Agricultural Efficiency of OIC Countries: Addressing SDG-2 Output

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The research method employs a DEA approach to measure the relative efficiency of each country in utilizing agricultural inputs to produce the desired outputs. The analysis was conducted to determine the annual average efficiency, the variation between countries, and the overall ranking based on the average efficiency over the study period. The analysis is further extended by measuring productivity using the Malmquist Productivity Index (MPI). The results reveal that several OIC countries, such as Egypt, Uzbekistan, and Yemen, consistently achieved full efficiency during the study period, while countries like Uganda and Afghanistan recorded persistently low efficiency levels. The MPI results show that overall productivity growth in OIC agriculture was driven mainly by technological progress rather than efficiency improvements. These findings indicate heterogeneous performance and underline the importance of technology adoption and governance quality in driving agricultural transformation. The results provide actionable insights for policymakers to design strategies enhancing agricultural efficiency, including regional cooperation, technological innovation, and institutional reforms to strengthen food security systems in OIC member states.

Keywords: Efficiency; Productivity; Agriculture; SDG 2; OIC Countries

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INTRODUCTION

Agriculture remains one of the most vital sectors in the global economy, serving as the backbone for ensuring adequate and nutritious food for a growing world population. Yet, despite significant advancements in agricultural technology, food insecurity persists as a critical global issue. According to recent estimates, over 2.4 billion people experience moderate to severe food insecurity (FAO, IFAD, UNICEF, WFP, & WHO, 2023). Moreover, the coexistence of undernutrition, micronutrient deficiencies, and obesity reflects the complex and structural nature of global malnutrition (Gómez & Ricketts, 2013). These conditions highlight the urgent need to reassess how effectively agricultural systems are utilizing their resources to achieve sustainable food security.

The challenge of ensuring food security is particularly pronounced among member countries of the Organization of Islamic Cooperation (OIC). Many OIC countries face persistent food insecurity, with 26 of them classified as Low-Income Food-Deficit Countries (LIFDCs), and 22 still requiring external food assistance (SESRIC, 2023). Conflicts, economic instability, and climate variability have exacerbated imbalances in food supply and access, particularly affecting vulnerable populations such as children under five, who suffer from high rates of stunting and wasting.

The agricultural sector not only provides food but also supports essential ecosystem services and livelihoods (Poulsen et al., 2015; Pawlak & Kołodziejczak, 2020). However, the contribution of agriculture to total GDP in OIC countries has declined over the past two decades, from 11.8% in 2000 to 10.4% in 2021 (SESRIC, 2023), despite rising domestic food demand. This discrepancy raises an important question regarding the efficiency and productivity of the sector in addressing food insecurity. In this context, improving agricultural efficiency becomes a key policy priority for achieving both economic resilience and food sovereignty.

Food security, as defined by the FAO (1996), exists when all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food that meets their dietary needs and preferences for an active and healthy life. It rests on four fundamental pillars: availability, access, utilization, and stability (FAO, 2008). The interdependence of these pillars implies that achieving food security requires not only adequate production but also equitable distribution, effective utilization, and long-term stability in food systems. Governments therefore carry the responsibility to ensure the right to food for all citizens, as mandated in international human rights frameworks (Roberts, 2021).

Aligned with the 2030 Agenda for Sustainable Development, the United Nations introduced Sustainable Development Goal 2 (SDG-2: Zero Hunger) to eradicate hunger, achieve food security, and promote sustainable agriculture (UN, 2015). However, achieving SDG-2 remains a formidable challenge for many OIC countries. Rapid population growth, changing dietary preferences, and increasing pressure on land and water resources threaten to undermine agricultural sustainability (Hall et al., 2017). Moreover, geopolitical conflicts and trade dependencies further destabilize food markets, heightening inflationary pressures and food insecurity (Filho et al., 2023). Consequently, international collaboration and efficient agricultural management are vital to ensuring progress toward SDG-2 (Ruben et al., 2019).

While the SDGs are designed to provide a universal framework, countries must adapt their implementation according to local contexts and capacities (Gil et al., 2019). In this regard, OIC countries face unique structural and institutional constraints that affect their agricultural productivity. Despite abundant arable land and human resources, inefficiencies in input utilization, weak infrastructure, and limited technological diffusion hinder optimal agricultural performance. Assessing how efficiently OIC countries use their agricultural resources is therefore essential for understanding disparities in food security outcomes.

This study contributes to the ongoing discourse by empirically evaluating the agricultural efficiency and productivity of 24 OIC member states from 2015 to 2021, explicitly linking the analysis to SDG-2 targets. Employing the Data Envelopment Analysis (DEA) and the Malmquist Productivity Index (MPI), this research identifies efficiency variations, productivity trends, and technological changes across countries. By integrating these approaches, the study provides an evidence-based benchmark for policymakers to design strategies that enhance agricultural efficiency and promote sustainable food systems.

The remainder of this paper is organized as follows. Section 2 reviews relevant literature on agricultural efficiency and its role in achieving food security and sustainable development. Section 3 outlines the research methodology, including data sources, variables, and analytical models. Section 4 presents and discusses the empirical findings, followed by Section 5, which elaborates on key insights and policy implications. Finally, Section 6 concludes with recommendations and directions for future research.

