COMCEC

Standing Committee
for Economic and Commercial Cooperation
of the Organization of Islamic Cooperation (COMCEC)

Ensuring the Sustainability of Agricultural Inputs to Combat Food Insecurity in OIC Member Countries

COMCEC COORDINATION OFFICE

October 2023

Table of Contents

LIST OF TABLES

LIST OF FIGURES

ACRONYMS

AOI - Agriculture Orientation Index

AQUASTAT - Food and Agriculture Organization of the United Nations Global Information System on Water and Agriculture

CAP - Common Agricultural Policy

CCHF - Crimean-Congo Hemorrhagic Fever

COMCEC - Standing Committee for Economic and Commercial Cooperation of the Organization of Islamic Cooperation

ECOWAS - Economic Community of West African States

EU - European Union

FAO - Food and Agriculture Organization of the United Nations

FAOSTAT - Food and Agriculture Organization of the United Nations Statistics Division

GDP - Gross Domestic Product

GHG - Greenhouse Gases

IPCC - Intergovernmental Panel on Climate Change

LASP - Agro-Sylvo-Pastoral Orientation Law

LSD - Lumpy Skin Disease

MDG - Millennium Development Goals

NENA - Near East and North Africa

OIC - Organization of Islamic Cooperation

SDG - Sustainable Development Goals

SEEA - System of Environmental-Economic Accounting

SESRIC - Statistical, Economic, and Social Research and Training Centre for Islamic Countries

SPSS - Statistical Package for the Social Sciences

UAE - United Arab Emirates

UN - United Nations

UNWFP - United Nations World Food Programme

WTO - World Trade Organization

EXECUTIVE SUMMARY

Establishment of food security and sustainable agricultural practices is a critical issue faced by the whole world. With the global population expected to reach 9 billion by 2050, producing sufficient quantities of nutritious food in an environmentally sustainable manner is a major challenge. Establishing food security requires that all people have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs. However, factors such as climate change, water scarcity and land degradation threaten agricultural productivity and access to food, particularly in developing countries and certain regions. The adoption of sustainable agricultural practices that conserve natural resources, reduce pollution and promote biodiversity is therefore critical and must be encouraged whenever and wherever possible. While sustainable agriculture aims to meet society's current and future food needs while ensuring the long-term productivity of agricultural systems, the transition to more sustainable food production methods will require significant shifts like the sensitive use of inputs to the reduction of waste and the integration of natural processes such as nutrient cycling into agriculture. Achieving long-term food security depends on making agriculture environmentally, economically and socially sustainable and from this perspective, coordinated action across sectors and societies can establish food chains that sustain both people and the planet.

This study focuses on sustainable agricultural input use centered on OIC member countries and the sustainability indicators have been determined as Population and Labor Force, Land Use, Water Resources and Irrigation, Fertilizers and Seed, Pesticides Use, Credit to Agriculture Sector, Government Expenditures, Agriculture Infrastructure, Emissions and Agricultural Trade. However, Considering the distribution of the 57 OIC member countries, it can be observed that they are geographically composed of Asian, Arab and African countries. While the difficulty of identifying the common problems of these countries remains on the one hand, the sustainable agriculture implementation recommendations and policies that these countries can implement will also vary.

In this study, analyzes are made considering the basic problems faced by OIC member countries in terms of agricultural sustainability. Major challenges faced by OIC countries can be summarized as follows;

- Inefficient agricultural resource management.

- Lack of modern inputs.

- Inefficient land market

- Non-existent of modern finance

- Lack of sufficient infrastructure

- Lack of rural roads' network and accessibility

- Lack of the irrigation system, electricity facilities

- Climate Change

- Needs to decrease GHG emissions in agriculture

To help assess these challenges for OIC countries, the Club Convergence Method, a method that takes into account the degree of convergence of a total of 57 countries for each variable, helps identify common problems and propose common solutions to create opportunities for cooperation by dividing OIC member countries into clubs.

The data used in the analyses in the study were obtained from FAOSTAT. Relevant data comes from countries submitting it into the international Sustainable Development Goals database. The data provided by the official institutions of the country to FAOSTAT are harmonized with the agreed valid standards and classifications and are obtained by estimating the possible gaps and making possible corrections with the accepted calculation method. In the study, agricultural inputs that ensure agricultural sustainability and utilized in the study are included under some groups. Among these groupings, the data under SDG indicators; "Forest area as a proportion of total land area", "Prevalence of undernourishment", "Agriculture share of government expenditure", "Agriculture value added share of GDP", "Level of water stress", "Water use Efficiency" were preferred. In addition to these data, "land use", "fertilizers by nutrient", "livestock manure", "pesticides use and trade", "crops and livestock products", "production indices" and "value of agricultural production", "trade indices", "food price index", "employment Indicators: agriculture", "government expenditure", credit to agriculture" and "emissions from farm gate" data were used.

It can be seen that the most prominent problem of OIC member countries in terms of agricultural sustainability is related to water resources. According to the 2017 data of OIC member countries, Kuwait, UAE, Saudi Arabia, Libya and Qatar are at the extreme critical stress level, while Yemen, Uzbekistan, Turkmenistan, Algeria, Bahrain, Syria, Pakistan, Tunisia, Sudan, Egypt, Oman and Jordan are at the critical level with stress levels above 100 per cent. Although the sectors covered by the stress level include manufacturing, electricity and services, agriculture is the most demanding sector in terms of freshwater

resources. In the OIC countries included in the study, agricultural production accounts for 79 per cent of employment and 57 per cent of GDP. When analysing the share of agriculture in the freshwater use of the countries, it is more than 95 per cent in Afghanistan; 95 per cent in Mali; 90 per cent in Azerbaijan, Kyrgyzstan, Turkmenistan, Uzbekistan; 85 per cent in Niger; 80 per cent in Chad and Tajikistan in 2018. The level of freshwater stress is therefore extremely important for the agricultural sector, including livestock. In this context, the study assesses water, one of the most important agricultural inputs, first by measuring water stress and second by measuring water use efficiency.

The Club convergence analysis shows that 3 OIC member countries (Libya, Saudi Arabia, United Arab Emirates) face severe water stress, while 12 other member countries, including Algeria, Azerbaijan, Egypt, Niger, Oman, Pakistan, Qatar, Syria, Tunisia, Türkiye, Uzbekistan, Uzbekistan and Yemen face water stress problems in the 2000-2020 period.

Water use efficiency; refers to the change in water use efficiency over time at the national level as an indicator in the SGD 6 group. This indicator, which should be assessed together with the level of water stress, expresses the changes in the ratio of agricultural value added to the volume of water used. In this respect, according to the results of the Club convergence analysis, 18 OIC member countries (Albania, Algeria, Bahrain, Benin, Egypt, Jordan, Kuwait, Lebanon, Malaysia, Oman, Qatar, Saudi Arabia, Suriname, Türkiye, United Arab Emirates, Uzbekistan and Yemen) perform better in terms of water use efficiency compared to other members.

The surface area of countries and the areas of agricultural production may not be proportional to each other. In the OIC member countries, some countries have large geographical areas but have deserts and agricultural production may take place in a small part of the country's territory. For example, Libya, Egypt, Sudan, Saudi Arabia, Syria, Iraq, Turkmenistan, Uzbekistan, Kazakhstan and Pakistan are OIC member countries with deserts on their borders. Some countries, such as Kyrgyzstan, are extremely mountainous and have relatively little flat land for agricultural production. Some countries have very fertile and arable land, but suffer from frequent natural disasters and continuous crop and soil loss. Others may have overpopulated agricultural land that is dedicated to other uses, such as construction. As a result, there is often a mismatch between the size of the country and its agricultural production area. According to the results of the Club Convergence Analysis, the agricultural area of 5 OIC member countries (Guinea-Bissau, Jordan, Gambia, Lebanon) is well below the OIC average.

An examination of the change in agricultural employment over time shows that it has declined and continues to decline in almost all countries. The decline of 12 per cent for the OIC average is lower than the world average. At the country level, the most significant declines of more than 20 per cent are

observed in Kyrgyzstan, Senegal, Sierra Leone, Togo, Cameroon, Benin, Bangladesh, Comoros, Yemen, Kazakhstan and Syria. According to the results of the Club Convergence Analysis, agricultural employment of 27 OIC member countries (Burkina Faso, Chad, Mali, Mozambique, Niger, Gambia, Guinea-Bissau, Afghanistan, Albania, Azerbaijan, Bangladesh, Cameroon, Ivory Coast, Morocco, Nigeria, Pakistan, Sierra Leone, Sudan, Tajikistan, Benin, Comoros, Gabon, Indonesia, Mauritania, Somalia, Togo, Yemen) is above the OIC average.

Pesticide use in the OIC region shows an average increase of 27.56 percent since the beginning of the period. This increase is 30 percent for the world average and 4.18 percent for the EU average. The use of pesticides in the OIC member countries varies considerably. While Oman, Mozambique, Cameroon, Burkina Faso, Cameroon, Burkina Faso and Brunei experienced the largest increases in pesticide use, Comoros, Guinea, Iran, Iraq, Libya, Mali, Niger, Pakistan, Tajikistan and Yemen experienced decreases. Although the reasons for each of these changes are different, the type of crops grown, input prices and national regulatory practices all have an impact on the level of pesticide use. According to the results of the Club convergence analysis, the pesticide use of 15 OIC member countries (Burkina Faso, Cameroon, Kazakhstan, Malaysia, Togo, Türkiye, Bangladesh, Morocco, Oman, Saudi Arabia, Algeria, Egypt, Pakistan, Tunisia, Turkmenistan) is above the OIC average in the 2000-2020 period. In addition, 18 OIC member countries (Ivory Coast, Indonesia, Malaysia, Mauritania, Mozambique, Türkiye, Algeria, Azerbaijan, Benin, Cameroon, Egypt, Kazakhstan, Kyrgyzstan, Maldives, Morocco, Pakistan, Uganda) It is above the OIC average.

Although fertilizer use in the OIC group is generally increasing in line with increasing production and agricultural land, it is still well below the world average. In 2017, the world average of fertilizer use per hectare was 141.9 kg, while the OIC average was 85.9 kg. Fertilizer, which is associated with productivity growth, is the most heavily subsidised agricultural input by governments. The situation in terms of productivity should be evaluated together with agricultural mechanisation, and the advantageous situation of the OIC group compared to the world average in terms of its impact on climate change should be taken into account. Agricultural producers use two types of fertilizer: animal manure and chemical fertilizer. Manure is a by-product of animal husbandry and is a very valuable life-cycle product that provides the nutrients needed by plants (nitrogen, phosphorus, potassium, copper and zinc) in an organic way. It is well known that higher crop yields can be achieved by increasing the amount of nutrients available to the soil and plants. It is important to determine the amount of fertilizer needed according to the type of crop being grown. In other words, the amount of fertilizer to be used per product is important, not per hectare. It is also a zero-cost input on farms where livestock and crop production are combined.

However, it is argued that the phosphate and nitrate in manure applied directly to the land without treatment pollutes ground and surface water, and that ammonia and nitrogen emissions acidify soils and damage biodiversity. To address environmental and global warming concerns, manure is being processed into new energy sources or bio-based products. Even when farmers process their manure into high quality fertilizer, there are limits to how much they can use and send to areas where there is a shortage. However, farmers' use of animal manure depends on the availability and price of chemical fertilizers.

The member countries where animal fertilizer use is above the OIC average in the 2000-2020 period are Indonesia, Pakistan, Kazakhstan, Nigeria, Chad, Malaysia, Sierra Leone, Sierra Leone, Tajikistan, Türkiye, Turkmenistan, Afghanistan, Burkina Faso, Uganda. In addition, the period average for the use of nitrogen-containing chemical fertilizers among OIC member countries is 71 percent. The average rate of phosphate-containing fertilizer use is 22 percent and Potash-containing fertilizer use is 7 percent. According to the results of the Club convergence analysis, 30 OIC member countries (Azerbaijan, Benin, Indonesia, Nigeria, Pakistan, Bangladesh, Egypt, Gabon, Mali, Senegal, Tajikistan, Afghanistan, Iran, Kazakhstan, Turkmenistan, Uzbekistan, Albania, Algeria, Burkina Faso, Cameroon, Ivory Coast, Guinea, Guyana, Iraq, Jordan, Malaysia, Morocco, Mozambique, Saudi Arabia, Tunisia) use nitrogenous fertilizers above the OIC average. Countries that are above the OIC average in potassium fertilizer use are Albania, Bangladesh, Benin, Guinea, Malaysia, Burkina Faso, Ivory Coast, Egypt, Guyana, Kuwait, Morocco, Nigeria, Pakistan, Senegal, Togo, Türkiye, Uzbekistan, Algeria, Azerbaijan, Cameroon, Gabon, Iran, Iraq, Mali, Mozambique, Oman, Saudi Arabia, Uganda, United Arab Emirates. In the use of phosphate-containing fertilizers, 26 OIC member countries (Bangladesh, Benin, Gabon, Guinea, Indonesia, Pakistan, Afghanistan, Ivory Coast, Egypt, Kazakhstan, Mali, Nigeria, Albania, Algeria, Burkina Faso, Cameroon, Iran, Iraq, Malaysia, Morocco, Mozambique, Saudi Arabia, Senegal, Togo, Tunisia, Uzbekistan) follow a course above the OIC average.

Financing is a necessary tool for mechanisation and investments that increase agricultural production. However, it is important that this instrument is made available or subsidised to small-scale agricultural producers on favourable terms, so that public policy can guide it, ensure that small-scale producers retain their means of production, and avoid widening income disparities. When governments want to provide such support to agricultural producers, government-led institutions such as agricultural credit cooperatives, public banks or farmers' associations offer better conditions than markets. This can be done through different modalities such as interest rate subsidy, collateral, repayment period or diversification. When public policies abandon protectionist policies in line with the WTO Agreement on Agriculture, agricultural producers borrow on market terms, and in developing countries where financial

markets have not reached a relatively sufficient degree of financialisation, they may resort to non-market borrowing. In both cases, small producers tend to lose their means of production. This is because in the developing economic structure dominated by agricultural production, which the OIC region also predominantly has, producers generally cannot achieve sufficient income levels to expand or modernise their production units, and they borrow in order to continue production. In this context, the OIC average for credit is calculated at 5.60 per cent for 40 countries. The EU average for agricultural loans is 2.43 and the world average is 2.42.

The area equipped for irrigation refers to the agricultural area equipped with infrastructure and equipment for irrigation of crops and used for irrigation. The area equipped for irrigation includes fully controlled and partially controlled irrigation using surface irrigation, rainfall irrigation or zonal irrigation methods. Partially controlled irrigation, also known as flood irrigation, involves the diversion of excess water to crops to control run-off from wetlands and valley bottoms. In this respect, according to the results of the club convergence analysis, irrigation infrastructure investments of 18 OIC member countries (Bangladesh, Indonesia, Iran, Afghanistan, Algeria, Egypt, Iraq, Saudi Arabia, Türkiye, Uzbekistan, Kazakhstan, Morocco, Palestine, Turkmenistan, Kyrgyzstan, Niger, Tajikistan, Libya, Malaysia, Mali) were above the OIC average in the 2000-2020 period.

As with water, the geography of the OIC region is one of the most vulnerable regions to global warming and climate change. Since 1990, the level of greenhouse gases, which have been measured since 1990, has been about 18 per cent in the OIC group. However, Sub-Saharan Africa, MENA and Central Asia, especially those with arid and semi-arid climates, have suffered most from this unfavourable process. In this group of countries, disasters such as heat waves, increased droughts, depletion of renewable water resources and floods are expected. It is important to reduce the amount of greenhouse gas emissions associated with this process, which can lead to food insecurity and social unrest.

Looking at the sectoral shares of GHG emissions in OIC member countries, agriculture contributes 13.7 per cent, while land use shift and forestry account for 19 per cent. In terms of emission gases, methane (CH_4) accounts for 21.3 per cent, N2O 7.3 per cent and F-gases 2.2 per cent. The Paris Agreement, the framework agreement on this issue, has been accepted by all OIC member countries except Libya, Iran and Yemen, and 26 member countries representing 56 per cent of intra-OIC GHG emissions have committed to reduce their GHG emissions by 30 per cent by 2030. These countries are Afghanistan, Bangladesh, Benin, Burkina Faso, Cameroon, Chad, Comoros, Ivory Coast, Djibouti, Indonesia, Iraq, Jordan, Kyrgyzstan, Lebanon, Mauritania, Morocco, Niger, Nigeria, Oman, Pakistan, Senegal, Togo, Tunisia, Türkiye and Uganda.

Across the OIC geography, there are member countries with high levels of mechanisation and very low levels of agricultural employment, producing high value added. However, the OIC average consists mainly of economies that seek to develop and grow by generating surpluses through agricultural production. While the share of agricultural employment is relatively high, the value of agricultural output as a share of GDP has been declining. This downward trend can be attributed to structural changes, instability in agricultural markets, increased environmental pressures and degradation of water and land resources. It should not be overlooked that, without a reduction in production volumes, this trend could lead to the impoverishment of exporting countries in international trade and of agricultural producers in the sector, which is expressed in the SESRIC (2020) report as a reduction in the ratio of agricultural value added to GDP. The same report lists the sectors to which the decline in agriculture will be channelled. The decline in agriculture is mainly substituted by the service sector, not by industry. This can be interpreted as the migration of the 'uneducated/low-skilled' labor force, who cannot make a living from agricultural production or who somehow leave agricultural production, to areas where the service sector is concentrated. In terms of contribution to the economy, this phenomenon may require an in-depth analysis of the sectoral structure in terms of the growth of the service sector, dominated by tourism and construction, and the increase in national income of countries. On the other hand, the addition of the potentially rising wage costs of the declining labor force to food security and food input prices and the declining volume of food production may be a sign that food price increases will deepen further. Within the OIC, the value of agricultural production has declined from 11.3 percent of GDP in the analysis period to 9.8 percent in 2018. According to the findings of the Club convergence analysis, 23 OIC member countries (Algeria, Bahrain, Brunei-Darrussalam, Egypt, Guyana, Iran, Jordan, Kazakhstan, Kuwait, Malaysia, Maldives, Nigeria, Oman, Palestine, Qatar, Saudi Arabia, Suriname, Syria, Tunisia, Türkiye, Turkmenistan, United Arab Emirates, Uzbekistan) have higher agricultural output per worker than the OIC average.

