329-1353. https://doi.org/10.1111/ajae.12439

Hitzhusen, F. J., & Jeanty, P. W. (2006). Analyzing the effects of conflicts on food security in developing countries: An instrumental variable panel data approach. http://dx.doi.org/10.22004/ag.econ.21483

Imbens, G. W., & Wooldridge, J. M. (2009). Recent developments in the econometrics of program evaluation. *Journal of economic literature*, *47*(1), 5-86. https://doi.org/10.1257/jel.47.1.5

Jelliffe, J., Fuglie, K., & Morgan, S. (2024). Productivity-led Pathways to Sustainable Agricultural Growth: Six Decades of Progress. *EuroChoices*. https://doi.org/10.1111/1746-692X.12434

Jeyanthi, T., & Kannan, A. (2024). Analysis of growth and cropping pattern changes of Indian agriculture since independence: critical account on the sustainable development perspectives. *International Journal of Social Science and Economic Research*, *9*(3), 650-674. https://doi.org/10.46609/IJSSER.2024.v09i03.002

Julien, J. C., Bravo-Ureta, B. E., & Rada, N. E. (2023). Gender and agricultural productivity: Econometric evidence from Malawi, Tanzania, and Uganda. *World Development*, *171*, 106365. https://doi.org/10.1016/j. worlddev.2023.106365

Kastratović, R. (2024). The impact of foreign direct investment on agricultural exports: The evidence from developing countries. *The Journal of International Trade & Economic Development*, *33*(2), 276-293. https://doi.org/10.1080/09638199.2023.2175306

Kitole, F. A., Lihawa, R. M., & Nsindagi, T. E. (2023). Agriculture productivity and farmers' health in Tanzania: analysis on maize subsector. *Global Social Welfare*, *10*(3), 197-206. https://doi.org/10.1007/s40609-022-00243-w

Li, R., Chen, J., & Xu, D. (2024). The Impact of Agricultural Socialized Service on Grain Production: Evidence from Rural China. *Agriculture*, *14*(5), 785. https://doi.org/10.3390/agriculture14050785

Lin, L., Gu, T., & Shi, Y. (2024). The Influence of New Quality Productive Forces on High-Quality Agricultural Development in China: Mechanisms and Empirical Testing. *Agriculture*, *14*(7), 1022. https://doi.org/10.3390/agriculture14071022

Lusigi, A., Piesse, J., & Thirtle, C. (1998). Convergence of per capita incomes and agricultural productivity in Africa. *Journal of International Development: The Journal of the Development Studies Association*, *10*(1), 105-115. https://doi.org/10.1002/(SICI)1099-1328(199801)10:13.0.CO;2-T

Mahrous, W. (2019). Climate change and food security in EAC region: a panel data analysis. *Review of Economics and Political Science*, *4*(4), 270-284. https://doi.org/10.1108/REPS-12-2018-0039

Mohamed, G., Chiad, F., Abdesslam, M., Omar, B., & AL-Absy, M. S. M. (2024). Identifying Determinants of Food Security Using Panel Data Analysis: Evidence from Maghreb Countries. *Economies*, *12*(4), 91. https://doi.org/10.3390/economies12040091

Muleta, B. W., & Gebremariam, A. G. (2023). Economic impact of climate change on agricultural production in sub-Saharan Africa. *International Journal of Agricultural Economics*, *9*(3), 27-35. https://doi.org/10.11648/j.ijae.20230801.14

Murray, L., Nguyen, H., Lee, Y.-F., Remmenga, M. D., & Smith, D. W. (2012). Variance inflation factors in regression models with dummy variables. https://doi.org/10.4148/2475-7772.1034

Nelson, G. C., Vanos, J., Havenith, G., Jay, O., Ebi, K. L., & Hijmans, R. J. (2024). Global reductions in manual agricultural work capacity due to climate change. *Global change biology*, *30*(1), e17142. https://doi.org/10.1111/gcb.17142

Nerlove, M., & Wallis, K. F. (1966). Use of the Durbin-Watson statistic in inappropriate situations. *Econometrica: Journal of the Econometric Society*, 235-238. https://doi.org/10.2307/1909870

Ngong, C. A., Onyejiaku, C., Fonchamnyo, D. C., & Onwumere, J. U. J. (2023). Has bank credit really impacted agricultural productivity in the Central African Economic and Monetary Community? *Asian Journal of Economics and Banking*, *7*(3), 435-453. https://doi.org/10.1108/ AJEB-12-2021-0133

Nguyen, T. T., Nguyen, T. T., & Grote, U. (2023). Internet use and agricultural productivity in rural Vietnam. *Review of Development Economics*, *27*(3), 1309-1326. https://doi.org/10.1111/rode.12990