LITERATURE REVIEW

Agricultural Efficiency and Economic Development

The agricultural sector has long been recognized as a fundamental driver of economic growth and structural transformation, particularly in developing countries (Dethier & Effenberger, 2012). Beyond its contribution to GDP, agriculture serves as a major source of employment and livelihood, especially in rural areas (Thorbecke, 2013). Historically, it has also been the initial comparative advantage in many export-driven growth models during the early stages of industrialization (Byerlee et al., 2009). Through its forward and backward linkages, agriculture not only supports food production but also stimulates the development of manufacturing and service sectors, generating multiplier effects throughout the economy.

However, the relationship between agricultural growth and economic welfare is neither linear nor guaranteed. Although increased agricultural output often signals progress, it does not automatically translate into improved food security or nutritional outcomes (Qaim, 2014). This paradox has been well documented: households in developing countries sometimes allocate rising incomes toward non-nutritious or non-food items (Subramanian & Deaton, 1996; Banerjee & Duflo, 2007). Consequently, agricultural policy should not only target productivity gains but also focus on efficiency, that is, the optimal utilization of resources such as land, labor, and capital to produce adequate, accessible, and nutritious food.

From a development perspective, agricultural efficiency reflects the sector's capacity to balance limited resources against the growing demand for food and raw materials. Efficiency improvement reduces production costs, minimizes waste, and enhances competitiveness, all of which are essential to achieving sustainable development outcomes (Pawlak & Kołodziejczak, 2020). In the context of developing countries, especially those facing rapid population growth and environmental constraints, efficiency gains may yield greater welfare improvements than simple output expansion.

Empirical Studies on Agricultural Efficiency and Productivity

The assessment of agricultural efficiency has evolved considerably, with a strong empirical foundation in production economics. A significant body of research has applied frontier-based methods, particularly Data Envelopment Analysis (DEA) and Stochastic Frontier Analysis (SFA), to evaluate the performance of agricultural systems across countries and regions. These approaches allow researchers to measure how effectively agricultural inputs are transformed into outputs and to identify the sources of inefficiency.

Anik et al. (2020), for example, analyzed global agricultural Total Factor Productivity (TFP) between 1969 and 2013 and found that global TFP increased by an average of 0.44% per year, primarily driven by improvements in efficiency rather than technological change. Regional variations were substantial, with South Asia demonstrating the highest TFP growth due to institutional reforms and technological adoption. Similarly, Chen et al. (2020) utilized the DEA-Malmquist productivity index to classify agricultural transformation stages, identifying three distinct phases, traditional, low-technology, and high-technology agriculture, based on shifts in efficiency and innovation.

Several recent studies emphasize that agricultural efficiency and productivity are shaped not only by input utilization but also by socio-institutional factors such as governance, education, and public investment. For instance, Galabada (2022) demonstrated that good governance, when coupled with technological progress, significantly enhances food security outcomes. Zafar and Zehra (2022) found that human capital, particularly education, plays a critical role in improving household-level food security by influencing production and consumption decisions. Furthermore, Vysochyna et al. (2020) emphasized the role of agricultural land availability and environmental sustainability in ensuring long-term food security, while Kamenya et al. (2022) identified government expenditure as a catalytic factor for improving food availability and accessibility across ECOWAS countries.

The methodological literature has also expanded toward productivity decomposition, with the Malmquist Productivity Index (MPI) becoming a standard tool to evaluate both technical efficiency change and technological progress over time (Caves et al., 1982). Studies adopting DEA-Malmquist frameworks, such as Rusydiana et al. (2019), highlight how the combination of efficiency and technology components provides a comprehensive picture of sectoral performance. These models have been successfully applied to sectors like manufacturing, banking, and energy, yet their application to agricultural systems in Islamic economies remains limited and underexplored.

Agriculture, Food Security, and the Sustainable Development Goals (SDG-2)

Agriculture plays a pivotal role in achieving Sustainable Development Goal 2 (Zero Hunger), which aims to eradicate hunger, ensure food security, and promote sustainable agriculture by 2030. SDG-2 emphasizes not only food availability but also equitable access, nutrition quality, and resilience to shocks such as climate change and market volatility (Gil et al., 2019). In this framework, agricultural efficiency becomes an indispensable component of sustainability: efficient production enables countries to meet food demand without exerting excessive pressure on natural resources.

Despite its importance, the literature on agricultural efficiency often treats food security outcomes as secondary, focusing instead on productivity or output growth. Few studies have explicitly linked efficiency measurement to SDG performance indicators. For instance, Viana et al. (2022) conducted a systematic review showing that sustainable agricultural systems are key to achieving multiple SDGs simultaneously, including poverty reduction (SDG-1) and climate action (SDG-13). However, empirical evidence quantifying the efficiency-food security nexus, particularly within OIC member countries, remains scarce.

OIC economies share distinctive structural characteristics: high dependence on agricultural employment, large rural populations, and diverse agro-ecological conditions. Yet, they also exhibit persistent inefficiencies due to fragmented policies, inadequate investment in agricultural technology, and weak institutional coordination (SESRIC, 2023). While global studies on agricultural efficiency provide valuable insights, they often aggregate countries in ways that obscure the heterogeneity of Islamic economies. Consequently, there is a need for a context-specific, comparative, and efficiency-based approach to evaluating agricultural performance in OIC countries.