Agricultural production within the OIC is categorized as cereals, fruits and vegetables. According to 2021 data, OIC geography meets 13.19 percent of world production and 73.71 percent of EU production in cereal production. Among OIC countries, Indonesia (18.37), Bangladesh (15.34), Pakistan (12.94), Türkiye (7.86), Nigeria (7.38), Egypt (5.50) are the major cereal producing countries with their shares. Bahrain has no cereal production. Looking at the 20-year average increase in cereal production; the world average increase in cereal production is 49.10 percent, the EU average is 43.03 percent and the OIC average is 46.84 percent.

Based on a similar comparison in fruit production, OIC production reach 20.73 percent of world production and 230.31 percent of EU production for 2021. The average production increase is 59.02 percent in the world and 76.15 percent in the OIC, while the EU decreases by 2.21 percent. Türkiye (13.28), Indonesia (12.52), Iran (8.83), Egypt (7.49), Nigeria (6.29), Pakistan (5.90), Uganda (4.91) are the main fruit producing countries.

In vegetable production; OIC members cover 14.41 percent of the world production and 186.38 percent of the EU average. The average production increase is 68.10 percent in the world, 6.07 percent in the EU and 83.80 percent in the OIC. Türkiye (16.02 percent), Nigeria (9.49), Egypt (9.36), Indonesia (7.82), Uzbekistan (6.22), Iran (5.61) are the largest vegetable producing countries in OIC.

The high level of average agricultural production of the OIC group is even more evident on a product basis. For example, 87 per cent of the world's palm oil, 64 per cent of cocoa, 44 per cent of millet, 37 per cent of cassava and sorghum are produced in OIC countries.

In the light of this information, OIC countries have a relatively small average land area and an agricultural structure dominated by small-scale, labor-intensive production. The advantage of this structure is that relatively abundant and cheap labor is directed towards high value-added fruit and vegetable production, such as greenhouses, vineyards and horticulture. On the other hand, intensive agriculture, where production is carried out on large plots of land with mechanisation and intensive use of chemical inputs, is concentrated in relatively industrialised economies in the developed category.

OIC member countries have started to meet the demand for livestock production by moving towards large-scale industrial production in line with changing food consumption patterns. In this direction, their livestock production has increased by 13 per cent since 2000, accounting for 8 per cent of world production. Over the period, meat production increased by an average of 85 per cent, milk production by 69 per cent and egg production by 98 per cent. Among the OIC countries, Pakistan, Turkey, Iran, Kazakhstan, Egypt and Morocco are the largest meat producers.

Fisheries production is also growing at an average annual rate of 2.2 per cent, accounting for 19.4 per cent of world production in inland fisheries and 19.6 per cent in marine fisheries. Due to the increasing global demand for seafood, FAO is shifting the agricultural production structure of arid coastal countries towards freshwater and seafood products.

Trade volumes between OIC member countries are presented. Although import and export values differ, a holistic analysis shows that Afghanistan, Benin, Comoros, Gambia, Jordan, Lebanon, Mali, Niger, Oman, Somalia, Sudan, Suriname, Syria, Tajikistan, Togo and Yemen have intra-OIC trade shares above 40

per cent. Guyana, which has the lowest share of intra-OIC trade, is located in a geographically disadvantaged region. Albania, Bangladesh, Comoros, Gabon, Guinea and Libya have the lowest export shares, while Nigeria, Kazakhstan and Suriname have the lowest import shares.

The UN has set the international poverty line at US$1.90 per day, based on 2011 purchasing power parity. This puts the poverty rate in the OIC geography at around 13 per cent. In Uganda, Yemen, Iraq, Guinea-Bissau and Nigeria, the poverty rate remains above the OIC average and has been increasing over time.

In terms of the food price index, the world average is 3.90, the EU average is 2.40 and the OIC average is 8.36. This increase has become more pronounced after the Covid-19 pandemic. The change in these values over the last 3 years is shown in Table 18. In 2019, the OIC average for the food price index is 6.07%, while in 2020 and 2021, the OIC average is 21.68% and 22.29% respectively. For the same periods, the EU average is 1.03 and 4.46 per cent, while the world average is 5.75 and 11.02 per cent, respectively. Moreover, these increases are not distributed proportionally across OIC member countries. For example, Qatar, Palestine, Comoros, Jordan, Morocco and Oman experienced decreases in the food price index, while Lebanon, Sudan, Syria and Türkiye experienced increases above the OIC average.

In general, although countries are grouped into clubs, undernourishment has increased, especially after the food price rises of 2008. However, this is not consistent with the food price index. That is, Chad, Jordan, Mozambique, Somalia and Yemen, which have the highest levels of undernourishment in the OIC, are not in the group with the highest food price increases. On the contrary, these countries are in the last two clubs with the lowest food price increases. Therefore, the implementation of policies to address the problem of undernourishment should take into account not only price increases, but also access to adequate quantities of nutritious and healthy food and its equitable distribution.

In addition to the Club convergence analysis, a survey of sector workers suggests that sustainable agriculture is gaining traction. There is a strong interest in sustainable farming practices, including soil and water conservation, responsible use of chemicals and the importance of mimicking natural ecosystems. It also reflects different perspectives on certain practices, indicating the complexity of sustainable agriculture, as pesticide control and optimising income levels at varying costs can be seen as issues that require much and precise attention.

Introduction

Sustainability is understood as economic, social, ecological or environmental sustainability and agricultural sustainability discussions are often viewed as a combination of these three pillars[1].Recent efforts to increase agricultural production despite the decline in arable land due to rapid population growth and urbanization, especially in developing countries, have led to a conflict between environmental sustainability and food security[2]. Although the green revolution has reduced farmers' concern about economic sustainability, the increase in the prices of seeds, fertilizers, labor, machinery, and decreases in productivity have led to extraordinary increases in production costs, raising concerns about economic sustainability again[3].Therefore, the agricultural sustainability approach needs to take into account the optimization of economic, environmental and social sustainability concepts and create an agricultural production system on this basis. Therefore, an agricultural sustainability approach needs to take the optimization of economic, environmental and social sustainability into account and establish an agricultural production system on this basis.

For example, the Green Revolution in Asia has led to an increase in agricultural production while significantly increasing the utilization of inputs[4]. The revolution led to an increase in agricultural production and significantly increased the utilization of inputs. Improvements in agricultural technology have led to a weighted average increase in agricultural yields in Asia by 3.7% per year over the 1965-1982 period[5].Per capita calories in Pakistan increased from 1748 in the 1960s to 2462 in the 2000s[6]. However, when the agricultural production growth in Pakistan is evaluated in terms of economic, social and environmental sustainability, it was observed that there is not a balanced distribution across all regions

[1] Smith A, Snapp S, Chikowo R, Thorne P, Bekunda M, Glover J (2017) Measuring sustainable intensification in smallholder agroecosystems: a review. Global Food Security 12:127–138.

[2]Miraglia M, Marvin HJP, Kleter GA, Battilani P, Brera C, Coni E, Cubadda F, Croci L, De Santis B, Dekkers S, Filippi L, Hutjes RA, Noordam M, Pisante M, Piva G, Prandini A, Toti L, Van Den Born G, Vespermann A (2009) Climate change and food safety: an emerging issue. Food Chem Toxicology 47:1009–1021

[3] Qi X, Fu Y, Wang RY, Ng CN, Dang H, He Y (2018) Improving the sustainability of agricultural land use: an integrated framework for the conflict between food security and environmental deterioration. Appl Geography 90:214–223

[4] Hazell PBR (2009) The Asian green revolution. A paper prepared for the project on millions fed: proven successes in agricultural development. IFPRI discussion paper 00911.

[5] Rosegrant MW, Hazell PBR (2000) Transforming the rural Asian economy: the unfinished revolution. Accessed on 24 Dec 2018. Available online at https://www.adb.org/publications/ transforming-rural-asian-economy-unfinished-revolution.

[6] Evenson RE (2005) The green revolution and the gene revolution in Pakistan: policy implications. The Pakistan Development Review 44:359–386

of Pakistan and even in some regions, over-exploitation of groundwater has eliminated agricultural sustainability[7].

Land ownership also has a significant impact on agricultural sustainability. For example, the promotion of the use of animal manure on farms with 70 hectares of land for environmental sustainability in Poland required these farms to maintain large livestock numbers, while the increased mechanization of farms with more than 30 hectares led to a reduction in the labor force working on the land, thus affecting social sustainability. As a result, while high levels of input use increase agricultural production over time, the costs of increased input use also threaten economic sustainability. In this respect, discussions on agricultural sustainability should take into account agricultural input use in addition to production growth and propose policies accordingly.

Environmental degradation caused by the increase in food demand and agricultural production caused by the global population growth is another source of concern in terms of environmental sustainability[8]. Since healthy and continuous food supply to ensure food security will also depend on the resilience of the agro-ecosystem, it is considered as a threat to environmental sustainability. Problems such as eutrophication caused by increased fertilizer use due to agricultural intensification[9], increase in the acid amount[10] and water scarcity[11] lead to an increase in environmental problems. Hence, sustainable agriculture should consider increasing production while protecting the environment and soil quality in order to meet the global food demand.

On the one hand, there are the problems of agricultural intensification and increased production; on the other, 83 million people in 45 countries face hunger. While the percentage of undernourished population is below 5% in developed countries, it is 13% and 20% in Asia and Africa respectively[12].

[7] Zulfiqar F, Thapa GB (2017) Agricultural sustainability assessment at provincial level in Pakistan. Land Use Policy 68:492–502

[8] Skaf L, Buonocore E, Dumontet S, Capone R, Franzese PP (2019) Food security and sustainable agriculture in Lebanon: an environmental accounting framework. Journal of Cleaner Production 209:1025–1032

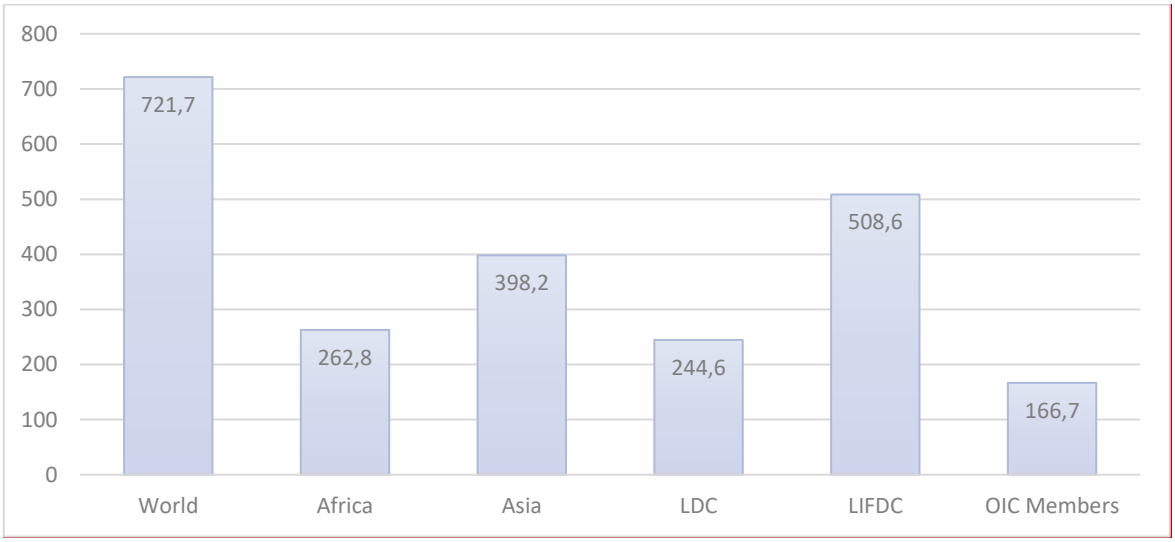
[9] Scherer L, Pfister S (2015) Modelling spatially explicit impacts from phosphorus emissions in agriculture. The International Journal of Life Cycle Assessment 20:785–795

[10] Tian D, Niu S (2015) A global analysis of soil acidification caused by nitrogen addition. Environmental Research Letters 10:24019

[11] Scherer L, Pfister S (2016) Dealing with uncertainty in water scarcity footprints. Environmental Research Letters 11:5: 054008.

[12] Prosekov AY, Ivanova SA (2018) Food security: the challenge of the present. Geoforum 91:73–77

Figure 1. Total number (million) of undernourished people



Source: FAO

As shown in Figure 1, the total world population facing food insufficiency is about 722 million people, approximately 509 million of whom live in low-income food deficit countries (LIFDC). Furthermore, about 23% of the total undernourished world population is in the OIC member countries.

Agricultural intensification seems inevitable due to the limited amount of arable land that can be used in the future to produce the required amount of food. In this context, it is argued that sustainable agricultural intensification is an important concept in terms of agricultural sustainability[13]. Sustainable agricultural intensification is possible through the realization of new agricultural practices. Although it is important to convince producers, consumers' preference for production with new techniques (such as soilless agriculture, vertical farms, biodiversity, afforestation, etc.) is also seen as an important threshold for the implementation of sustainable agricultural intensification[14].

In addition, the issue of climate change or global warming is recognized as an important agenda for sustainable agricultural production and input use. Global greenhouse gas emissions from agricultural production systems account for 19-29% of total emissions and contribute to global warming. While most of this emission is in the form of CH_4 and N_2O from agricultural activities, a portion of it is the result of

[13] Pretty J (1997) The sustainable intensification of agriculture. Natural Resource Forum 21:247–256

[14] Scherer LA, Verburg PH, Schulp CJE (2018) Opportunities for sustainable intensification in European agriculture. Global Environmenal Change 48:43–55

agriculturally induced changes in land cover.[15] Accordingly, it is believed that measures such as novel policies, crop products, crop rotation techniques, integration of crop and livestock production will contribute to reducing global greenhouse gas emissions.

The recent outbreak of Covid-19 and the effects of global and national pandemic response policies on agricultural production and food demand make it imperative to be prepared for such outbreaks that may occur in the future and to develop novel policies. It was observed that the logistics and trade disruptions that emerged with the pandemic created both supply and demand-side effects in terms of food and agricultural products. While the supply-side effects of the pandemic have caused difficulties in the supply of intermediate inputs, fixed capital and labor, fluctuations in food demand, disruptions in access to food and high prices in contrast to the decline in workers' incomes have increased the dependence of many countries on food imports[16].Demand-side vulnerabilities arising from the pandemic have increased in OIC countries, especially in low-income countries. 70% of OIC countries are at medium-high and high risk to demand-side impacts, forcing the poor to live in countries with food insecurity[17].

This study assesses how to ensure food security through the use of sustainable agricultural inputs within the framework of the OIC countries. In the first part, the indicators defined as sustainable agricultural input indicators and the conceptual framework related to them are discussed along with the advantages of the Club Convergence methodology applied in the analyses, highlighting the circumstances arising from the advantages/disadvantages caused by the economic, social and geographical differences among the OIC countries. The second part comparatively presents the sustainable agricultural inputs and food security issues for OIC member countries based on the results of the Club Convergence analysis. The third part evaluates the use of agricultural inputs, food security policies, implementation results and achievements along with observations made during field visits of selected countries; Netherlands, Türkiye, Kyrgyzstan and Egypt in detail. It also presents the results of the survey conducted in OIC member countries and the insights gained. Finally, recommendations, policy suggestions and a guide that can serve as a roadmap for sustainable agricultural practices that can ensure food security through sustainable use of agricultural inputs for OIC member countries are offered within the framework of descriptive analyses and findings.

[15] Vermeulen SJ, Campbell BM, Ingram JSI (2012) Climate change and food systems. Annual Review of Environmental Resource 37:195

[16] Schmidhuber J, Pound J, Qiao B (2020) COVID-19: Channels of transmission to food and agriculture Rome FAO. https://doi.org/10.4060/ca8430en

[17] SESRIC (2020) Agriculture and Food Security in OIC Member Counries, https://sesricdiag.blob.core.windows.net/sesric-site-blob/files/article/748.pdf, Date of access: 16.04.2023

Conceptual Framework

The Principles of Sustainable Agriculture

The basic principles for sustainable agriculture can be summarized as follows;

- Integrating biological and ecological processes into food production processes

- Reducing the use of non-renewable inputs

- Reducing external costs by increasing the know-how of human capital

- Efficient use of collective capacities to solve common problems in agriculture and natural resources[18]

Agricultural Sustainability Indicators

Sustainable agriculture is addressed in three dimensions: economic, environmental and social. Sustainable agriculture focuses on protecting biodiversity, developing and utilizing local resource ecosystems, and reducing negative externalities on the environment and health. While environmental sustainability in agricultural activities takes topography and soil quality into account[19], economic sustainability considers agricultural productivity and income issues, as well as farmers' participation, satisfaction and know-how are defined as agricultural sustainability[20].

[18] Pretty NJ (2008) Agricultural sustainability: Concepts, principles and evidence, Philosophical Transactions of The Royal Society B Biological Sciences 363(1491):447-6

[19] Abhishek, R.; Jhariya, M.K.; Khan, N.; Banerjee, A.; Meena, R.S. (2021) Ecological Intensification for Sustainable Development. In Ecological Intensification of Natural Resources for Sustainable Agriculture; Springer: Berlin/Heidelberg, Germany, pp. 137–170.