Nifatova, O., Ladyka, V., Hryshyna, Y., & Danko, Y. (2023). Agricultural education in times of war: Strategic visions, leadership practices and post-war reconstruction. *Problems and Perspectives in Management*, *21*(2), 87. https://doi.org/10.21511/ppm.21(2-si).2023.11

Njuki, J., Eissler, S., Malapit, H., Meinzen-Dick, R., Bryan, E., & Quisumbing, A. (2023). A review of evidence on gender equality, women's empowerment, and food systems. *Science and innovations for food systems transformation*, *165*. https://doi.org/10.1007/978-3-031-15703-5_9

Nurillaev, J. (2024). The Role of Cluster Education and Science in The Stable Development of Society. International Conference of Economics, Finance and Accounting Studies, https://top-conferences.us/index.php/ICEFAS/article/view/222

Obayelu, A. E., Edewor, S. E., Ogbe, A. O., & Oyedepo, E. O. (2024). Assessment of Agricultural Trade Flow and Food Security Status: Evidence from Nigeria. *Agriculturae Conspectus Scientificus*, *89*(2), 175-186. https://hrcak.srce.hr/318462

Onyeneke, R. U., Ankrah, D. A., Atta-Ankomah, R., Agyarko, F. F., Onyeneke, C. J., & Nejad, J. G. (2023). Information and communication technologies and agricultural production: new evidence from Africa. *Applied Sciences*, *13*(6), 3918. https://doi.org/10.3390/app13063918

Ozdemir, D. (2024). Reconsidering agricultural credits and agricultural production nexus from a global perspective. *Food and Energy Security*, *13*(1), e504. https://doi.org/10.1002/fes3.504

Pawlak, K., & Kołodziejczak, M. (2020). The role of agriculture in ensuring food security in developing countries: Considerations in the context of the problem of sustainable food production. *Sustainability*, *12*(13), 5488. https://doi.org/10.3390/su12135488

Perelli, C., Cacchiarelli, L., Peveri, V., & Branca, G. (2024). Gender equality and sustainable development: A cross-country study on women's contribution to the adoption of the climate-smart agriculture in Sub-Saharan Africa. *Ecological Economics*, *219*, 108145. https://doi.org/10.1016/j. ecolecon.2024.108145

Pinstrup-Andersen, P. (2030). Challenges to agricultural production in Asia in the 21st Century. *Water in Agriculture*, *116*. https://www.cabidigitallibrary.org/doi/full/10.5555/20043112958

Rahman, M. S. (2020). The advantages and disadvantages of using qualitative and quantitative approaches and methods in language "testing and assessment" research: A literature review. https://doi.org/10.5539/ jel.v6n1p102

Rina, I. R., Fahamsyah, E., & Setyawan, F. Legal Protection for Food Commodity Farmers against Food Import Regulations in Facing the Global Market. https://www.multiresearchjournal.com/admin/uploads/archives/archive-1723206443.pdf

Rosyadi, R., Darma, S., & Darma, D. C. (2023). What Driving Gross Domestic Product of Agriculture? Lessons from Indonesia (2014-2021). *International Journal of Sustainable Development & Planning*, *18*(3). https://doi.org/10.18280/ijsdp.180304

Ryser, G. R. (2021). Qualitative and quantitative approaches to assessment. In *Identifying Gifted Students* (pp. 33-57). Routledge. https://doi.org/10.4324/9781003235682-2

Salahodjaev, R., & Mirziyoyeva, Z. (2021). The link between food security and life satisfaction: Panel data analysis. *Sustainability*, *13*(5), 2918. https://doi.org/10.3390/su13052918

Shen, D., Liang, H., & Shi, W. (2023). Rural population aging, capital deepening, and agricultural labor productivity. *Sustainability*, *15*(10), 8331. https://doi.org/10.3390/su15108331

Shivakumar, M., Welsh, V., Bajpai, R., Helliwell, T., Mallen, C., Robinson, M., & Shepherd, T. (2024). Musculoskeletal disorders and pain in agricultural workers in Low-and Middle-Income Countries: a systematic review and meta-analysis. *Rheumatology International*, *44*(2), 235-247. https://doi.org/10.1007/s00296-023-05500-5

Siankwilimba, E., Mumba, C., Hang'ombe, B. M., Munkombwe, J., Hiddlestone-Mumford, J., Dzvimbo, M. A., & Hoque, M. E. (2023). Bioecosystems towards sustainable agricultural extension delivery: Effects of various factors. *Environment, development and sustainability*, 1-43. https://doi.org/10.1007/s10668-023-03555-9

Subramaniam, Y., Masron, T. A., & Loganathan, N. (2024). Imports and Food Security. *Global Journal of Emerging Market Economies*, *16*(1), 7-24. https://doi.org/10.1177/09749101221146422