Despite the growing body of literature on agricultural productivity and efficiency, several gaps remain that warrant further exploration, particularly within the context of Islamic economies. Most existing studies have primarily focused on global or regional analyses without paying sufficient attention to the heterogeneity of OIC member countries, which differ significantly in their institutional structures, resource endowments, and policy frameworks. Moreover, previous research tends to emphasize aggregate productivity growth or output expansion while neglecting the efficiency dimension that determines how effectively agricultural inputs are transformed into food security outcomes. Few studies explicitly integrate agricultural efficiency assessment with the Sustainable Development Goal 2 (Zero Hunger) framework, leaving a gap in understanding how efficiency improvements contribute to achieving food security targets. Additionally, empirical evidence employing dynamic productivity analysis, such as the Malmquist Productivity Index (MPI), remains limited in this context, particularly for evaluating temporal changes in efficiency and technological progress among Islamic countries. Addressing these gaps, this study introduces a comprehensive DEA–Malmquist approach to measure both efficiency and productivity dynamics of the agricultural sector across 24 OIC countries from 2015 to 2021, thereby offering novel empirical insights into how resource utilization, technology adoption, and institutional quality interact to influence the achievement of SDG-2.

RESEARCH METHOD

This study aims to assess the agricultural efficiency and productivity performance of 24 member countries of the Organization of Islamic Cooperation (OIC) during the period 2015–2021 within the framework of Sustainable Development Goal 2 (Zero Hunger). The analysis applies a quantitative, non-parametric approach combining Data Envelopment Analysis (DEA) and the Malmquist Productivity Index (MPI). The DEA technique measures the relative efficiency of each country in converting agricultural inputs into outputs, while the MPI captures changes in productivity over time by decomposing total factor productivity into efficiency and technological components. The integration of both approaches provides a comprehensive understanding of agricultural performance from both static and dynamic perspectives.

The data employed in this study are secondary and sourced from the Statistical, Economic and Social Research and Training Centre for Islamic Countries (SESRIC), the World Bank's World Development

Indicators (WDI), and the Food and Agriculture Organization (FAO). The period from 2015 to 2021 was selected to coincide with the implementation phase of the SDGs. The variables are grouped into two main categories: inputs and outputs. Input variables include the agricultural labor force (LAB), human development index (HDI), agricultural land area (AREA), and government agricultural expenditure (EXP). These variables represent the essential resources required for agricultural production and reflect labor quantity, labor quality, land availability, and institutional support. Output variables consist of the well-nourished population (WN), population with food security (FS), and the food production index (FPI). These variables capture the outcomes of agricultural performance and are directly linked to the availability and access pillars of food security (FAO, 2008). The selection of these variables follows prior studies such as Anik et al. (2020), Galabada (2022), and Vysochyna et al. (2020), which emphasize the importance of combining physical, human, and institutional factors in assessing agricultural efficiency.

The DEA model developed by Charnes, Cooper, and Rhodes (1978) and later extended by Banker, Charnes, and Cooper (1984) is used to estimate efficiency scores for each country. This study employs the input-oriented BCC model assuming variable returns to scale (VRS), suitable for comparing countries with different sizes and resource endowments. Formally, the DEA efficiency for each decision-making unit (DMU) j is obtained by solving the following linear programming problem:

$$\min_{\theta,\lambda} \ \theta$$

subject to:

$$-Y\lambda + y_j \leq 0, \theta x_j - X\lambda \geq 0, N1'\lambda = 1, \lambda \geq 0$$

where x_j and y_j are the input and output vectors for country j; X and Y represent the matrices of inputs and outputs for all DMUs; λ is a vector of intensity weights; and θ is the efficiency score with a range of $0 < \theta \leq 1$. A value of $\theta = 1$ indicates that a country is fully efficient, meaning it lies on the production frontier, while values below one suggest inefficiency in resource utilization (Rusydiana & Nugroho, 2017). The DEA approach allows the identification of best-performing countries that can serve as benchmarks for others in improving agricultural performance.

To analyze productivity changes over time, the Malmquist Productivity Index (MPI) proposed by Caves, Christensen, and Diewert (1982) is applied. The MPI measures the total factor productivity (TFP) change between two periods t and $t+1$ as:

$$M_0^{t,t+1}(x^t, y^t, x^{t+1}, y^{t+1}) = [\frac{D_0^t(x^{t+1}, y^{t+1})}{D_0^t(x^t, y^t)} \times \frac{D_0^{t+1}(x^{t+1}, y^{t+1})}{D_0^{t+1}(x^t, y^t)}]^{1/2}$$

where $D_0^t(x^t, y^t)$ is the distance function representing the distance of the production point from the efficiency frontier at time t. The MPI can be decomposed into two multiplicative components: efficiency change (EFFCH) and technological change (TECHCH), such that

$$TFPCH = EFFCH \times TECHCH$$

and further:

$$EFFCH = PECH \times SECH$$

where PECH represents pure efficiency change and SECH represents scale efficiency change. An MPI value greater than one indicates productivity improvement, equal to one indicates stagnation, and less than one reflects a decline. This decomposition enables the identification of whether productivity growth is driven by improved resource management (catch-up effect) or by technological progress (frontier-shift effect), as emphasized in Färe et al. (1994) and Kumar and Russell (2002).