[20] Khanh, C.N.T. (2022) Driving Factors for Green Innovation in Agricultural Production: An Empirical Study in an Emerging Economy. Journal of Cleaner Production, 368, 132965

Based on the studies in the literature, the indicators for sustainable agriculture can be summarized as follows;

Table 1. Sustainability Indicators

Dimension	**Indicators**
Social	Acceptable agricultural practices
	Compatibility
	Contribution to employment
	Demographic structure
	Ecosystem services
	Education
	Employment
	Equality
	Farmers' rights
	Farmers' well-being
	Food
	Food safety
	Health and nutrition
	Health and Safety
	Isolation
	Knowledge
	Life quality—consumers
	Life quality—workers
	Multifunctionality
	Quality of life
	Quality of product
	Quality of rural areas
	Quality of process
	Relative wages

	Resilience
	Share of the family labor force
	Social implication
	Technology
	Women empowerment
	Working condition
Economic	Accessibility
	Agricultural activities
	Agricultural labor productivity
	Agricultural support
	Animal feeding
	Capital productivity
	Cost
	Credit availability
	Diversification of activities
	Diversification of income
	Efficiency
	External financing
	External income
	External inputs
	Farm's profitability
	Farmer's risks
	Food loss
	Income
	Investment intensity
	Labor productivity
	Land productivity
	Liquidity
	Market access
	Marketability

	Mineral fertilizers
	Non-agriculture activities
	Price
	Production
	Profitability
	Subsidies
	Working capital level
Environment	Agriculture practices
	Biodiversity
	Biological soil quality
	Chemical soil quality
	Climate change
	Compaction measurements
	Complex model
	Crop protection intensity
	Crop rotation
	Culture reside management
	Domestic biodiversity
	Ecosystem
	Emission of acidifying gasses
	Emission of greenhouse gasses
	Energy intensity
	Environment measure
	Farm structure
	Fertilizer use intensity
	Greenhouse gas emission intensity
	Importance of grasslands
	Land use and loss of biodiversity
	Livestock density
	Machine use

	Nitrogen farm-gate balance
	Non-renewable
	Operational model
	Organic carbon indicator
	Organic fertilization
	Permanent grasslands
	Physical soil quality
	Pollution
	Renewable resources
	Resources
	Soil analysis
	Soil cover
	Soil health
	Soil type
	Soil fertility
	Specific positive
	Water availability

Sustainable agriculture indicators, as shown in Table 1, are widely used in the literature. Sustainable agriculture is essentially about meeting human needs now and in the long term, while improving the living standards of farmers and society as a whole. It is important to consider threats such as climate change, high rates of biodiversity loss, soil erosion and degradation, salinisation, loss of agricultural land, contamination of water resources, increasing production costs, reduction in the number of farmers and associated poverty and decline in the rural population, which have the potential to hinder the achievement of this goal now and in the future.[21].

[21]Bathaei, A.; Štreimikiene, D. (2023) A Systematic Review of Agricultural Sustainability Indicators Agriculture 13, 241. https://doi.org/ 10.3390/agriculture13020241

Since this study focuses on the sustainable use of agricultural inputs, with a focus on OIC member countries and the problems they face, the following sustainability indicators were identified;

- Population and Labor force
- Land Use
- Water resources and Irrigation
- Fertilizers and Seed
- Pesticides Use
- Credit to Agriculture Sector
- Government Expenditures
- Agriculture Infrastructure
- Emissions
- Agricultural Trade

Methodology

Looking at the distribution of the 57 OIC member countries, it can be observed that they are geographically composed of Asian, Arab and African countries. While it is possible to identify the common problems of these countries, the recommendations for the implementation of sustainable agriculture and the policies that these countries can implement will vary.

Major challenges faced by OIC countries can be summarized as follows;

- Inefficient agricultural resource management.
- Lack of modern inputs.
- Inefficient land market.

- Non-existent of modern finance
- Lack of sufficient infrastructure
- Lack of rural roads' network and accessibility
- Lack of the irrigation system, electricity facilities
- Climate Change
- Needs to decrease GHG emissions in agriculture

To help assess these setbacks for the OIC countries, the Club Convergence Analysis, a method that takes the degree of convergence of a total of 57 countries for each variable into account, contributes to identifying common problems and proposing common solutions to create opportunities for cooperation by categorizing OIC member countries into sub-clubs.

Club convergence analysis[22] groups the countries in the data matrix according to their similarities and examines whether there is convergence within each group with the "Log t" test[23].

$$y_{it} = \delta_{it}\mu_t$$

The panel datay_{it}shown in equation shows the variables used in the agricultural sustainability analysis of OIC member countries. N is the number of countries and T is the time dimension (t=1,...T). $y_{it}$is divided into two components. Both $\delta_{it}$and $\mu_t$are time-varying components. $\delta_{it}$is the idiosyncratic component and $\mu_t$is the common component.

According to the convergence hypothesis, $\delta_{it}$is assumed to converge to a given value $\delta_i$for each country and the distance between the two decreases at the rate $1/(t^{\alpha}\log(t+1))$ ($\alpha \geq 0$and $\delta_i = \delta$ is assumed for each country). This process is used to determine whether the factor loadings converge to δ_{it}.

$$h_{it} = logy_{it}/\overline{log_t}$$

[22]Phillips, P. C. B. and Sul, D. (2007) Transition Modeling and Econometric Convergence Tests Econometrica, 75(6): 1771-1855

[23]Apergis, N., and Payne, J. E. (2017) Per Capita Carbon Dioxide Emissions Across U.S. States by Sector and Fossil Fuel Source: Evidence From Club Convergence Tests Energy Economics, 63: 365-372

The average of the logarithmic values of the horizontal cross-sections is used to calculate the h_{it}transition path[24].

The horizontal cross-sectional variance $H_1/H_t$is calculated using $H_t = \frac{1}{N}\sum_{i=1}^{N}(h_{it} - 1)^2$. This equation shows the calculation of the variance of each horizontal cross-section and the distance of the panel to the common value. To test whether each cross-section in the panel converges to the common value, the following hypotheses are used;

$$H_t: \delta_i = \delta_t and \alpha \geq 0$$

$$H_t: \delta_i \neq \delta_t and \alpha < 0$$

Lastly, the "Log t" regression is tested by taking these hypotheses into account.

$$\log\left(\frac{H_1}{H_t}\right) - 2logL(t) = c + blogt + u_t$$

In order to estimate this equation, t=[rt],[rt]+1,...,T and r[0.2,0.3] must be observed. The "t" test is used to detect convergence and the null hypothesis of conditional convergence is rejected if the t test value is less than -1.65 with a 5% margin of error. This test can be used for subgroups to analyze whether there is convergence or not.

In this study, Club Convergence analysis is conducted for selected variables of 57 OIC member countries based on panel data covering the period 2000-2020 from FAO database.

[24]Ulucak, R. and Apergis, N. (2018) Does Convergence Really Matter for The Environment? An Application Based on Club Convergence and on The Ecological Footprint Concept for The EU Countries Environmental Science and Policy, 80: 21-27.

Descriptive Analysis of OIC Member Countries in Terms of Sustainability of Agricultural Input Uses and Food Security

COMCEC is a committee of 57 OIC member countries working together to develop economic and trade relations. With the impact of food price increases in 2012; COMCEC defined the area of cooperation as agriculture in the strategy document of the 4th Extraordinary Session and started to implement efforts to increase the productivity of the agricultural sector and ensure sustainable food security in the COMCEC region by establishing an Agriculture Working Group. To achieve this goal, the intermediate objectives were identified as increasing productivity, providing/improving the regulatory framework and institutional capacity, obtaining reliable and up-to-date data and improving access to market performance/outputs.

The working group conducted studies on irrigation systems, in-field and post-harvest food losses, food waste, agricultural market institutions and market information systems, resilience and food security, and good governance for food security and nutrition to share knowledge and experiences in the OIC region.

After the 2012 meeting, in a rapidly changing environment, input price increases and climate change, mainly due to energy price increases and supply chain disruptions caused by the pandemic, have significantly increased the cost of food production. Particularly in economies dependent on imported inputs, food production and sustainability based on exports are disrupted and domestic consumption cannot be met. In this regard, The COMCEC Agriculture Working Group held its 2023 meeting on "Combating Food Insecurity". The meeting sought to address the sustainability of agricultural production and combatting food insecurity through promoting the sustainability of agricultural inputs in OIC member countries.

In line with the COMCEC meeting and the information gathered, the sustainability of the growing human population and its nutritional needs appears to be possible through sustainable agriculture with sustainable inputs. Sustainable agriculture involves production

conditions that mitigate the climate crisis by conserving soil, air, water, biodiversity and underground resources, while enhancing plant and animal welfare. It also implies that the inputs used in production are sustainable in normal processes and that sustainable agricultural production based on sustainable inputs actually reflects the level of self-sufficiency of countries.

As we have seen throughout history and in recent times, crises that arise as a manifestation of global changes begin and end in agriculture. Countries that have not completed their industrialisation are the ones most affected by these adverse developments and are exposed to long-term unstable growth and underdevelopment, income inequality and insufficiency, unemployment, poverty, hunger and the social unrest that accompanies them. These problems manifest themselves most clearly in food and health problems, environmental pollution and alienation from nature. States, international organisations, multinational corporations, transnational organisations such as the OIC and regional supranational organisations such as the European Union are trying to find alternative ways of reconciliation.

The concept of sustainability encompasses these alternative trade-offs in a holistic way. Socio-economic, environmental/health and nutritional concerns are directly related to the sustainability of agricultural activities. Sustainability in agriculture refers to the achievement of sufficient income to continue agricultural production and to the form and relationships during production in accordance with the state of nature. Therefore, sustainable agriculture rests on economic, environmental and social pillars[25].

Key points emerge in this perspective. On the one hand, standards are set from the seed to the final product stage in the form of organic agriculture and good agricultural practices , while on the other hand it is important to ensure that agricultural inputs are continuously provided and that the final outputs are offered to the society and that nutrition is provided in sufficient quantity and time in terms of being able to obtain and purchase. Raw

[25]Bathaei and Streimikiene, (2023), p. 2.

materials, basic inputs and rural (agricultural) labor, fair trade conditions, the level of profitability that allows farming to continue, and the availability of clean and usable nature are therefore the sub-items to be assessed within the framework of sustainable inputs.

The study assesses the inputs used in agricultural production and their sustainability, followed by topics on organic farming, good agricultural practices and alternative agricultural production techniques such as soilless and vertical farming, which require high levels of agricultural mechanization.

Agricultural Input Variables

The data used in the analyses in the study come from FAOSTAT. The relevant information is reported by countries to the international SDG (Sustainable Development Goals) database. The data entered into the FAOSTAT database by the relevant official agencies are then harmonised using common standards and classifications, and finally derived by estimating possible discrepancies using scientifically accepted calculation methods and making the necessary adjustments[26].

The inputs used in the study to ensure agricultural sustainability are categorised under different groups.

From these groupings, the data used under the SDG indicators were;

- Forest area as a proportion of total land area,
- Prevalence of undernourishment,
- Agriculture share of government expenditure,
- Agriculture value added share of GDP,
- Level of water stress,
- Water use Efficiency.

[26] FAOSTAT, (2023), "SDG Indicators: Metadata", (https://www.fao.org/faostat/en/#data/SDGB), (Date of access: 01.07.2023).

Other data which were utilized are as follows;

- “crops and livestock products”, “production indices” and “value of agricultural production” under the Production category,
- "land use", "fertilizers by nutrients", "animal manure", "pesticide use and trade" under the Land, Inputs and Sustainability category,
- “trade indices” under the Trade category,
- “food price index” under the Price category,
- “land use”, “fertilizers by nutrient”, “livestock manure”, “pesticides use and trade” under Lands, Inputs and Sustainability category,
- “employment Indicators: agriculture”, under the Employment category,
- “government expenditure”, credit to agriculture” and “foreign direct investment”, under the Investment category,
- “emissions from manure left on pasture and applied to soil”,“emissions from synthetic fertilizers”, “emissions from energy use in agriculture” and “emissions from farm gate” under Climate Change: Agrifood System Emmissions category
- “emissions from farm gate” under Climate Change: Agrifood System Emmissions category[27].

Water Resources

Although "water", one of the most important inputs for agricultural production, has been monitored by AQUASTAT since 1994, it was first included in the Millennium Development Goals (MDGs) in group 7.A and then in the United Nations (UN) Sustainable Development Goals (SDGs) no. 6 by 2030. SDG no. 6.4, which deals with accessible water,

[27] FAOSTAT, (2023), “Data”, (https://www.fao.org/faostat/en/#data/QCL), (Date of access: 06.08.2023).

sanitation and sustainable water management, prioritizes increasing water use efficiency and sustainable freshwater extraction and supply to address and reduce water scarcity. Other sub-goals 6.5 and 6.6 relate to cooperation between countries and regions, water management models, innovation and local participation[28]. The OIC-2025 Action Programme also focuses on clean and usable freshwater resources, which is one of the three main priority domains[29] identified alongside SDG 6 on improving and developing infrastructure for the efficient use of existing water resources and cooperation for the use of innovative technologies[30].

Level of Water Stress

Among the indicators identified in this set of goals, the level of water stress is defined in the MDGs as the ratio of total water resources used, while in the SDGs it is defined as the ratio of freshwater withdrawn from sources to available freshwater resources (freshwater withdrawn/available freshwater)[31]. The data collected through AQUASTAT are based on technical and economic data as well as surveys and questionnaires collected from the relevant government agencies of countries[32].

In this framework, FAO measured the water stress level on a world scale and ranked countries in 5 groups between (0-100). Countries with a water stress level of (0-24.99) per cent are in the non-stress group, (25-49.99) per cent in the low stress group, (50-74.99) per cent in the medium stress level, (75-99.99) per cent in the high stress level and countries

[28] SKA, (2021), "Sürdürülebilir Kalkınma Amaçları ve Göstergeler", Türkiye Cumhuriyeti Cumhurbaşkanlığı, Strateji ve Bütçe Başkanlığı, p.13.
[29] The priority areas identified in the OIC 2025 Programme of Action are Environment, Climate Change and Sustainability; Agriculture and Food Security; Health; and Cooperation in the field of water resources management to minimise the destructive impact.
[30] SESRIC (2021), "OIC Environment Report", Statistical Economic and Social Research and Training Centre for Islamic Countries, s. 43.
[31]FAOSTAT, (2023),Ibid., p.14.
[32] UNSTAT, (2023), "SDG Indicators", (https://unstats.un.org/sdgs/metadata/files/Metadata-06-04-01.pdf).

above 100 per cent in the critical stress level[33]. According to OIC data (2017), Kuwait, UAE, Saudi Arabia, Libya and Qatar are at extremely critical stress level, while Yemen, Uzbekistan, Turkmenistan, Algeria, Bahrain, Syria, Pakistan, Tunisia, Sudan, Egypt, Oman, Jordan are at critical level with stress levels above 100 per cent[34].

High levels of water stress can be seen as having a negative impact on sustainability, while extremely low levels may indicate that water is not being used appropriately in relation to the needs of the population[35] and should be considered in conjunction with the proxy indicator of water use efficiency. Fresh water is not evenly distributed around the world, but is found in basins. These basins are critical for agricultural production and are considered to be the habitat of a significant proportion of the world's population. It is therefore vital that freshwater resources, especially rivers and groundwater, are used efficiently and are renewable to prevent famine and maintain a healthy ecosystem[36].

Although the sectors covered by the stress level include manufacturing, electricity and services, agriculture is the most demanding sector in terms of freshwater resources. In the OIC countries included in the study, agricultural production accounts for 79 per cent of employment and 57 per cent of GDP. When analysing the share of agriculture in the freshwater use of the countries, it is more than 95 per cent in Afghanistan, 95 per cent in Mali, 90 per cent in Azerbaijan, Kyrgyzstan, Turkmenistan, Uzbekistan, 85 per cent in Niger, 80 per cent in Chad and Tajikistan in 2018. The level of freshwater stress is therefore extremely important for the agricultural sector, including livestock production. In this context, the study assesses water, one of the most important agricultural inputs, first by measuring water stress and then by measuring water use efficiency.

[33] FAO, (2021), "Progress on Level of Water Stress", Food and Agriculture Organization of the United Nations, Global Status and Acceleration Needs for SDG Indicator 6.4.2, p.20.
[34] SESRIC, (2021), "OIC Environment Report", Statistical Economic and Social Research and Training Centre for Islamic Countries, s. 45.
[35] FAO, (2021), "Progress on Level of Water Stress", Food and Agriculture Organization of the United Nations, Global Status and Acceleration Needs for SDG Indicator 6.4.2, p.27.
[36]FAO (2021),ibid., 23.

Water resources, which are closely linked to climate change and global warming, are particularly important for OIC member countries. Except for a few basins, the OIC landscape is not generous in terms of water abundance. Taking into account the effects of global warming, it is estimated that water stress in the OIC region will increase 1.4 times by 2040[37]. In the report published by SESRIC in this framework, attention is drawn to the connection between the level of water stress and natural wetlands. Between 2005-2018, wetlands in the OIC geography decreased by 0.01 per cent. While this decrease is 0.07 per cent at a more adverse level for OIC member countries, the country-based picture varies. In the same years, Algeria, Sudan, Sudan and Pakistan achieved an increase of 72 per cent, 55 per cent and 42 per cent in clean water resources, while Uzbekistan, Afghanistan and Somalia experienced a decrease of 47 per cent, 34 per cent and 25 per cent, respectively[38]. In a sense, the protection, storage and enhancement of water resources and watersheds are very important in terms of water stress and agricultural sustainability in the OIC region and are closely related to forest areas. In order to cope with possible external shocks and to achieve the goals of agricultural sustainability, a water management model that integrates all sectors is considered important. In this context, instead of the traditional country-based water management policies aimed at increasing physical output, the basin-based "Integrated Water Resources Management Model", which aims at enriching the basins in the OIC region and which many member countries are implementing, can increase efficiency. It would be beneficial to share the experience of Kuwait, Qatar and the United Arab Emirates, which have made significant progress in the basin model, and other countries with successful implementations with others. Looking at OIC member countries, Niger, Cameroon, Benin, Mali, Tunisia and Uganda cover more than 70 per cent of shared waterways, while Bahrain, Comoros, Kuwait, Maldives, Oman, Qatar, Saudi Arabia, UAE and Yemen have none. Therefore, it is necessary to increase

[37] SESRIC, (2021), “OIC Environment Report”, Statistical Economic and Social Research and Training Centre for Islamic Countries, p.44.
[38]SESRIC(2021),ibid., 46.

the basin areas covered by the agreement, which covers 44.1 per cent of the OIC member countries, at least for sustainable water use[39].

In addition to this model, it is important to make investments to increase the proportion of land under sprinkler irrigation and localized irrigation, or to maintain incentives in this direction. Besides the allocation of water, which is the most important agricultural input, the need for government-supported pricing in terms of sustainability is another issue that should not be overlooked[40].