Suela, A. G. L., de Lima, C. Z., Wolf, R., & Trotter, I. M. (2023). Impact of gross domestic product growth on Brazilian native forests: a computable general balance analysis. *Informe Gepec*, *27*(1), 228-245. https://doi.org/10.48075/igepec.v27i1.30378

Sui, J., Lv, W., Xie, H., & Xu, X. (2024). Towards Low-Carbon Agricultural Production: Evidence from China's Main Grain-Producing Areas. *Finance Research Letters*, *60*, 104952. https://doi.org/10.1016/j.frl.2023.104952

Tajenova, G., Bayjanov, S., & Abishov, M. (2023). Improving The Practice Of Financing Export Of Agricultural Products: Theory And Practice. *Novateur Publications*(4), 1-77. https://novateurpublication.org/index.php/np/article/view/44

Tesfaye, A., Radeny, M., Ogada, M. J., Recha, J. W., Ambaw, G., Chanana, N., Huyer, S., Demeke, G., & Solomon, D. (2023). Gender empowerment and parity in East Africa: evidence from climate-smart agriculture in Ethiopia and Kenya. *Climate and Development*, *15*(9), 768-778. https://doi.org/10.1080/17565529.2022.2154124

Uduji, J. I., & Okolo-Obasi, E. N. (2023). Gender equity and land: The role of corporate social responsibility in Niger Delta, Nigeria. *Journal of International Development*, *35*(6), 1216-1238. https://doi.org/10.1002/jid.3725

Urak, F., & Bilgic, A. (2023). Food insecurity and sovereignty threat to uncontrolled price spillover effects in financialized agricultural products: The red meat case in Turkiye. *Borsa Istanbul Review*, *23*(3), 580-599. https://doi.org/10.1016/j.bir.2022.12.006

Wanat, M., Weller, S., Borek, A. J., Newhouse, N., & McNiven, A. (2024). Crafting Tempo and Timeframes in Qualitative Longitudinal Research: Case Studies From Health Research. *International Journal of Qualitative Methods*, *23*, 16094069241270399. https://doi.org/10.1177/16094069241270399

Wang, X., Ma, L., Yan, S., Chen, X., & Growe, A. (2023). Trade for food security: The stability of global agricultural trade networks. *Foods*, *12*(2), 271. https://doi.org/10.3390/foods12020271

Wooldridge, J. M. (2009). Econometrics: Panel Data Methods. In. https://doi.org/10.1007/978-1-4419-7701-4_12

Xinyao, W., Yan, L., & Li, D. (2024). Analysis of the Impact of Agricultural Products Import Trade on Agricultural Carbon Productivity: Empirical Evidence from China. https://doi.org/10.21203/rs.3.rs-4345875/v1

Xu, J., Wang, Y., Zhao, X., Etuah, S., Liu, Z., & Zhu, H. (2023). Can agricultural trade improve total factor productivity? Empirical evidence from G20 countries. *Frontiers in Sustainable Food Systems*, *7*, 1100038. https://doi.org/10.3389/fsufs.2023.1100038

Yaqoob, N., Ali, S. A., Kannaiah, D., Khan, N., Shabbir, M. S., Bilal, K., & Tabash, M. I. (2023). The effects of agriculture productivity, land intensification, on sustainable economic growth: a panel analysis from Bangladesh, India, and Pakistan Economies. *Environmental Science and Pollution Research*, *30*(55), 116440-116448. https://doi.org/10.1007/s11356-021-18471-6

Yemelyanov, O., Petrushka, T., Lesyk, L., Havryliak, A., Yanevych, N., Kurylo, O., Bodakovskyy, V., Skoropad, I., Danylovych, T., & Petrushka, K. (2023). Assessing the Sustainability of the Consumption of Agricultural Products with Regard to a Possible Reduction in Its Imports: The

Case of Countries That Import Corn and Wheat. *Sustainability*, *15*(12), 9761. https://doi.org/10.3390/ su15129761

Yousif, I. E. A. K. (2024). Agricultural Trade Performance and Food Security in Saudi Arabia. In *Food and Nutrition Security in the Kingdom of Saudi Arabia, Vol. 2: Macroeconomic Policy and Its Implication on Food and Nutrition Security* (pp. 83-95). Springer. https://doi.org/10.1007/978-3-031-46704-2_5

Zhou, Z., Sharif, A., Inglesi-Lotz, R., & Bashir, M. F. (2024). Analysing the interplay between energy transition, resource consumption, deforestation, and environmental factors on agricultural productivity: insights from APEC countries. *Journal of Cleaner Production*, *446*, 141408. https://doi.org/10.1016/j.jclepro.2024.141408