The use of the DEA–MPI combination in this study is justified for several reasons. First, DEA is a non-parametric approach that does not require specification of a production function, which is suitable for analyzing multiple countries with different production technologies (Coelli et al., 2005). Second, the VRS assumption captures the diverse economic scales and institutional conditions of OIC countries, reflecting the real heterogeneity within the sample. Third, integrating MPI allows the study to observe temporal productivity shifts that are essential in evaluating the agricultural sector's long-term sustainability and contribution to SDG-2. This approach has been increasingly applied in cross-country analyses to measure the dynamic performance of sectors where technological innovation and institutional quality are crucial determinants (Chen et al., 2020; Viana et al., 2022).

Overall, the methodological framework adopted in this study provides both static and dynamic perspectives on agricultural performance. DEA identifies the relative efficiency of each country in utilizing resources to enhance food security, while MPI captures whether productivity improvements are driven by technological advancement or better management practices. By applying this integrated framework to 24 OIC member states over the period 2015–2021, the study aims to generate empirical evidence on how agricultural resource utilization, human development, and government policy interact in shaping the achievement of Zero Hunger targets. This methodological approach not only strengthens the analytical rigor of the study but also offers policy-relevant insights for promoting sustainable agricultural transformation across Islamic economies.

RESULT ANALYSIS

The empirical analysis aims to evaluate the agricultural efficiency and productivity of 24 member countries of the Organization of Islamic Cooperation (OIC) from 2015 to 2021, focusing on their progress toward achieving Sustainable Development Goal 2 (Zero Hunger). The analysis integrates Data Envelopment Analysis (DEA) and the Malmquist Productivity Index (MPI) to measure, respectively, the relative efficiency of agricultural resource utilization and the dynamic changes in total factor productivity. The results are presented in three main parts: descriptive statistics of variables, efficiency performance across OIC countries, and productivity dynamics based on MPI decomposition.

Table 1. Descriptive Statistic

Variables	Obs	Mean	SD	Min	Max
LAB	168	34.88	17.76	2.00	76.90
HDI	168	0.62	0.13	0.41	0.84
AREA	168	46.65	20.60	3.75	77.35
EXP	168	3.37	1.94	0.48	13.90
WN	168	88.45	10.02	57.10	97.50
FS	168	60.86	21.86	10.80	95.10
FPI	168	107.48	13.37	78.18	181.33

The statistical description in Table 1 provides an overview of the data used in the DEA and MPI estimations. The results indicate significant variation among countries in both agricultural inputs and food security outcomes. The average share of the agricultural labor force (LAB) is 34.88%, with a wide dispersion (SD = 17.76), suggesting structural heterogeneity in labor dependence across the OIC. The Human Development Index (HDI) averages 0.62, indicating a moderate level of human capital development, yet with considerable differences between countries such as Malaysia (high HDI) and Afghanistan (low HDI). Agricultural land area (AREA) accounts for an average of 46.65% of total land, while government expenditure on agriculture (EXP) averages 3.37%, implying that public financial support for the sector remains relatively limited. Regarding output indicators, the average proportion of the population with adequate nutrition (WN) reaches 88.45%, while food security (FS) averages only 60.86%, reflecting persistent challenges in food access and stability. The Food Production Index (FPI) averages 107.48, indicating moderate improvements in agricultural output across the period. Overall, these descriptive statistics suggest that while many OIC countries have sufficient agricultural potential, disparities in human capital and fiscal capacity continue to affect performance outcomes.

The efficiency analysis results presented in Figure 1 and Table 2 show variations in agricultural performance among OIC member countries. The overall trend depicted in Figure 1 suggests that the annual efficiency scores between 2015 and 2021 remained relatively stable, with minor fluctuations. Although the average efficiency level improved slightly over time, certain years, particularly 2017 and 2019, witnessed notable declines in the lowest efficiency levels, suggesting ongoing difficulties for less efficient countries in sustaining progress. Such fluctuations reflect structural vulnerabilities in agricultural systems, particularly for countries facing political instability, limited technology adoption, or climate-related constraints.

As shown in Table 2, several OIC member countries, including Azerbaijan, Egypt, Uzbekistan, and Yemen, consistently achieved full efficiency (efficiency score = 1) throughout the study period, ranking among the top performers. These countries appear to have effectively utilized their agricultural resources and developed policies supporting modernization and resilience in the food system. Egypt and Uzbekistan, for instance, have long benefited from targeted agricultural reforms emphasizing irrigation development, mechanization, and government-led food programs, which enhance both productivity and food access.