The grouping of OIC countries according to their water stress levels is shown in Table 2. While club 1 shows the highest water stress level, club 6 groups the countries with the lowest stress level and all clubs contain those that are converging to each other. Countries in the same club are converging countries in terms of rates of change in water stress over the 2000-2020 period. In other words, those in the same club follow a similar trend. The countries in the Club defined as not convergent group do not conform to any convergence and should be assessed independently. When we look at these countries, Turkmenistan, Djibouti, Djibouti and Kuwait are humid regions with the coasts of the Caspian Sea, Red Sea and Persian Gulf, respectively, which are predominantly located in the equatorial belt and have an abundance of water.

Table 2. OIC Convergence Clubs for Level of Water Stress

Clubs	**Countries**
Club 1 (3 Members)	Libya | Saudi Arabia | United Arab Emirates
Club 2	| Algeria | Azerbaijan | Egypt | Niger | Oman | Pakistan | Qatar | Syrian | Tunissia | Türkiye | Uzbekistan | Yemen |

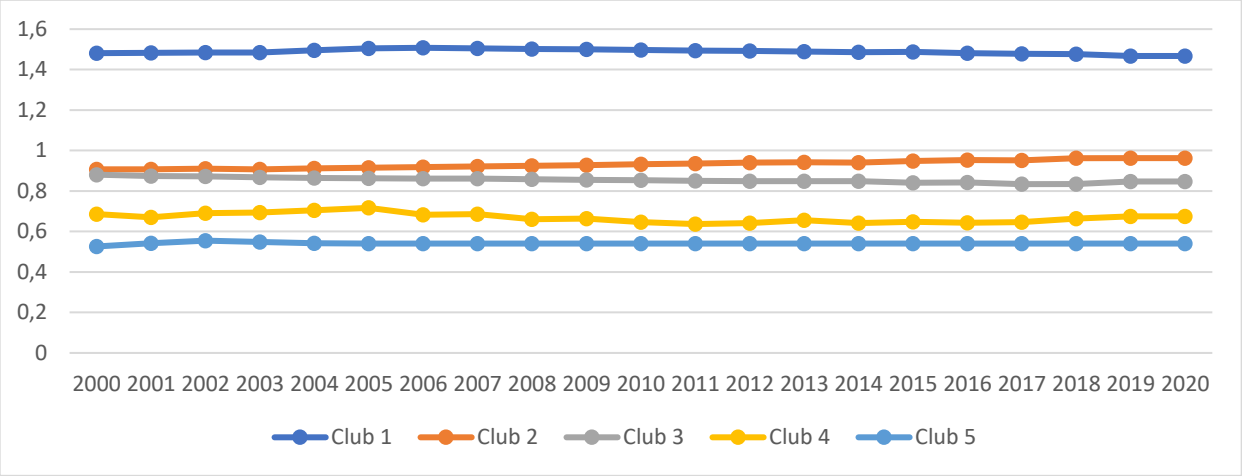
[39]SESRIC(2021, ibid., 47.
[40]SESRIC(2021, ibid., 48.

(12 Members)	
Club 3 (10 Members)	| Afghanistan | Bahrain | Indonesia | Iran | Iraq | Jordan | Kyrgyzstan | Morocco | Somalia | Tajikistan |
Club 4 (2 Members)	| Kazakhstan | Palestine |
Club 5 (2 Members)	| Mauritania | Senegal |
Club 6 (10 Members)	| Albania | Benin | Burkina Faso | Ivory Coast | Gabon | Guinea |Mozambique | Sierra Leone | Suriname | Uganda |
Not convergent Group (15 Members)	| Brunei-Darrussalam | Cameroon | Chad | Comoros | Djibouti |Gambia | Guinea-Bissau | Guyana | Kuwait | Lebanon | Malaysia |Mali | Nigeria | Togo | Türkmenistan |

When the clubs obtained in Table 2 are analysed in detail, Club 1 is clearly different from the other clubs. Although there seems to be an improvement as a group in Club 1, where the water stress level is quite high, a detailed analysis of the countries in the club shows that this trend does not apply to all countries. It should be noted that, in general, with the exception of Club 2 where the water stress level has increased, countries have not experienced a significant change in water stress compared to the respective Club average.

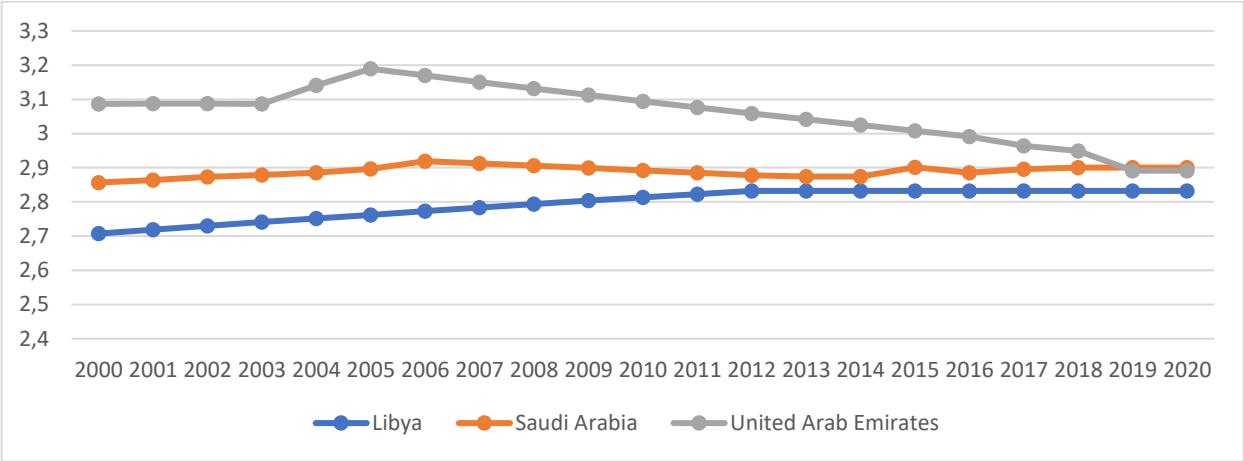
Therefore, it can be argued that there will be no dramatic change unless options other than traditional infrastructure practices are considered to reduce water stress.

Figure 2. Relative Transition Paths of Clubs



Club 1 consists of 3 countries that have relatively the highest water stress among the OIC member countries and are converging towards each other. As a result of the experiences of the countries in this group, the rates of change in water stress levels in the 20-year development paths are similar. Libya, Saudi Arabia and United Arab Emirates (UAE), which had different levels of water stress in the initial period shown in Figure 2, show very close rates of change by 2020. While the water stress level increases in Libya, it decreases in Saudi Arabia and United Arab Emirates. Especially the UAE's policy that ensured the steady decrease in the water stress level after 2005 is noteworthy.

Figure 3. Relative Transition Paths of Countries in Club 1



In the following tables, where country groups are analysed in detail, it can be seen that the change trends are close in absolute terms. For example, while Libya's water stress level in 2000 increased by 33.24 per cent compared to 2020, it decreased by 36.22 per cent in the UAE. Looking at the background of this improvement, the UAE's FAO-mediated initiative under the National Food Security 2051 programme stands out. In 2017, the UAE government supported the expansion of FAO's subregional office for the Gulf Cooperation Council countries and Yemen. Within the scope of the renewed UAE-FAO co-operation, the UAE Ministry of Food Safety was established and started the 2051 national food strategy target as of 2018. Consisting of 7 key components, the first objective of the strategy is the most efficient use of water and other scarce resources to achieve the best economic return for a typical agricultural enterprise[41].

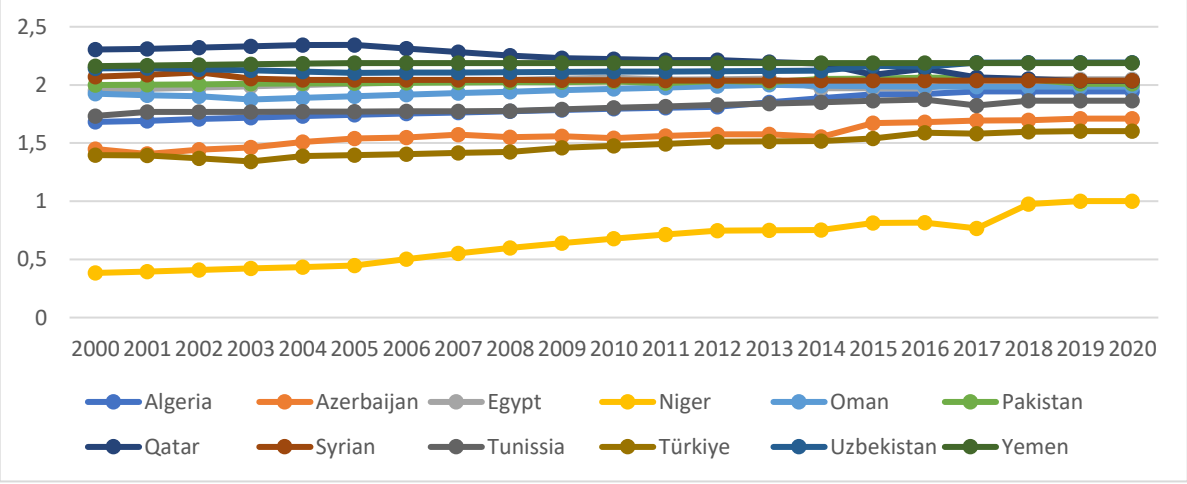
The UAE's support policy under the FAO Regional Initiative on Water Scarcity in the Near East and North Africa, launched in 2015 with the Centre for Agricultural Research in Arid Areas, aims to improve nutrition levels and food security and reduce water consumption. The project, which will establish a new-generation greenhouse prototype, will support conservation agriculture, water resource accounting, relevant legislation and

[41] FAO, (2019), "United Arab emirates and FAO: Partnering for Sustainable Agricultural Development and Food Security", (https://www.fao.org/3/az580e/AZ580E.pdf), p.1.

regulations, and cooperation on the use of treated wastewater in agriculture [42]. The establishment of drought management and early warning systems for countries in the region is also a water-related theme of the cooperation[43]. Water stress level of the country, which peaked in 2005, declined rapidly after 2015 and fell below the stress level of Saudi Arabia.

In Club 2, which is made up of 12 countries, Niger differs from the others. Despite the downward trend in the water stress levels of the countries in this club, an increase has been observed in Niger. In addition to the significant increase in the stress level, which started from a very low point, this trend has a negative impact on the club average. Niger, a country located in the major water basins of the African continent, together with Lake Chad among the OIC members, has a significant potential for cooperation on transboundary waters. However, the dry and hot climate of the country and the low level of total irrigated area which corresponds to 0.24 per cent of the country's territory[44], combined with the internal unrest and local terrorism incidents in the country for many years, have adversely affected access to water.

Figure 4. Relative Transition Paths of Countries in Club 2



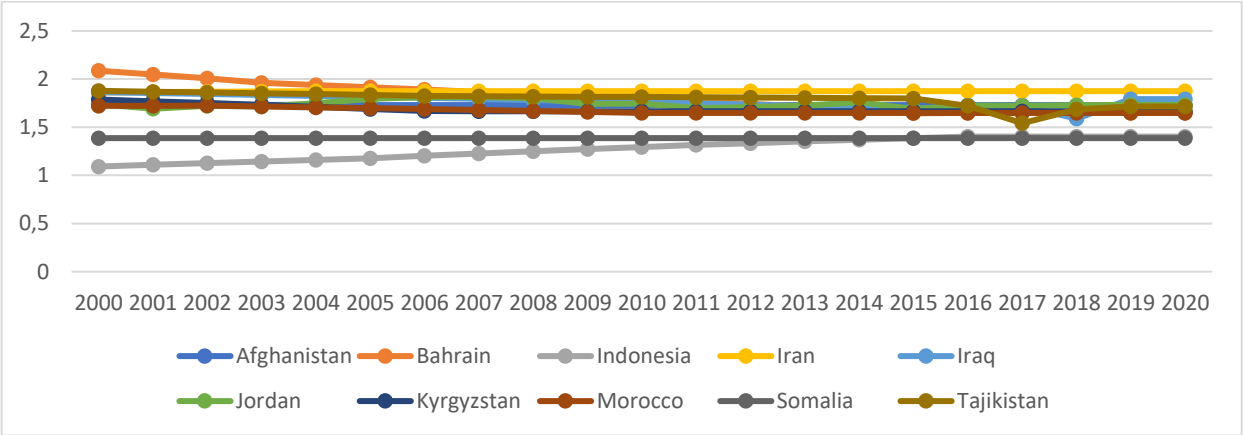
[42] FAO, (2019), "United Arab emirates and FAO: Partnering for Sustainable Agricultural Development and Food Security", (https://www.fao.org/3/az580e/AZ580E.pdf), p.2.
[43] Ibid., p.2.
[44] OIC, (2023), "OIC Countries in Figure: Nijer", (https://www.sesric.org/cif.php?c_code=38).

In Niger which has rich uranium and oil resources but cannot directly receive the revenues of those and is dependent on agricultural production income, the water dependency rate is 89.72 per cent as 91.02 per cent of the water withdrawn is used in the agricultural sector. Although the water withdrawn for agriculture corresponds to 8.9 per cent of renewable water resources and 11 per cent in total; Niger's water stress increased 5 fold in 2012, 2018 and 2019 compared to 2000.[45].

While no change is observed in Afghanistan, Iran and Somalia among the Club 3 countries, it can be seen that the water stress level of Indonesia has increased compared to the club average. The Asian country, which has recently attracted attention for its rising national income and population, has suffered earthquakes, tsunamis, floods, hurricanes and volcanic eruptions. Natural disasters are quite common in the country where 85 per cent of the drawn water is used in the agricultural sector. 2004, 2010, 2018 Tsunamis, 2000, 2005, 2006, 2009, 2021 earthquakes, 2018 Lombak earthquake, 2007, 2010, 2021 volcano eruptions, 2010, 2014, 2019 water floods were some of the major disasters[46]. These disasters significantly damaged infrastructure and high-flow clean water channels. Underground water channels and artesian wells were displaced. The Java drought, to which 60 per cent of the population is affected, the fact that the Citarum River, the country's main source of water, is the most polluted river in the world and that the water level drops every year increase water stress. 80 per cent of Indonesian people live dependent on rivers and groundwater. Pollution caused by dumping of wastes in water bodies creates a problem in terms of sustainability.[47].

[45] UN, (2023), "UN Water: Nijer", (https://sdg6data.org/en/country-or-area/Niger#anchor_6.4.2), Date of access: 01.08. 2023).
[46] Statista, (2023), "Natıural Disasters in Indonesia", (https://www.statista.com/topics/8305/natural-disasters-in-indonesia/#topicOverview), (Date of access: 01.08.2023).
[47]UN, (2023), "UN Water: Indonesia", (https://sdg6data.org/en/country-or-area/Indonesia#anchor_6.4.2), Date of access: 01.08. 2023).

Figure 5. Relative Transition Paths of Countries in Club 3



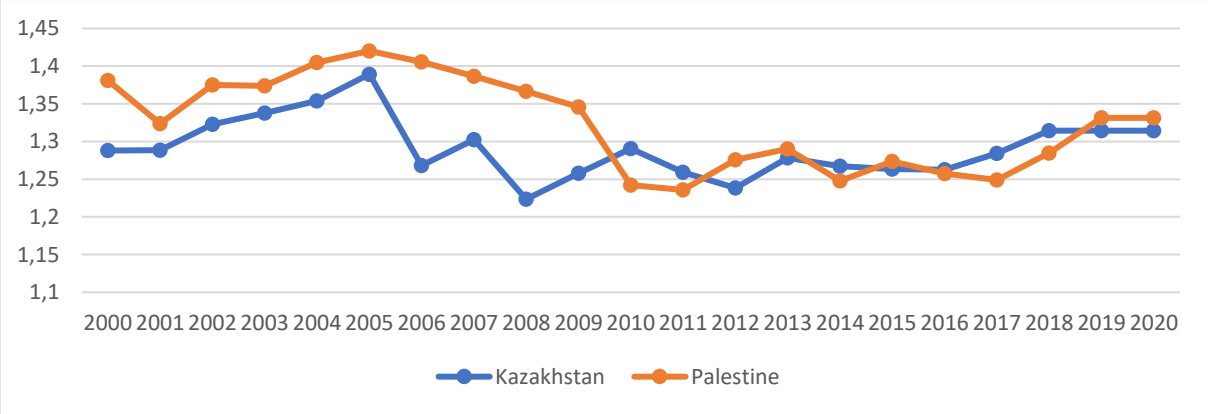
Indonesia's extremely dry season also negatively affects the production process and the level of welfare. For instance, the country, which concentrates on rice production with excessive water demand, awaits rainwater during dry seasons and experiences yield declines.

There are two countries in Club 4. Although their climate and geography are different, the two countries start from different levels of water stress and tend towards the same ratios. Palestine, a major port country located in the historic Levantine trade centre of the eastern Mediterranean, has a typical Mediterranean climate and does not receive much rainfall. Although water is an additional source of conflict with Israel and it has no wetlands outside the Mediterranean, its water stress level was relatively high in 2000 and decreased until 2010. Water resources in the country where 45 per cent of clean usable water goes to agriculture, consist of wells, natural springs, desalinated water [48] and water purchased from an Israeli company. Israel obtains 40 per cent of its water from Palestinian water sources and controls Palestinian water. The level of water stress in Palestine, which interferes with the

[48] OIC, (2023), "OIC Country Figures: Phalestine", (https://www.sesric.org/cif.php?c_code=42), Date of access: 02.08.2023)

drilling of new wells or any water development innovation, depends on Israel's biased policies and favourable climatic conditions[49].

Figure 6.Relative Transition Paths of Countries in Club 4



Kazakhstan, whose water stress levels started relatively low and increased over time, has recently stepped up its investment in agriculture and rural development and is moving towards green technology. In modernising its agricultural sector, the country is focusing on sustainable intensive agriculture, organic farming, conservation agriculture to support fragile ecosystems in its sub-regions, and sustainable natural resource management[50]. In the country where 63 per cent of the usable fresh water is used in the agricultural sector[51], it is argued that the rapidly growing construction sector because of the recent migration and population growth in the capital and the increasing drought due to climate change have increased the water stress level. Kazakhstan, which is implementing a water management model to address potential water stress due to population growth, has been providing reliable drinking water to its population since 2001, when water stress began to increase[52].

[49] PCRF, (2023), "Water Quality Issues in Palestine", (https://www.pcrf.net/president-s-blog/water-quality-issues-in-palestine.html?gclid=EAIaIQobChMI1buO3fOxgQMVj_p.3Ch3xkQDIEAAYAyAAEgJINfD_BwE), (Date of access: 02.08.2023).

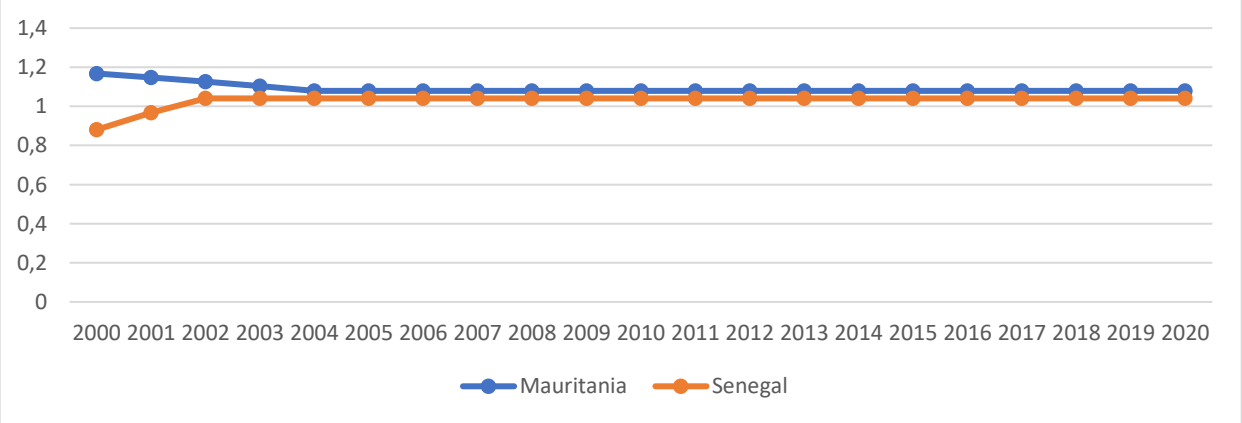
[50] FAO, (2019), "Kazakhstan and FAO: Partnering to Achieve Sustainable Livelihoods and Food Security", p.1.

[51] UN, (2023), "UN Water: Kazakhstan", (https://sdg6data.org/en/country-or-area/Kazakhstan#anchor_6.4.2), (Date of access: 03.08.2023).

[5252] UN, (2023), "UN Water: Kazakhstan", (https://sdg6data.org/en/country-or-area/Kazakhstan#anchor_6.4.2), (Date of access: 03.08.2023).

In Club 5, Mauritania and Senegal, which began with different levels of water stress, are now close to each other and face parallel levels of water stress. Of these two West African countries, which are geographically contiguous, 46 per cent of Senegal's usable land is agricultural and 42 per cent is forest. In Senegal, where the level of water stress is low, 91 per cent of available freshwater resources are used in the agricultural sector[53]. The country receives heavy rainfall for 6 months of the year and is able to replenish its water resources with its humid climate. Increased levels of water stress in 2002 and 2018[54] are explained by the severe droughts in these years[55].

Figure 7. Relative Transition Paths of Countries in Club 5



Mauritania, on the other hand, is more prone to floods, as well as the droughts of 2001 and 2017, because its climate is shaped by sea winds, the southern monsoon and Saharan winds in winter.[56].

[53] UN, (2023), "UN Water: Senegal", (https://sdg6data.org/en/country-or-area/Senegal#anchor_6.4.2), (Date of access: 03.08.2023).
[54] OIC, (2023), "OIC Country Figures: Senegal", (https://www.sesric.org/cif.php?c_code=45), Date of access: 02.08.2023)
[55] CCKP, (2023), "Senegal: Historical Hazards", Climate Change Knowledge Portal for Development Practitioners and Policy Makers, (https://climateknowledgeportal.worldbank.org/country/senegal/vulnerability#:~:text=Senegal%20faces%20a%20number%20of,to%20the%20country's%20development%20goals.), (Date of access: 02.08.2023).
[56] CCKP, (2023), "Mauritania: Historical Hazards", Climate Change Knowledge Portal for Development Practitioners and Policy Makers,(https://climateknowledgeportal.worldbank.org/country/mauritania/vulnerability), (Date of access: 02.08.2023).

Ivory Coast, Gabon, Sierra Leone in Club 6 do not experience significant changes in water stress levels. Although there is an increase in Uganda, the countries in this club are already in the group with the lowest water stress levels, as they are taking advantage of favourable climatic conditions and it is not meaningful to discuss any possible risk.

Water Use Efficiency

As an indicator in the SDG 6 group, this expresses the change in water use efficiency at national level over time. This indicator, which should be assessed together with the level of water stress, refers to changes in the ratio of agricultural value added to the volume of water used. An increase in the level of the indicator is a desirable condition. According to this dataset, countries are divided into 8 different clubs. Iran, Morocco and Somalia are the countries that do not show convergence with other countries.

Table 3. OIC Convergence Clubs for Water Use Efficiency

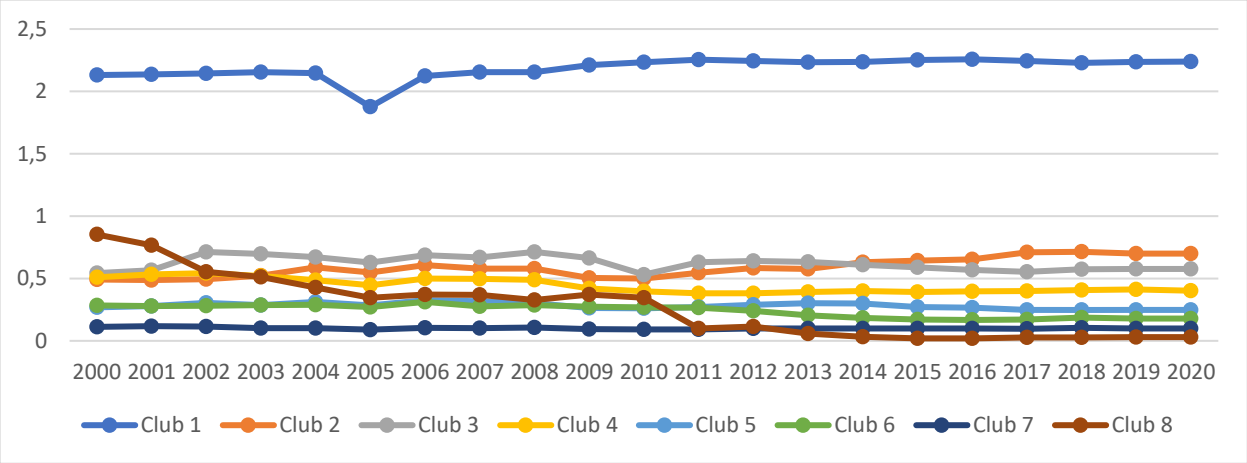
Clubs	**Countries**
Club 1 (18 Members	| Albania | Algeria | Bahrain | Benin | Egypt | Jordan | Kuwait | Lebanon | Malaysia | Oman | Qatar | Saudi Arabia | Suriname | Türkiye | United Arab Emirates | Uzbekistan | Yemen |
Club 2 (5 Members)	| Ivory Coast | Mauritania | Pakistan | Tajikistan | Tunissia |
Club 3 (2 Members)	| Indonesia | Nigeria |
Club 4 (4 Members)	| Azerbaijan | Gabon | Guinea-Bissau | Türkmenistan |
Club 5 (5 Members)	| Afghanistan | Comoros | Iraq | Kyrgyzstan | Sierra Leone |

Club 6 (5 Members)	| Burkina Faso | Gambia | Mozambique | Senegal | Syrian |
Club 7 (5 Members)	| Cameroon | Chad | Guinea | Kazakhstan | Mali |
Club 8 (3 Members)	| Libya | Niger | Togo |
Not convergent Group	| Iran | Morocco | Somalia |

Looking at the clubs, the first club with the largest group of countries has the highest water use efficiency and this efficiency tends to increase. The other clubs show relatively similar levels of convergence.

A closer look at the clubs shows a decrease in water use efficiency in Club 1 in 2005 and a stable trend thereafter. Club 8, in contrast to the other clubs, moves from relatively higher efficiency levels to negative levels with the breakpoints in 2002 and 2011.

Figure 8. Relative Transition Paths of Clubs



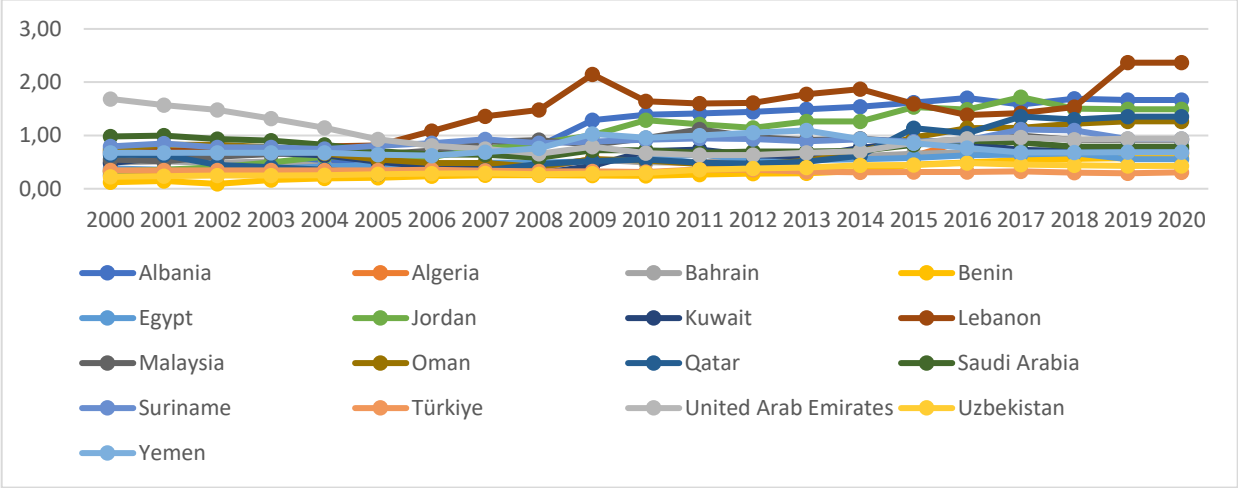
Looking more closely at the countries influencing the average trends of the clubs in Figure 8, a number of countries stand out. The increase in efficiency of the United Arab Emirates despite the increase in inefficiency of Lebanon in Club 1, the severe inefficiency of Nigeria in 2002 and 2008 in Club 3, the steady increase in efficiency of Azerbaijan in Club 4, Kyrgyzstan and Iraq in Club 5, Syria in Club 6, Guinea in Club 7 and Libya in Club 8 are notable examples.

UAE and Lebanon stand out in Club 1. As mentioned above, UAE is achieving positive outcomes in water use efficiency and food security within the scope of programmes and targets as a result of cooperation with FAO.

In Lebanon, where 64 per cent of the country's territory is agricultural land and 14 per cent is forested, the rate of water withdrawn for irrigated agriculture is 38 per cent. Other agricultural products are nourished by rainwater[57]. In examining the causes of the change in water use efficiency in Lebanon, institutions and participation and management instruments can be seen as negative factors. In Lebanon, which is part of FAO's NENA (Near East and North Africa) region, water is particularly important for food security due to its relative scarcity in the region. For this reason, regional and national programmes for sustainable water use and management are being implemented in the countries of the region. The "Arab Strategy for Water Security 2010-2030" and the "Regional Initiative for the Assessment of Climate Change Impacts on Water Resources and Socio-Economic Vulnerability in the Arab Region" projects are being implemented to increase the effective and efficient use of water[58].

[57] UN, (2023), "UN Water: Lebanon", (https://sdg6data.org/en/country-or-area/Lebanon#anchor_6.4.1), (Date of access: 07.09.2023).
[58]FAO, (2023), "FAO Regional Office for Near and North Africa", (https://www.fao.org/neareast/perspectives/water-scarcity/en/), (Date of access: 05.08.2023).

Figure 9. Relative Transition Paths of Countries in Club 1



Algeria, Bahrain, Egypt, Iraq, Jordan, Kuwait, Lebanon, Libya, Libya, Yemen, Mauritania, Mauritania, Morocco, Oma, Qatar, Saudi Arabia, Sudan, Syrian Arab Republic, Tunisia and United Arab Emirates, which are among the OIC member countries in the NENA region, have less natural water resources than other parts of the world and the productivity of their agricultural activities is determined by rainfall. Within the scope of the above-mentioned programmes, the per capita water reservoirs of the region are being developed, and basin planning is being implemented for Egypt, Sudan, Iraq, Iran and Syria, covering internal resources from beyond their borders[59].

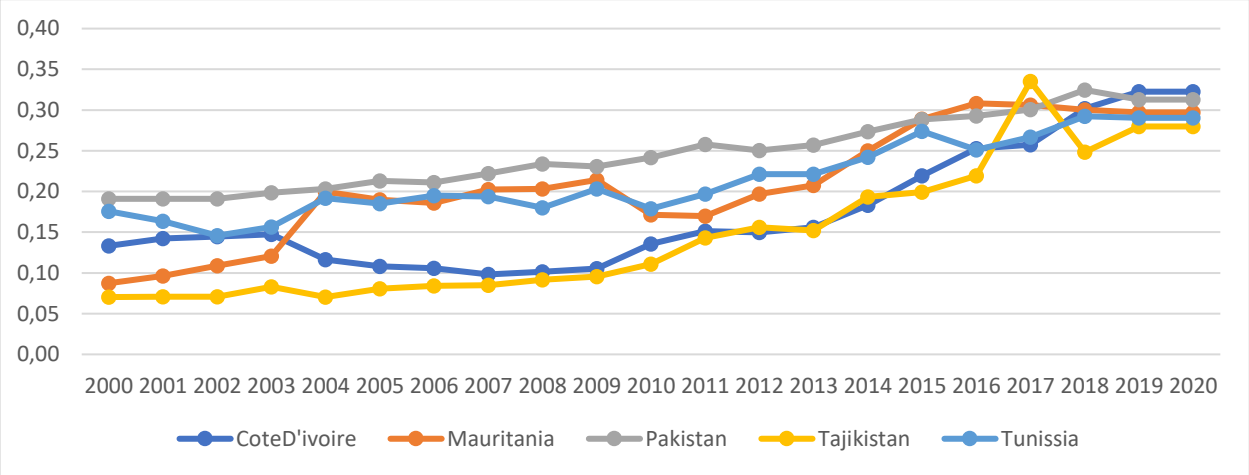
Agriculture, the largest water-consuming sector in the region, produces mainly cereals and feeds 2/3 of the agricultural population. The region's arid climate, uncertainty and low efficiency of rain-fed irrigation increase the use of inland water-based irrigation methods. However, the increasing demand for irrigation water has become the main issue of discussion among countries, due to the focus on high value-added irrigated agricultural products, the pressure on and depletion of groundwater resources, combined with increasing droughts. Regional knowledge and investments involving all sectors and levels

[59] FAO, (2015), "Towards a Regional Collabrorative strategy on Sustainable Agricultural Water Management and Food Security in the Near East and North Africa", Main Report, Second Edition, p.4., (https://www.fao.org/fileadmin/user_upload/rne/docs/LWD-Executive-Summary-2nd-Edition.pdf).

have been improved, wastewater treatment and reuse is maximised, basin-based priority planning is carried out to maximise benefits from transboundary waters, and technical information and experience on climate change and groundwater are shared in the region[60].

As a result, relatively similar trends and ratios are observed in the countries in Club 1. Lebanon, which mainly produces fruits and vegetables, differs in terms of water use efficiency with its higher forest area compared to other club and regional countries.

Figure 10. Relative Transition Paths of Countries in Club 2



In Club 2, where water use efficiency has generally increased, Tunisia, which is included in NENA and Ivory Coast, which exhibits a higher increasing trend in terms of efficiency compared to other countries, stand out. The water use efficiency of Ivory Coast, a West African country which has an advantageous climate compared to other country groups, has increased significantly after 2011 due to the good weather conditions in the region[61]. In the country where 1 per cent of the agricultural areas have an irrigation system, irrigation is provided by rain. Cocoa, cashew nuts, yam and grain coffee are predominantly produced and

[60]FAO (2015), ibid., p.-5-8.
[61] OIC, (2023), "OIC Countries in Figures: Ivory Coast", (https://www.sesric.org/cif.php?c_code=15), (Date of access: 05.08.2023).

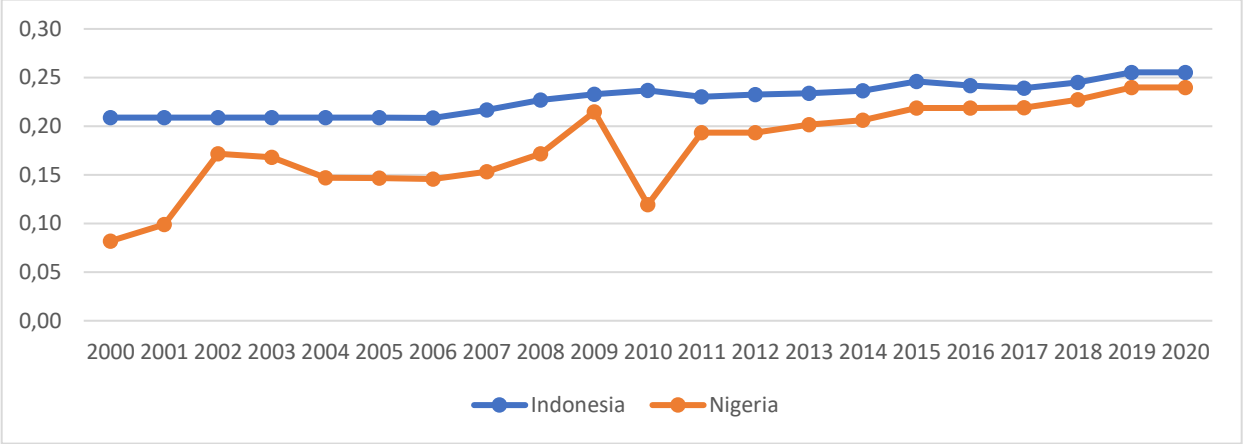
exported and the already fertile soils are fed with manure and urea without using chemical inputs. This differentiates the country from other club members[62].