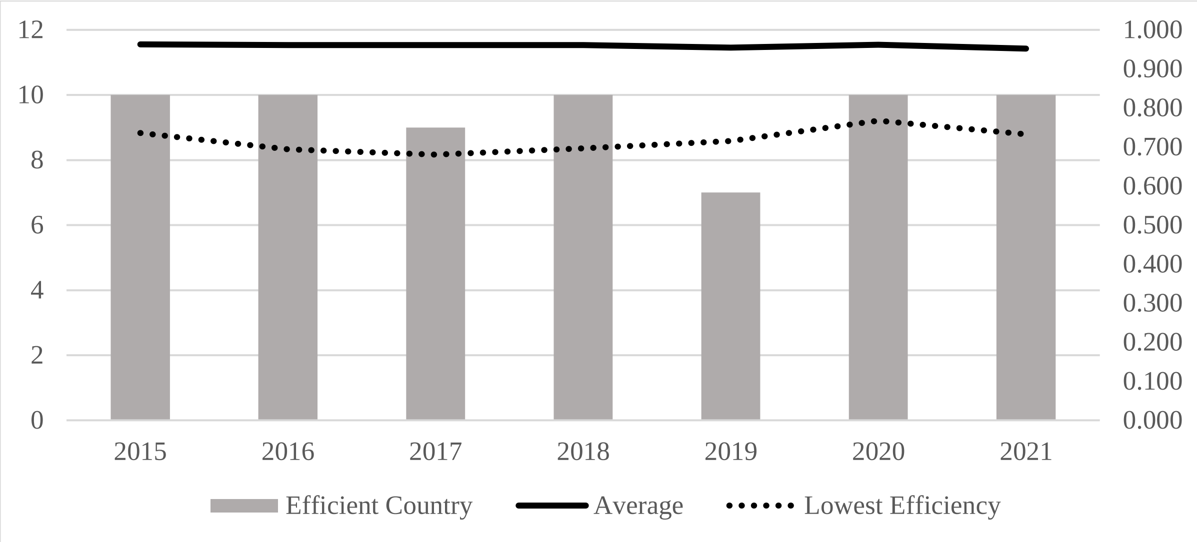

Figure 1. Efficiency Score Analysis

Similarly, Azerbaijan and Yemen demonstrate the successful integration of agricultural modernization policies and food distribution networks, enabling them to sustain high performance despite varying resource constraints.

Table 2. Agricultural Efficiency in OIC Countries

Countries	2015	2016	2017	2018	2019	2020	2021	Average	Rank
Afghanistan	0.867	0.857	0.842	0.819	0.788	0.767	0.767	0.815	23
Albania	0.982	0.983	0.983	0.984	0.984	0.984	0.984	0.983	13
Algeria	1.000	1.000	0.999	1.000	1.000	1.000	1.000	1.000	5
Azerbaijan	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1
Bangladesh	0.895	0.897	0.902	0.904	0.912	0.913	0.918	0.906	21
Burkina Faso	1.000	1.000	0.980	0.972	0.974	1.000	0.934	0.980	15
Cameroon	1.000	0.996	0.986	0.982	0.983	0.984	0.979	0.987	10
Cote d'Ivoire	0.971	0.969	0.993	1.000	0.979	0.995	1.000	0.987	11
Egypt	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1
Guinea	0.971	0.950	1.000	0.976	0.960	0.964	0.965	0.969	17
Indonesia	1.000	1.000	0.993	0.997	0.995	1.000	1.000	0.998	8
Iran	0.961	0.956	0.952	0.952	0.954	0.962	0.963	0.957	19
Kuwait	1.000	1.000	1.000	0.999	0.999	1.000	1.000	1.000	6
Malaysia	0.963	0.967	0.972	0.981	0.987	0.993	0.998	0.980	14
Mauritania	1.000	1.000	0.993	0.988	0.982	0.977	0.961	0.986	12
Nigeria	0.996	0.981	1.000	0.964	0.925	0.923	0.906	0.956	20
Pakistan	1.000	1.000	1.000	1.000	0.965	1.000	0.879	0.978	16
Senegal	0.986	0.989	1.000	1.000	1.000	1.000	1.000	0.996	9
Sierra Leone	0.932	0.984	0.950	1.000	0.951	0.954	1.000	0.967	18
Togo	0.850	0.843	0.846	0.847	0.855	0.869	0.868	0.854	22
Tunisia	0.999	0.998	0.999	1.000	1.000	1.000	0.995	0.999	7
Uganda	0.736	0.694	0.681	0.697	0.715	0.806	0.733	0.723	24
Uzbekistan	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1
Yemen	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1

Conversely, countries such as Uganda and Afghanistan recorded the lowest average efficiency scores (0.723 and 0.815, respectively), highlighting structural inefficiencies in resource utilization and food production systems. These inefficiencies may stem from limited infrastructure, low agricultural investment, or inadequate access to technology. Middle-performing countries such as Indonesia, Tunisia, and Malaysia show steady improvements, reflecting gradual modernization and institutional strengthening. On average, OIC member countries achieved an efficiency level of around 0.90, suggesting moderate performance but also room for improvement. Enhancing agricultural infrastructure, increasing public investment, and supporting human resource development are therefore crucial strategies for improving efficiency across the OIC.

The productivity analysis using the Malmquist Productivity Index (MPI) complements the DEA findings by capturing temporal changes in agricultural performance. The results illustrated in Figure 2 and summarized in Table 3 show how productivity evolved across countries through two primary components: efficiency change (EFFCH) and technological change (TECHCH). The overall MPI results reveal that most OIC countries experienced positive productivity growth during the study period, though with notable heterogeneity. The average total factor productivity change (TFPCH) exceeded 1 in many countries, indicating productivity improvement, while declines in 2019 and 2020, suggest temporary setbacks linked to global and domestic disruptions such as the COVID-19 pandemic, trade restrictions, and supply chain instability.