Club 3 consists of Indonesia and Nigeria. As shown by the water stress indicator, Indonesia is a country that invests in technology and know-how for agricultural production, but struggles with natural disasters, especially after 2000. In particular, severe soil movements and floods have caused major damage to infrastructure investments, and the country's largest freshwater source is struggling with pollution. Despite the disasters and a growing population, the country has made progress in the efficient use of water.

In Nigeria, except for the years 2002 and 2016, the increase in efficiency in the level of water use is striking[63]. In response to the food crisis and the risk of hunger in the country, which is the largest producer of sorghum in West and Central Africa and is affected by regional conflicts, FAO has initiated cooperation in the areas of access to improved agricultural inputs, reduction of post-harvest losses and market access. In this context, the N-Power Agro programme has been implemented by identifying safe production areas and providing technical assistance. The programme, which is particularly targeted at young and female workers, has increased productivity by addressing crop-livestock-fisheries in a holistic manner, similar to traditional agricultural production. Technical assistance from support institutions and stakeholders on seeds, irrigation and productive livestock breeds are at the forefront[64].

[62]FAO, (2022), "Climate-Smart Agriculture in Ivory Coast", p.4., (https://www.fao.org/3/ca1322en/CA1322EN.pdf)
[63] OIC, (2023), "OIC Countries in Figures: Nigeria" (https://www.sesric.org/cif.php?c_code=39), (Date of access: 05.08.2023).
[64] FAO, (2023), "FAO in Nigeria", (https://www.fao.org/nigeria/programmes-and-projects/programmes/en/), (Date of access: 18.08.2023).

Figure 11. Relative Transition Paths of Countries in Club 3



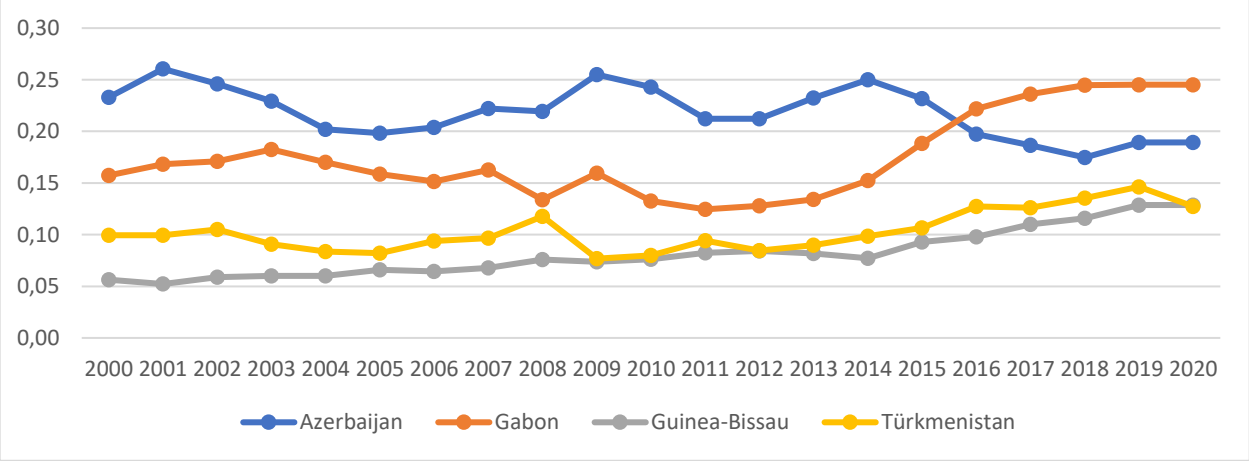
In addition to this technical assistance, the cultivation of sorghum is seen as another important development that increases water use efficiency. The country continues to increase sorghum production, with more than half of the country's cereal production area and almost 15 per cent of arable land devoted to sorghum. Historically grown by small-scale subsistence farmers, the crop has been introduced to the food and beverage industry as a savanna speciality crop. Savanna, whose production and trade is supported by public policies and private sector cooperation, is a substitute for imported wheat and barley. Sorghum, which has been refined through technical and scientific studies, not only increases productivity on marginal drylands, but also requires less water than its alternatives, maize and rice, and is able to absorb deeper groundwater. Particularly in periods of extreme drought, it can significantly increase its yield with little irrigation[65].

Among the Club 4 countries, Azerbaijan's water use efficiency level is higher at the beginning of the period than at the end. This can be explained by the fact that Azerbaijan's water use efficiency level increased by 75.6% despite the 4.4% increase in the share of

[65] Ajeigbe, A., Hakeem, (2017), "Productivity and Water Use Efficiency of Sorghum Grown Under Different Nitrogen Applications in Sudan Savanna Zone, Nigeria", Hindawi International Journal of Agronomy, Vol.2018, pp.1-11, doi: 10.115/2018/7676058.

agricultural production in GDP[66]. In other words, Azerbaijan is increasing its agricultural production by increasing water use. On the other hand, in its 2004-2018 and 2018-2025 development plans, Azerbaijan aims to increase national water security and water use efficiency within the framework of a green economy and sustainable water management. The country, whose main water basins are the Caspian Sea, Aras and Kura rivers, has recently increased the efficiency of water use with agreements on secondary use of water through purification, effective use of groundwater, reduction of oil pollution by 60 per cent and appropriate use of water through regional cooperation in transboundary waters[67].

Figure 12. Relative Transition Paths of Countries in Club 4

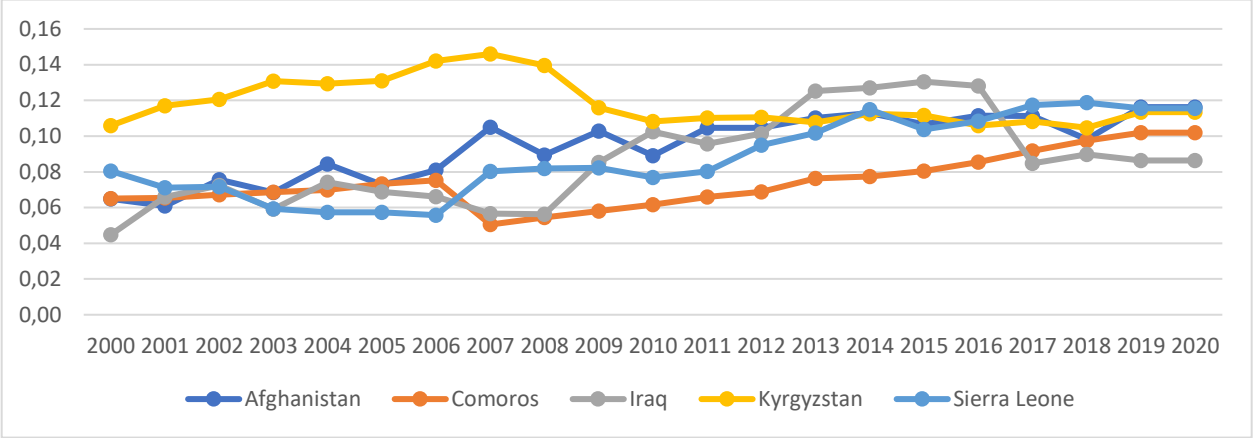


The other club countries Gabon, Guinea-Bissau and Turkmenistan tend to increase their efficiency levels. Although Gabon and Turkmenistan are in the same group, their water efficiency levels tend to act in opposite directions in the same periods. In periods in which Gabon's activity level decreased, Turkmenistan's increased.

[66] ENISEIS, (2017), "Total Water Use in the Republic of Azerbaijan", European Environment Agency, (https://eni-seis.eionet.europa.eu/east/indicators/c3-2013-total-water-use-in-the-republic-of-azerbaijan), (Date of access: 18.08.2023).

[67] Ahmadov, Elshan, (2020), "Water Resources Management to Achieve Sustainable Development in Azerbaijan", sustainable Futures, Elsevier, Vol(2), 100030, pp.1-10.

Figure 13. Relative Transition Paths of Countries in Club 5



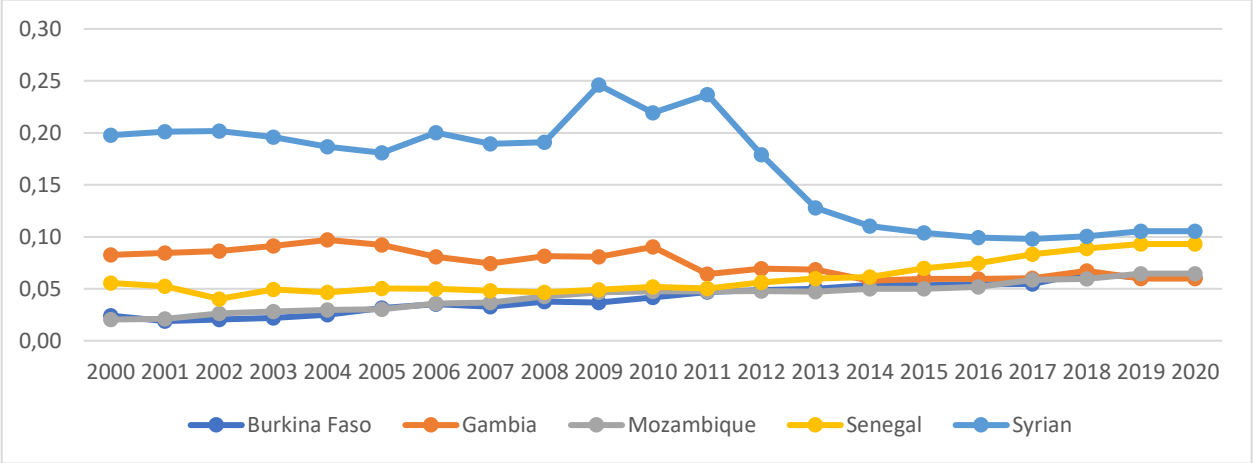
Among the countries in Club 5, Kyrgyzstan started with a higher level of water use efficiency than Afghanistan, Comoros, Iraq and Sierra Leone, but approached these countries by the end of the analysis period. As Kyrgyzstan is one of the countries analysed in the field research, detailed information is provided in the relevant section, but the country, which has a large amount of surface water resources in a vast landscape, has recently been affected by increasing droughts. The country has lost 36 per cent of its 8.85 per cent increase in waterways due to obsolescence of technical innovations in the fields, partial use of irrigated land through crop rotation and changes in cropping patterns, loss of efficiency of large farms that have been fragmented, and financial inadequacy to replace them[68].

Iraq experiences a periodic increase in efficiency. Starting to rise after 2003, the efficiency at the level of water use accelerated after 2014 and peaked in 2018[69]. In overall terms, it is apparent that countries are approaching each other in terms of water use efficiency.

[68] Djailoobayev, A.Sh., "National Report on the Regional Water Partnership:Republic of Kyrgyzstan", Ministry of Water Resources and Agriculture, p.2., (https://www.gwp.org/globalassets/global/gwp-cacena_files/en/pdf/kyrgyzstan.pdf).

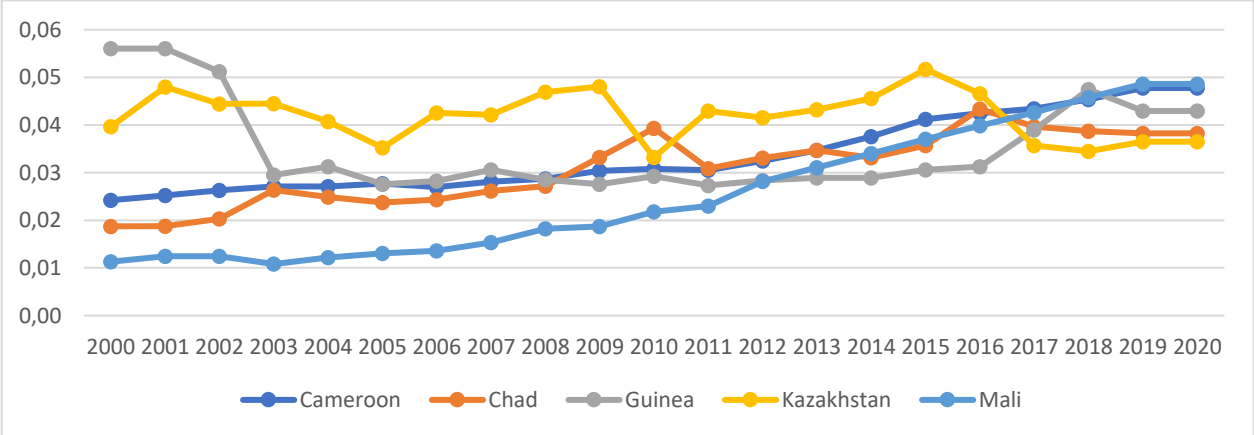
[6969]OIC, (2023), "OIC Countries in Figures: Iraq" , (https://www.sesric.org/oic-member-countries-linecharts.php?ind_code=3246&c_code=24), (Date of access: 18.08.2023).

Figure 14. Relative Transition Paths of Countries in Club 6



In the 6th club, Syria is significantly different from other countries. Starting in 2011, Syria is deemed to be less efficient in the level of water use due to the decreasing and displaced population, decreasing production and destroyed infrastructures because of instability and terrorism acts.

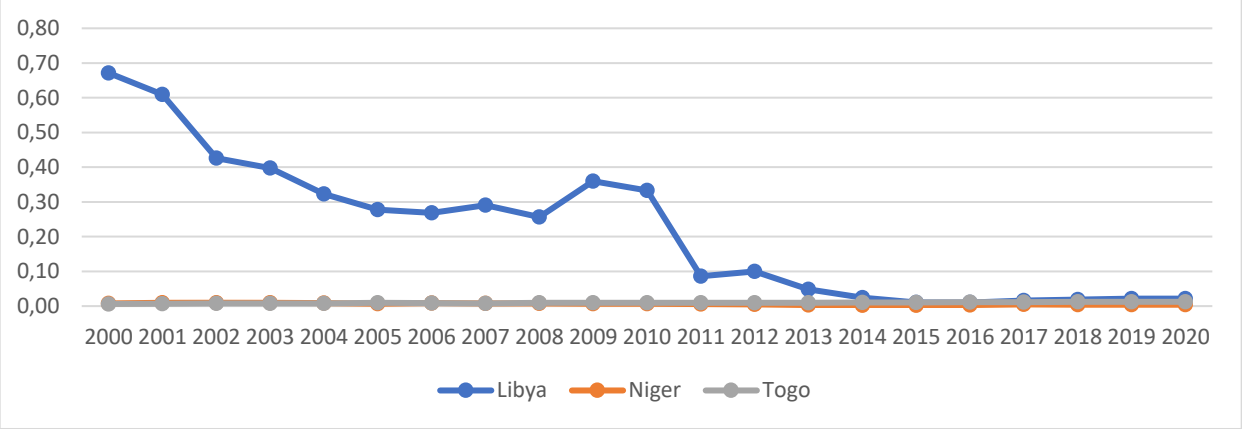
Figure 15. Relative Transition Paths of Countries in Club 7



Countries in the 7th club started with varying levels of efficiency like the 5th club and achieved levels close to each other. While Mali, Cameroon and Chad increased their efficiency levels, Guinea experienced efficiency losses.

The increase in water consumption in the construction sector due to the increasing population in Kazakhstan's water use level and organic agriculture practices are mentioned in the data set on water stress level. In parallel, the water use efficiency of the country has been increasing after 2005[70]. In other words, the country is utilizing more water and achieving effective technical progress.

Figure 16. Relative Transition Paths of Countries in Club 8



In Club 8, Libya had a relatively high level of water use, but experienced inefficiency losses as it converged with Niger and Togo. The post-2011 process in the region, which led to a change of government and social unrest in Libya, destroyed the country's population, production and infrastructure and depleted its renewable water resources. Although 83 per cent of the water withdrawn in the country, where relative stability has been achieved, is used by the agricultural sector, the sectoral and value-added shares of agriculture are around 4 per cent.[71]

[70]OIC, (2023), "OIC Countries in Figures: Kazakhstan", (https://www.sesric.org/oic-member-countries-linecharts.php?ind_code=3246&c_code=28), (Date of access: 18.08.2023).
[71] UN, (2023), "UN Water: Libya", (https://sdg6data.org/en/country-or-area/Libya#anchor_6.4.1), (Date of access: 18.08.2023).

Agricultural Land Use

In the analysis of land use, agricultural land is analysed. Agricultural land includes land used for growing crops and breeding livestock. This definition includes arable land and permanent pasture[72].

Among the data obtained by the questionnaire method sent to the countries by AQUASTAT and returned by the official institutions of the relevant country, those related to land use, fertilizers and pesticides were analyzed within the scope of the study. Among the land use data, agricultural land was preferred due to its inclusiveness in agricultural production. FAO collects data on land use by survey method and enters data in hectares (1000 ha). Land use includes agriculture, forestry, aquaculture and fisheries. Data on irrigation and agricultural practices are also collected through surveys. The development map is monitored through analysis at national, regional and international levels. The names and definitions used in the survey are compatible with the System of Environmental-Economic Accounting (SEEA) and World Census of Agriculture (2020). Emissions data have also been harmonised according to the 2006 Intergovernmental Panel on Climate Change (IPCC) guidelines[73].

The agricultural area refers to the land, which is the main means of production, and is directly related to its size, productivity level, terrain, temperature and water level, production quantity and quality. OIC region has ¼ of the world's arable land[74]. Water and labor are two important elements in maintaining large areas of arable land that are relatively less polluted than the world average. While water was discussed in the previous section, labor will be analyzed in detail in the next section.

[72] FAOSTST, (2023), "Definitions and Standarts: Land Use", (https://www.fao.org/faostat/en/#data/RL), (Date of access: 20.08.2023.
[73] FAOSTAT, (2023), "Land Use", (https://www.fao.org/faostat/en/#data/RL), (Date of access: 09.09.2023).
[74] OIC (2020), "Agriculture and Food Security in OIC Member Countries: 2020", Organization of Islamic Cooperation, Statistical Economic and Social Research and Training Centre for Islamic Countries, pvii

The surface areas of the countries and the areas where agricultural production is carried out may not be proportional with each other. In OIC member countries, some countries have large geographical expanses but harbour deserts and agricultural production can take place in a small part of the country's geography. For example, Libya, Egypt, Sudan, Saudi Arabia, Syria, Iraq, Turkmenistan, Uzbekistan, Kazakhstan, Pakistan are OIC member countries that host deserts within their borders. Some countries, such as Kyrgyzstan, are extremely mountainous and have relatively little flat land for agricultural production. Some countries have very fertile and arable land but suffer from frequent natural disasters and continuous crop and soil loss. Others may have agricultural land that has been allocated to other uses, such as construction, due to overpopulation. As a result, the size of the country and the area of agricultural production generally differ.

When countries are grouped according to their agricultural lands, 11 different clubs are obtained as seen in Table 4. Among these clubs, the countries in club 1 have the closest agricultural land use to each other. As the definition of the data implies, this includes not only crop production but also areas where animal production is carried out, excluding aquaculture production.

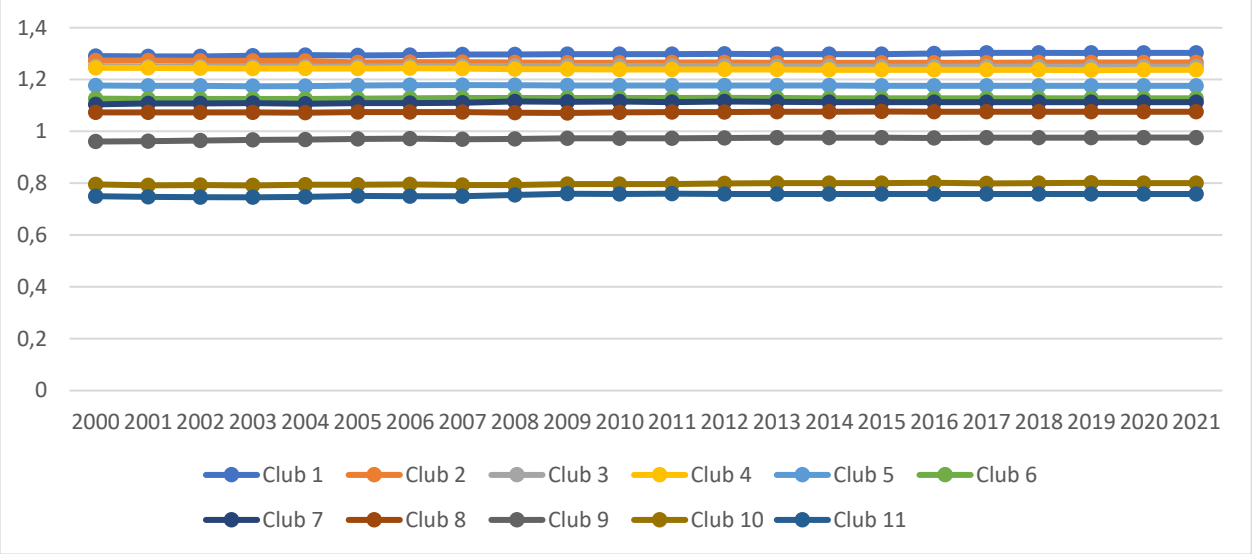
Table 4. OIC Convergence Clubs for Agricultural Land Use

Clubs	**Countries**
Club 1 (2 Members)	| Indonesia | Nigeria |
Club 2 (3 Members)	| Chad | Iran | Niger |
Club 3 (4 Members)	| Algeria | Mali | Mozambique | Somalia |
Club 4	| Afghanistan | Pakistan | Türkiye |

(3 Members)	
Club 5 (2 Members)	| Ivory Coast | Yemen |
Club 6 (3 Members)	| Guinea | Libya | Uganda |
Club 7 (2 Members)	| Burkina Faso | Syrian |
Club 8 (6 Members)	| Bangladesh | Cameroon | Iraq | Kyrgyzstan | Malaysia | Tunisia |
Club 9 (5 Members)	| Azerbaijan | Benin | Egypt | Sierra Leone | Togo |
Club 10 (3 Members)	| Guinea-Bissau | Jordan |
Club 11 (2 Members)	| Gambia | Lebanon |
Not Convergent Group	| Albania | Bahrain | Brunei-Darussalam | Comoros | Djibouti | Gabon | Guyana | Kazakhstan | Kuwait | Maldives | Mauritania | Morocco | Oman | Palestine | Qatar | Saudi Arabia | Senegal | Suriname | Tajikistan | Turkmenistan | United Arab Emirates | Uzbekistan |

Countries in the not convergent group do not converge with others. For example, in Kazakhstan, by 2020, 80 per cent of arable land is under agriculture, while 1 per cent is forested[75].

Figure 17. Relative Transition Paths of Clubs



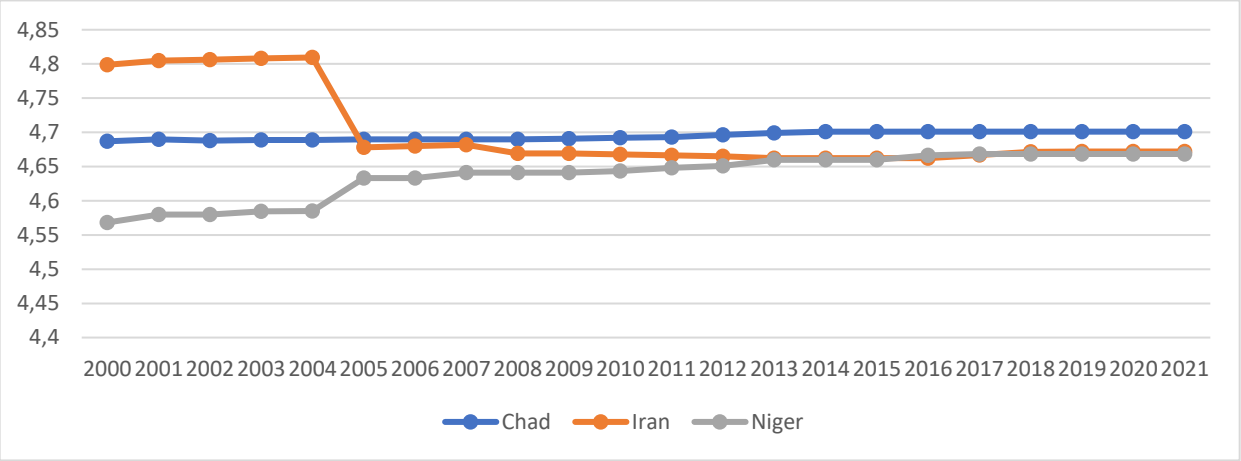
In Indonesia, the archipelago country in the first club, agriculture covers an average of 2.91 per cent of the country's land area. Following the Southeast Asian crisis of the 1990s, Indonesia embarked on a period of significant growth, increasing its agricultural area by 17.36 percent by 2000 and becoming a leading producer of palm oil, coffee and cocoa. While 15 per cent of the country's agricultural land consists of large export-oriented plantations, around 70 per cent of agricultural producers are smallholders with an average of 0.79 hectares of land[76]. The Agricultural Development Plan, which was implemented in the country in 2013 and aims to improve the welfare of small-scale producers by ensuring food sovereignty by 2045, aims to develop agricultural infrastructure and services and reduce

[75] UN (2023), "UN Water: Kazakhstan", (https://sdg6data.org/en/country-or-area/Kazakhstan), (Date of access: 02.07. 2023).

[76] FAO, (2017), "Country Fact Sheet on Food and Agriculture Policy Trends: Indonesia", (https://www.fao.org/3/i7696e/i7696e.pdf), p.1., (Date of access: 16.08.2023).

natural risks. Accordingly, the Law on Protection and Empowerment of Farmers was enacted in 2013, facilitating access to land, financing and markets[77].

Figure 18. Relative Transition Paths of Countries in Club 2



The countries in the second club have land use rates between 4.88 and 4.55 percent and are quite far apart. While Chad's land use trend remains unchanged, there is a decreasing trend in Iran and an increasing trend in Niger. By 2005, they are converging as a result of the policies implemented by the countries and are continuing in a stable manner. Since 2005, Iran has implemented a number of medium- and long-term policies and measures related to agriculture. These policies can be summarized under the themes of reducing poverty by increasing productivity, ensuring self-sufficiency in basic commodities, improving dietary patterns by increasing animal protein intake, and increasing private sector participation and investment in agriculture[78]. In line with its strategy to increase production and productivity, the country has not made any positive adjustments with regard to the expansion of agricultural areas, and in 2005 there was a 74 percent decrease compared to the previous year. However, there was an increase of 101 percent in arable land, 101 percent in cropland,

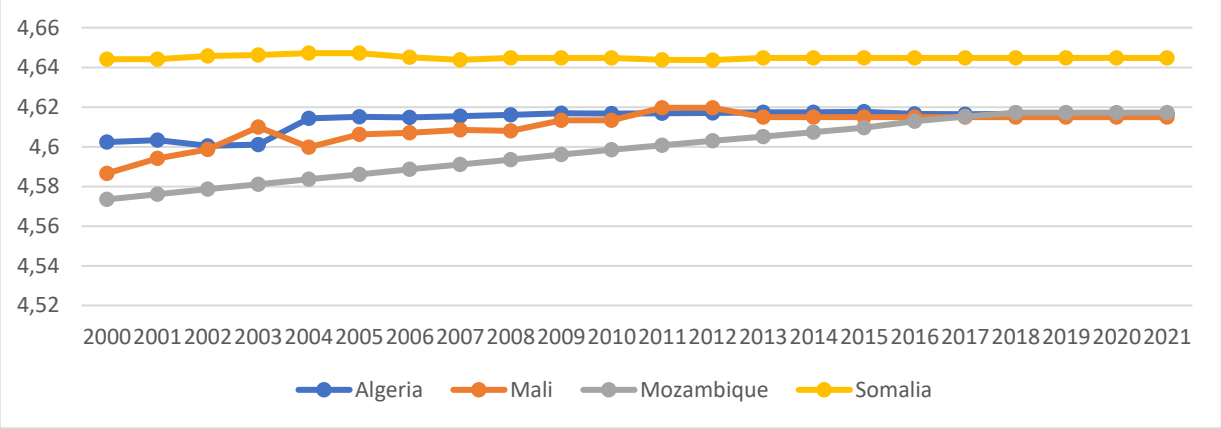
[77] Ibid., FAO, (2017), p.2

[78] FAO, (2017), "Country Fact Sheet on Food and Agriculture Policy Trends: Iran", (https://www.fao.org/3/i4126e/i4126e.pdf), p.2., (Date of access: 16.08.2023).

101 percent in irrigated land and 103 percent in land under permanent crops.[79] While there was no change in forested areas in 2005, a remarkable increase of 115 percent was observed in 2010.

Niger aims to improve the well-being of vulnerable households by focusing on food security, rural development and sustainable agriculture. Agricultural production and productivity increases are supported through livestock and fisheries activities to break the cycle of poverty. Support for agricultural inputs is provided through seed breeding, fertilizer, access to cheap finance and storage areas. The improvement of degraded land in plateaus, valleys and oases and the implementation of the Sahel-Sahara Great Green Wall have brought land use in Niger to its current state in 2007[80].

Figure 19. Relative Transition Paths of Countries in Club 3

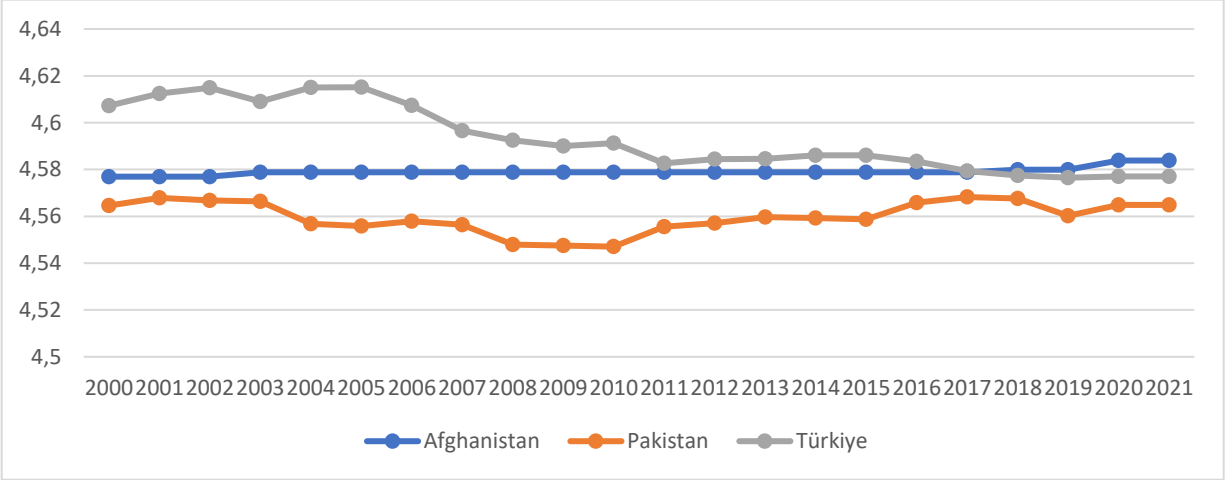


While there is a relative increase in the area of agricultural land in the Club 3 countries, Somalia has maintained its initial level of agricultural land. Somalia, which started with a higher proportion of agricultural land than other countries, appears to have similar proportions as a result of the convergence of Algeria, Mali and Mozambique. Mali, which has the lowest level of land use in the group, has adopted a policy of increasing agricultural land use under "2007-2017: Key Policy Decisions'. In Mali, which is dominated by small-scale

[79] FAOSTAT, (2023), "Land Use", (https://www.fao.org/faostat/en/#data/RL), (Date of access: 16.08.2023).
[80] FAO, (2017), "Le Niger at la FAO", (https://www.fao.org/3/bc031f/bc031f.pdf), (Date of access: 16.08.2023).

agricultural producers, the government has ensured equal and secure access to new land, especially in rural areas. With the main challenge being conflicts of interest between livestock and crop farmers, ¼ of the target area has been opened up to agriculture as new land. In this way, 5.5 percent of Mali's agricultural land has been brought under cultivation[81].

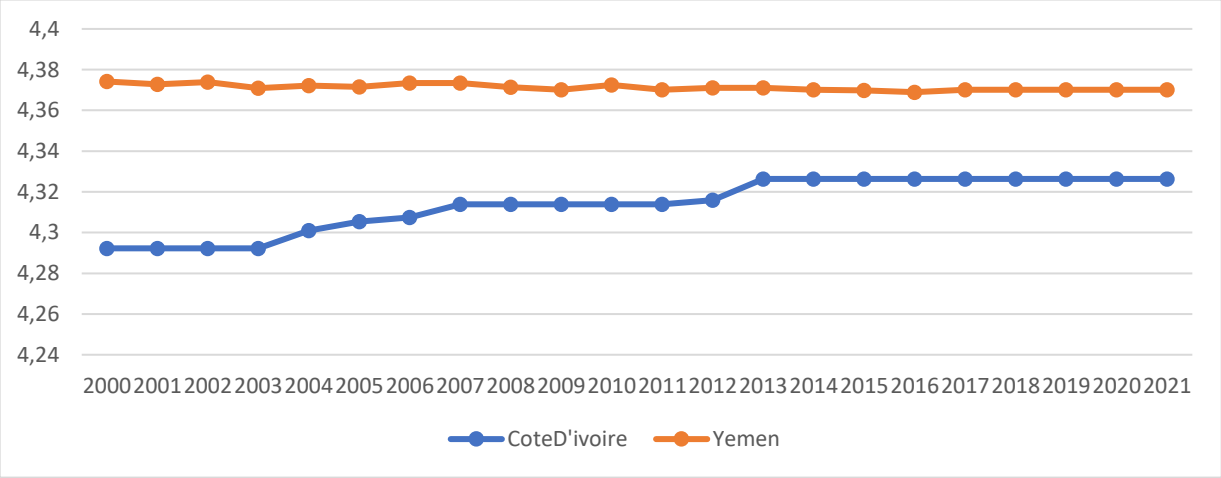
Figure 20. Relative Transition Paths of Countries in Club 4



Club 4 is where Pakistan and Türkiye stand out. In Türkiye, there is a land protection and land use law No. 5403 on the protection and prevention of misuse of agricultural land. In order to ensure the sustainability and stability of agricultural production, sensitivity is shown to the misuse of agricultural lands and legal regulations have been introduced to prevent the fragmentation of agricultural lands through land reform laws, farmer landing law, regulation of wetlands, registration of agricultural lands by establishing the Farmer Registration System in 2011 and even inheritance. Nevertheless, loss of quality of agricultural lands and the decrease in agricultural areas due to increasing residentialization could not be prevented.

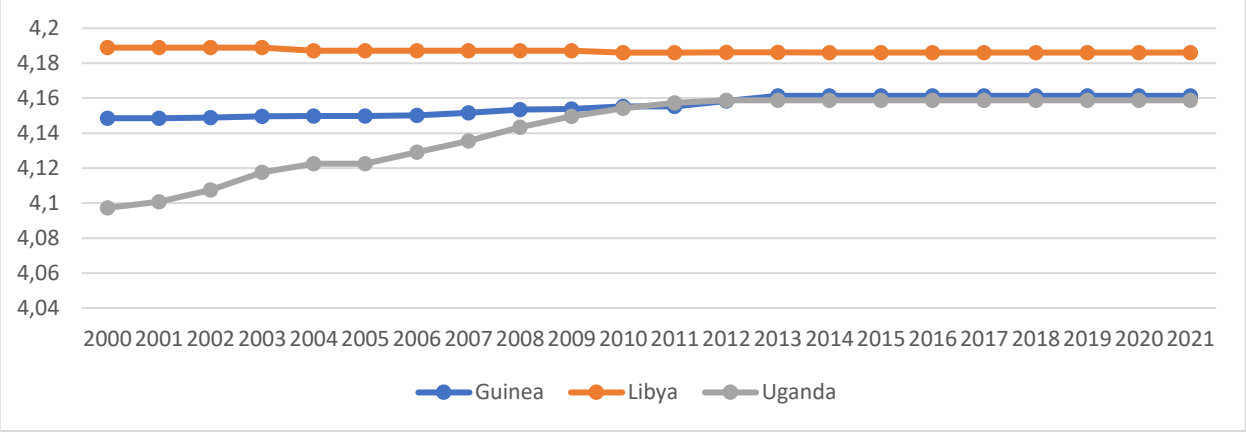
[81] FAO (2017), "Country Fact Sheet on Food and Agriculture Policy Trends: Mali", p.3., (https://www.fao.org/3/i7617e/i7617e.pdf), (Date of access: 15.09.2023),

Figure 21. Relative Transition Paths of Countries in Club 5



Ivory Coast in Club 5 has increased its agricultural land use and is approaching Yemen's level of agricultural land use. In Côte d'Ivoire, where smallholders are the main producers, high value-added, export-oriented products such as cocoa, coffee, bananas, pineapples and palm oil are the focus. In a country with abundant water resources, agro-industrial plantations have become increasingly important. The sector continues to grow through increased land use and agricultural employment[82].