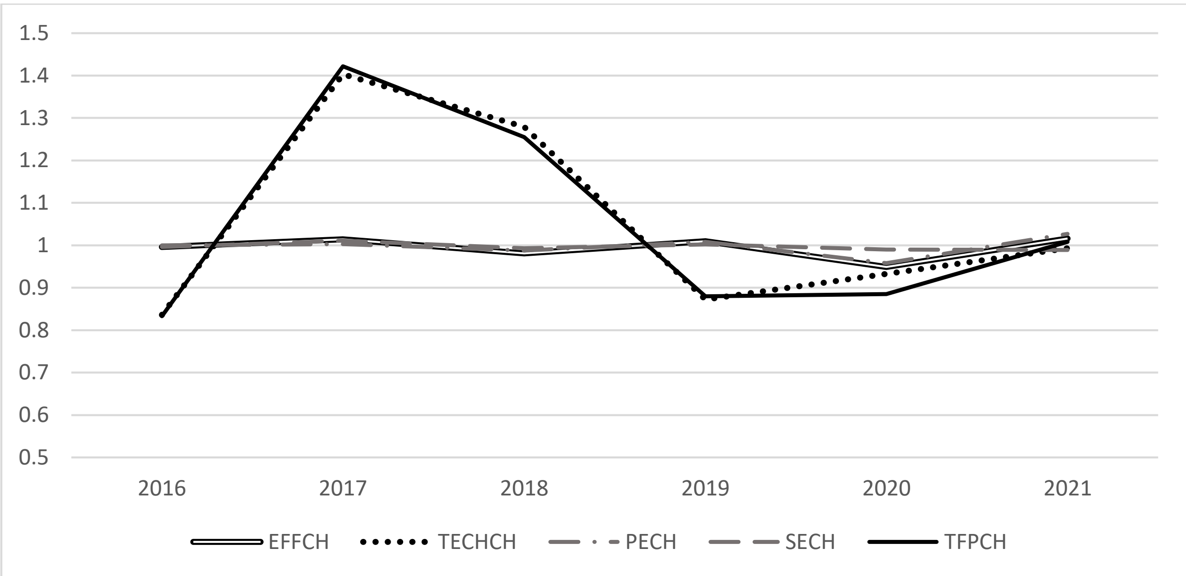

Figure 2. MPI Result

Table 3 reveals that countries like Egypt (TFPCH = 1.110), Indonesia (TFPCH = 1.120), and Malaysia (TFPCH = 1.221) recorded the strongest productivity growth, primarily driven by technological advancement (TECHCH > 1). In these countries, productivity gains appear to result from increased investment in agricultural research, the adoption of digital technologies, and more efficient supply chain management. For instance, Malaysia's productivity surge (TECHCH = 1.206) may be attributed to government incentives promoting precision agriculture and sustainable farming practices. Similarly, Uzbekistan (TFPCH = 1.225) benefited from comprehensive irrigation reforms and enhanced access to agricultural machinery. These findings indicate that innovation and policy-driven modernization play pivotal roles in boosting agricultural productivity within the OIC region.

In contrast, several countries—including Afghanistan, Bangladesh, Cameroon, and Nigeria—experienced productivity declines (TFPCH < 1). The declines in these cases were largely associated with negative technological change (TECHCH < 1), implying a stagnation or regression in technological progress rather than efficiency deterioration. For example, Nigeria's TFPCH of 0.932 and TECHCH of 0.932 indicate that despite stable efficiency, technological stagnation constrained productivity growth. These results highlight the dependency of many OIC countries on imported technologies and external technical assistance, underlining the need to strengthen domestic innovation ecosystems to sustain productivity gains.

Across the OIC, the decomposition of productivity change suggests that technological progress has been the main driver of agricultural growth, while improvements in managerial and operational efficiency have remained modest. The average EFFCH values close to 1 indicate limited gains in resource utilization efficiency, consistent with earlier findings by Färe et al. (1994) and Kumar and Russell (2002), who noted that technological innovation often precedes efficiency improvement in developing contexts. This pattern reflects a broader challenge in the OIC, where technological adoption occurs without parallel institutional reforms to optimize production processes. Consequently, while technological upgrades have improved output, the absence of comprehensive management and policy alignment limits the sustainability of these gains.

Table 3. Agricultural Productivity in OIC Countries

Countries	EFFCH	TECHCH	PECH	SECH	TFPCH
Afghanistan	1.000	0.898	1.000	1.000	0.898
Albania	1.000	0.913	1.000	1.000	0.913
Algeria	1.000	0.987	1.000	1.000	0.987
Azerbaijan	0.984	0.992	0.994	0.990	0.976
Bangladesh	0.967	0.998	0.976	0.991	0.965
Burkina Faso	0.963	0.987	0.980	0.983	0.951
Cameroon	0.964	0.973	0.980	0.983	0.937
Cote d'Ivoire	0.978	0.956	0.994	0.984	0.935
Egypt	1.004	1.106	1.003	1.001	1.110
Guinea	0.985	1.080	0.997	0.988	1.064
Indonesia	1.005	1.114	1.001	1.004	1.120
Iran	1.000	1.100	1.000	1.000	1.100
Kuwait	1.000	1.220	1.000	1.000	1.220
Malaysia	1.012	1.206	1.003	1.010	1.221
Mauritania	1.000	1.076	1.000	1.000	1.077
Nigeria	0.999	0.932	1.000	0.999	0.932
Pakistan	1.000	0.919	1.000	1.000	0.919
Senegal	1.000	1.009	1.000	1.000	1.009
Sierra Leone	0.995	0.982	1.000	0.995	0.977
Togo	1.000	0.977	1.000	1.000	0.977
Tunisia	1.000	1.003	1.000	1.000	1.003
Uganda	1.000	1.035	1.000	1.000	1.035
Uzbekistan	1.001	1.223	1.000	1.001	1.225
Yemen	1.000	1.194	1.000	1.000	1.194

Overall, the DEA–MPI results demonstrate that agricultural development in OIC countries has advanced gradually, characterized by modest efficiency gains and substantial technological progress. The findings highlight a clear divide between high-performing and low-performing economies, suggesting that policy capacity, governance quality, and infrastructure investment are crucial determinants of agricultural performance. From a policy perspective, the evidence indicates that achieving SDG-2 in OIC countries requires a dual approach, first, by fostering technology adoption and agricultural innovation to sustain productivity growth, and second, by strengthening institutional capacity and human capital to ensure efficient use of agricultural resources. Collaborative initiatives among OIC members, such as knowledge exchange, regional agricultural R&D partnerships, and capacity-building programs, could play a vital role in accelerating this transformation. By doing so, the OIC can collectively move closer to ensuring food availability, accessibility, and stability, thereby contributing meaningfully to the global Zero Hunger age.

FINDINGS

The empirical results reveal that agricultural efficiency among OIC countries remained relatively stable during the period 2015–2021, although with notable annual fluctuations. Azerbaijan, Egypt, Uzbekistan, and Yemen consistently demonstrated full efficiency levels, indicating their ability to utilize agricultural resources optimally for achieving food security. These high-performing countries are characterized by strong agricultural governance, effective infrastructure development, and successful implementation of modernization strategies such as irrigation systems, mechanization, and policy coordination. Conversely, countries such as Uganda and Afghanistan recorded the lowest efficiency scores, reflecting structural challenges related to institutional weakness, limited investment, and low technology adoption.

Overall, the agricultural sector remains a vital pillar of economic and social stability across OIC countries. Data from SESRIC (2023) show that agriculture employs approximately 216 million people, or 32% of the total OIC workforce, contributing 10.4% to total GDP, significantly higher than the global average of 4.3%. This underscores both the economic importance and the potential of agriculture to drive inclusive growth and poverty reduction. However, despite the sector's substantial contribution, disparities in efficiency highlight uneven progress toward achieving SDG 2 (Zero Hunger), with some countries yet to fully harness their productive potential. The statistics also reveal significant heterogeneity in agricultural inputs and outputs. While the average share of agricultural land is nearly half of total land area (46.65%), government agricultural expenditure averages only 3.37% of total public spending. Such imbalances indicate that public investment remains insufficient relative to the sector's strategic importance. Furthermore, although the average proportion of the well-nourished population is relatively high (88.45%), food security (FS) averages only 60.86%, pointing to persistent access and distribution issues rather than production shortages.

From a productivity standpoint, the Malmquist Productivity Index (MPI) results show that most OIC countries experienced overall productivity growth during the study period. However, the decomposition reveals that this growth was primarily driven by technological progress rather than efficiency improvements. Countries such as Egypt, Indonesia, Malaysia, and Uzbekistan achieved the highest Total Factor Productivity Change, reflecting strong technological advancement supported by investment in agricultural innovation and infrastructure. These findings align with prior studies (Anik et al., 2020; Karthikeyan & Pandian, 2021; Abraliyev et al., 2023) emphasizing the transformative impact of modern technologies, such as digital monitoring, automation, and precision agriculture,on productivity and resource optimization. Nonetheless, several countries exhibited negative or stagnant productivity growth, particularly in 2019–2020, as indicated by declines in TECHCH and TFPCH. These years coincided with external shocks, including global trade disruptions and pandemic-related supply chain constraints. This pattern suggests that technological resilience and institutional adaptability remain critical for sustaining agricultural productivity. The findings therefore reinforce the importance of strengthening innovation ecosystems, promoting agricultural R&D, and improving institutional capacity to translate technological progress into sustainable efficiency gains.

In essence, while OIC agriculture demonstrates encouraging progress in terms of technological advancement and moderate efficiency stability, the persistence of structural disparities implies that agricultural development strategies must extend beyond production to include institutional reform, knowledge transfer, and regional integration. This multidimensional improvement is crucial not only for achieving SDG 2 but also for advancing other interlinked goals such as poverty reduction (SDG 1), decent work (SDG 8), and climate resilience (SDG 13).

The empirical findings carry significant implications for agricultural policy formulation and regional cooperation within the OIC. First, technology transfer and cross-country collaboration emerge as strategic priorities. Countries with advanced agricultural systems, such as Malaysia, Egypt, and Turkey, can play a catalytic role in disseminating modern agricultural practices and technologies to lower-performing member states. This includes knowledge exchange in areas such as irrigation management, precision farming, agro-digitalization, and value-chain integration. Facilitating intra-OIC technology partnerships can accelerate efficiency convergence across the bloc, particularly through collaborative research platforms, innovation hubs, and digital agriculture initiatives.

Second, Islamic institutions such as the Islamic Development Bank (IsDB) and the Standing Committee for Economic and Commercial Cooperation (COMCEC) have a pivotal role in strengthening agricultural capacity building. These institutions can support targeted programs that enhance technical expertise, fund agricultural innovation projects, and develop data-driven decision-support systems. For instance, IsDB could expand its Science, Technology, and Innovation (STI) programs to focus on agricultural digitalization and climate-smart technologies. Similarly, COMCEC could coordinate member states' agricultural strategies by aligning national plans with SDG 2 indicators, facilitating policy harmonization, and establishing a shared monitoring framework for efficiency and productivity performance.

Third, enhancing agricultural data systems and efficiency research is essential. Many OIC countries lack consistent and reliable agricultural data, limiting evidence-based policymaking. Developing standardized agricultural efficiency indicators, coordinated through SESRIC, would enable policymakers to benchmark progress and identify priority intervention areas. Strengthening national statistical systems and supporting open agricultural data platforms could further enhance transparency, regional comparability, and policy coordination.

Fourth, investment in human capital and youth participation remains central to long-term agricultural transformation. Encouraging youth engagement in agriculture through vocational education, entrepreneurship programs, and access to finance can foster innovation and ensure generational continuity in the sector. Educational initiatives and extension services, as emphasized by Haryanto et al. (2023) and Borda et al. (2023), can equip farmers with the technical knowledge and digital skills needed to improve efficiency and resilience.

Finally, institutional and policy coherence should be prioritized to maximize the impact of technological progress. Integrating agricultural policy with environmental management, energy efficiency, and food value chain governance, as recommended by the European Commission (2015), can foster a holistic approach to sustainability. Coordinated regional efforts to improve land governance, strengthen rural finance, and promote inclusive agricultural markets will not only enhance productivity but also contribute to food security, social welfare, and environmental preservation across the OIC.

In summary, the findings underline that achieving food security in the OIC requires moving beyond production-oriented strategies toward a multidimensional framework that combines technological innovation, institutional strengthening, and regional collaboration. By leveraging cross-country knowledge sharing, the leadership of Islamic development institutions, and robust agricultural data systems, the OIC can accelerate progress toward SDG 2 and ensure that its vast agricultural potential translates into sustainable and equitable food systems for its 1.9 billion citizens.

CONCLUSION

The findings of this study demonstrate that the agricultural sector plays a pivotal role in advancing Sustainable Development Goal 2 (Zero Hunger) across OIC member countries. Using an integrated Data Envelopment Analysis (DEA) and Malmquist Productivity Index (MPI) framework, the study reveals that agricultural efficiency between 2015 and 2021 remained relatively stable but unevenly distributed. Countries such as Azerbaijan, Egypt, Uzbekistan, and Yemen consistently achieved full efficiency, supported by effective governance and strong agricultural policies, while Uganda and Afghanistan exhibited lower efficiency due to structural constraints in infrastructure, investment, and human capital.

Moreover, the MPI results show that productivity growth was largely driven by technological progress, particularly through mechanization, irrigation improvement, and digital agriculture, rather than by efficiency gains. Countries such as Malaysia, Egypt, and Indonesia recorded notable productivity advances, though the modest change in efficiency (EFFCH ≈ 1) suggests that technological innovation has not been matched by equivalent managerial or institutional improvements. The temporary productivity decline in 2019–2020 further underscores the sector's vulnerability to global disruptions. Overall, these findings highlight that maximizing the agricultural potential of OIC countries requires integrated efforts that combine technology adoption, institutional strengthening, and regional cooperation to achieve sustainable and inclusive food security.

Based on the findings, several strategic recommendations can be proposed to strengthen agricultural efficiency and productivity across OIC countries. The first priority is enhancing cross-country technology transfer and regional cooperation to accelerate agricultural modernization. OIC member states should establish collaborative research platforms and innovation networks to facilitate the sharing of knowledge, technology, and best practices in sustainable agriculture. High-performing countries such as Malaysia, Egypt, and Turkey can play a leading role in mentoring and assisting lower-performing members through joint initiatives in areas such as precision agriculture, irrigation management, agro-digitalization, and climate-smart farming. Strengthening such intra-OIC cooperation will help narrow the efficiency gap and promote collective progress toward achieving SDG 2 (Zero Hunger).

In addition, Islamic development institutions, particularly the Islamic Development Bank (IsDB) and the Standing Committee for Economic and Commercial Cooperation (COMCEC), should play a more proactive role in agricultural capacity building and financial support. These institutions can facilitate access to financing for agricultural innovation, provide grants for technology adoption, and fund programs that enhance institutional efficiency. Expanding the use of Islamic finance instruments such as *sukuk* for agricultural infrastructure or *qard al-hasan* for smallholder farmers can improve financial inclusion and stimulate investment in the rural economy. By aligning development financing with the objectives of agricultural modernization, these institutions can act as catalysts for sustainable agricultural transformation within the OIC.

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