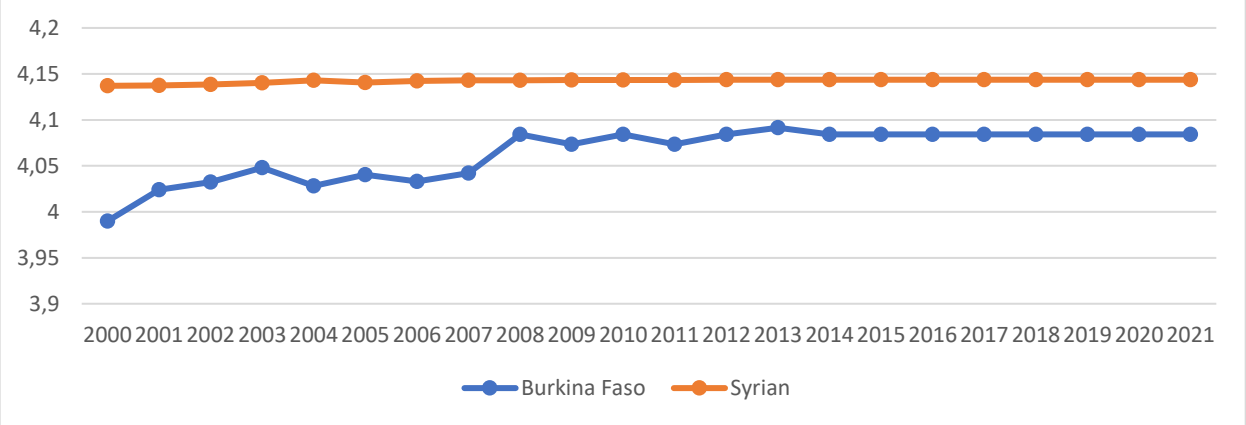
Figure 22. Relative Transition Paths of Countries in Club 6



[82]FAO, (2005), "Profil de Pays-Ivory Coast", (https://www.fao.org/3/i9921fr/I9921FR.pdf), (Date of access: 27.08.2023).

Guinea and Libya, both in Club 6, maintained their level of agricultural land. Uganda's agricultural land expansion in the period to 2010 is in line with the club average. Poverty is the main problem in the country, which has high growth potential due to its large areas of fertile land, a climate with regular rainfall and rich natural resources. In Uganda, access to agricultural land is hampered by a four-tier land tenure system. In the north, most land is communal and used for grazing. The land in the center is owned by the kingdom, i.e. the treasury land, and is leased for a fixed period of time[83]. However, more than 80 per cent of the country's land is farmed informally. To establish rights in this context, sustainable and equitable land management was introduced through credit facilities to increase land acquisition in 2008, a law to prevent informal evictions from cultivated land in 2010, and a government land policy in 2013[84].

Figure 23. Relative Transition Paths of Countries in Club 7

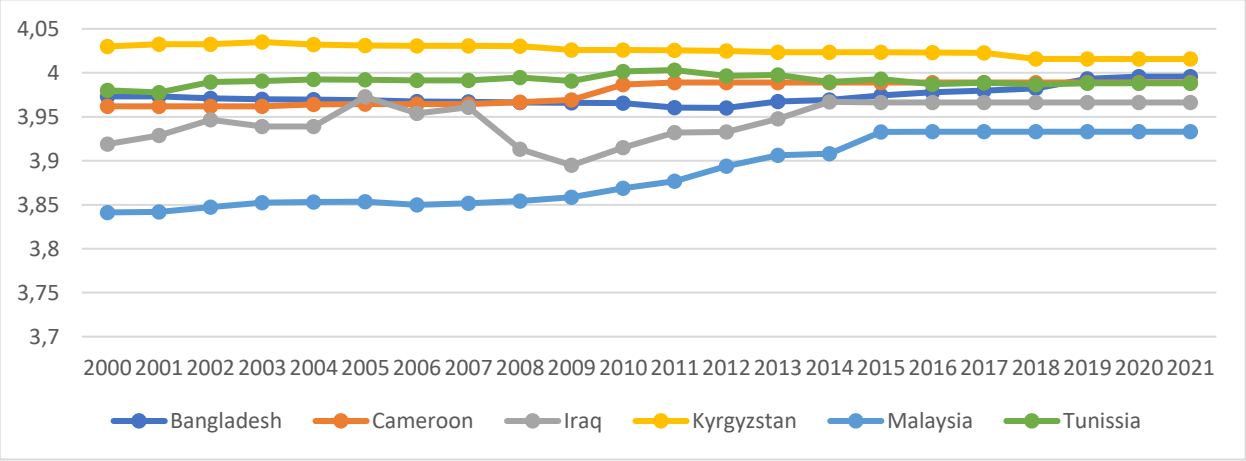


In Club 7, Syria has maintained its share of agricultural land while Burkina Faso has seen an increase. In Burkina Faso, the share of agriculture in GDP is 23.40 percent on average and the share of agricultural employment is 79 percent on average. The country, where 3 major cotton companies are located, is the largest cotton producer and exporter in Africa.[85].

[83] Ibid., FAO, (2017).
[84] Ibid., FAO, (2017).
[85] FAO, (2017), "Country Fact Sheet on Food and Agriculture Policy Trends: Burkina Faso", (https://www.fao.org/3/i3760e/i3760e.pdf), p.3, (Date of access: 15.09.2023).

However, the country is highly vulnerable to rural poverty, external shocks related to energy prices and production instability due to natural phenomena. In addition, malnutrition is a growing problem in the country. In line with various programmes and strategies to address these issues, land use in the country was initially governed by customary law, but with the Land Use Acts of 2009 and 2012, rights have been legally recognised. In this way, individual and collective use rights were transformed into private property. The environment of trust created by such practices is believed to have increased the amount of land available for use.[86]

Figure 24. Relative Transition Paths of Countries in Club 8



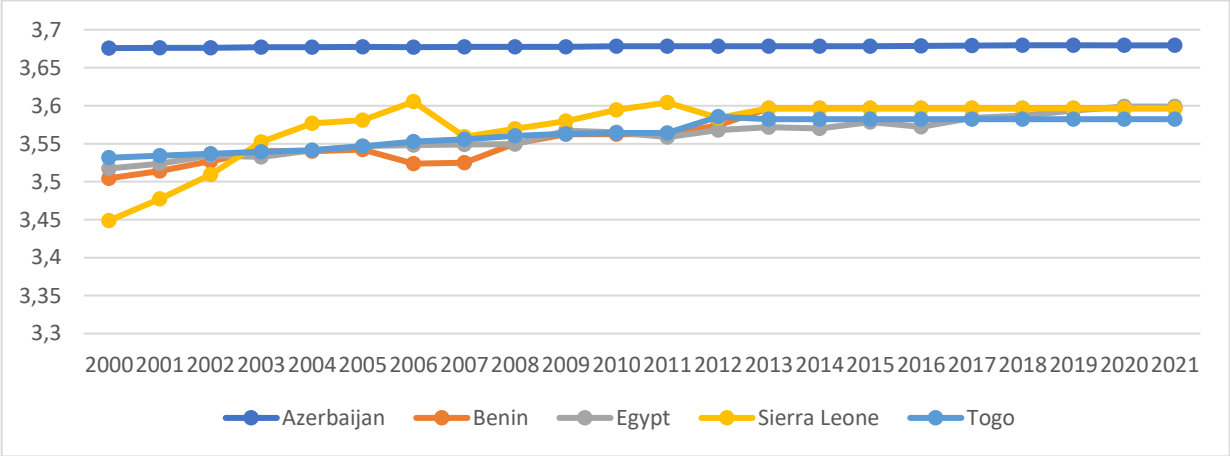
Among the countries in Club 8, Malaysia increased its agricultural land use rates as of 2009 and converged to the club average.

Iraq, on the other hand, started the period around the Club average and reduced the amount of land used as a result of the 2009 crisis, but maintained its trend towards the Club average towards the end of the period. Due to internal instability and insecurity, agricultural land has fluctuated and the displacement of people from agricultural production has had a negative impact on food security in Iraq[87]. The movement of people from areas of instability to unaffected areas has increased pressure on access to food. In addition, local and temporary

[86] Ibid., FAO, (2007), p.3.
[87] FAO, (2018), "FaO and Iraq: Partnering to Strengthen Recovery and Resilience", (https://www.fao.org/3/AU080E/au080e.pdf), (Date of access: 28.08.2023).

food problems, high prices and instability have increased the number of migrating households. Although public policies and external support have encouraged the recovery of agricultural production, it takes time for households to return to production.

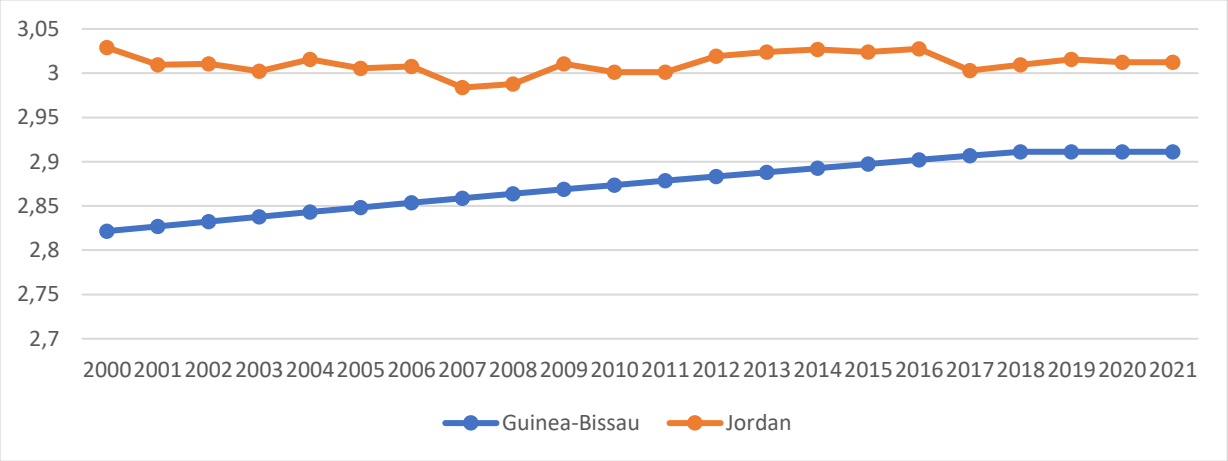
Figure 25. Relative Transition Paths of Countries in Club 9



The development of Sierra Leone in Club 9 is particularly noteworthy. The country, which possesses rich deposits of diamonds, gold and iron, has achieved relative stability with the end of the civil war in 2002 and the arrival of the United Nations peacekeeping force in 2005 to bring peace to the country[88]. In 2010, with the lifting of the embargoes imposed on the country, agricultural land use and agricultural production increased.

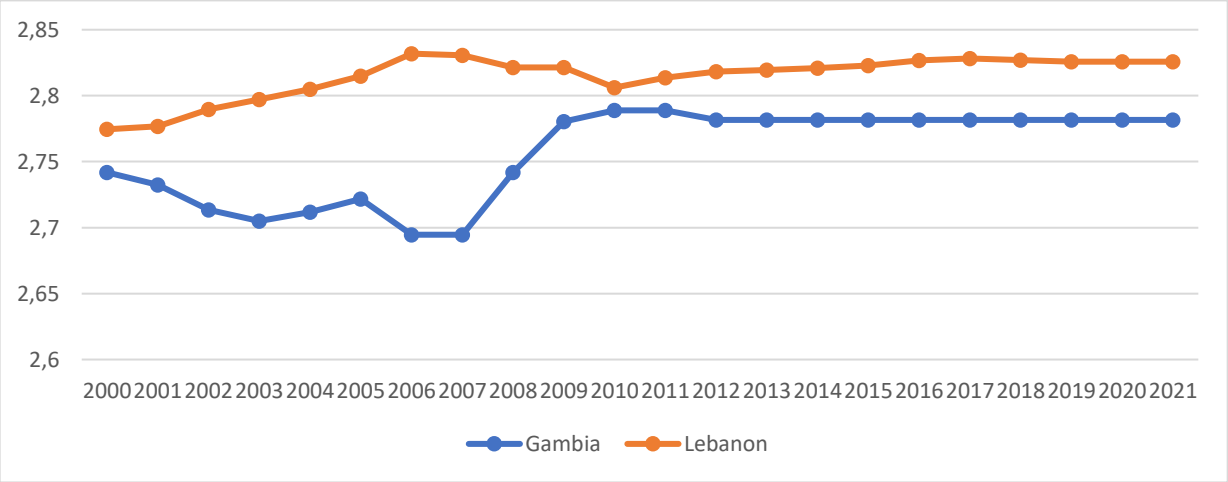
[88] MFA, (2023), "Sierra Leone'nin Siyasi Görünümü", (https://www.mfa.gov.tr/sierra-leone-siyasi-gorunumu.tr.mfa), (Date of access: 28.08.2023)

Figure 26. Relative Transition Paths of Countries in Club 10



Club 10 shows that Jordan has generally maintained its level of agricultural land use, while Guinea Bissau has steadily increased its agricultural area. Plagued by coups and political instability, the country remains well below its potential in terms of agricultural products and fisheries[89].

Figure 27. Relative Transition Paths of Countries in Club 11



[89] [89] MFA, (2023), "Guinea Bissau'nun Siyasi Görünümü", (https://www.disisleri.gov.tr/gine-bissau-ekonomisi.tr.mfa), (Date of access: 28.08.2023

In Club 11, Gambia has converged to Lebanon's development trajectory by increasing its agricultural land by 2008, after declining considerably between 2005 and 2007.

Agricultural Employment

Maintaining a young and healthy population is crucial to ensure the continuity of agricultural production, or increasing the productivity of a declining agricultural workforce. The rural population is decreasing day by day. At the very least, slowing down the rate of emigration of the young population is a necessity for the continuation of agricultural production.

Looking at the evolution of agricultural employment over time, it can be observed that it has decreased and continues to decrease in almost all countries. With the exception of Togo and Cameroon, these countries cannot cover their external agricultural trade with exports. In particular, Yemen, Sierra Leone, Senegal and the Comoros are not self-sufficient in agriculture.

Table 5. Agricultural Employment

Country	**$A_{emp.}$ average**	**$A_{employment}$ change**	**$A_{employment}$ (2021)**	**Country**	**$A_{emp.}$ Aver.**	**$A_{employment}$ change**	**$A_{employment}$ (2021)**
Afghanistan	53.81	-18.6	46.9	*Maldives*	12.59	-3.9	10.5
Albania	43.51	-16.1	34.6	*Mali*	66.28	0.7	67.7
Algeria	14.30	-11.9	10.3	*Mauritania*	35.8	-12.7	29.5
Azerbaycan	37.71	-6.8	34.2	*Morocco*	39.74	-9.4	34.6
Bahrain	1.2	-0.7	1	*Mozambique*	75.96	-12.7	70.3
Bangladesh	46.53	-23.7	37.1	*Niger*	75.59	-8	70.7

Benin	41.66	-23.7	28.1	*Nigeria*	41.16	-14.1	35.2
Brunei	1.37	-0.1	1.3	*Oman*	6.04	-2.3	4.1
Burkina Faso	78.97	-12	73.3	*Pakistan*	42	-7.6	37.5
Cameroon	54.11	-24	42.6	*Phalestine*	11.46	-7.4	6.7
Chad	74.41	-13.7	68.9	*Qatar*	1.79	-1.4	1.2
Comoros	45.33	-22.6	35	*Saudia Arabia*	5.70	-4.4	2.7
Ivory Coast	47.25	-5.7	45	*Senegal*	36.13	-27.7	21.6
Djibouti	1.77	-1.2	1.2	*Sierra Leone*	60.14	-26.5	42.7
Egypt	27.38	-9.8	19.8	*Somalia*	33.84	-12.1	26.3
Gabon	35.07	-11.8	29	*Sudan*	45.56	-11.1	40.6
Gambia	52.10	-5.4	48.5	*Suriname*	7.56	0.7	7.9
Guinea	65.41	-12.1	59.2	*Syria*	18.18	-20.4	12.5
Guinea-Bissau	57.25	-10.6	50.3	*Tajikistan*	51.25	-17.8	42.6
Guyana	19.6	-12.1	13.1	*Togo*	43.12	-25.9	30.9
Indonesia	37.56	-16.3	29	*Tunissia*	17.08	-7	13.9
Iran	18.85	-6.4	16.3	*Türkiye*	24.43	-18.9	17.1
Iraq	23.85	-7.5	19.8	*Turkmenistan*	30.31	-14	22.3
Jordan	3.66	-1	3.2	*Uganda*	69.12	-6.6	62.9
Kazakhstan	25.94	-21.2	15	*UAE*	4.15	-6.8	1.7
Kuwait	2.34	-0.4	2	*Uzbekistan*	29.11	-13.8	23.9
Krygyzstan	32.82	-36.5	16.6	*Yemen*	30.99	-21.5	28.1

Lebanon	4.32	-1.5	3.8	*OIC Average*	33.25	-11.58	27.66
Libya	18.77	-5.3	16.3	*World*	32.65	-13.43	26.6
Malaysia	13.15	-8.8	9.6	EU	7.26	-5.95	5.12

Source: FAO Statistics; $A_{employment}$average: The average (%) value of the ratio of agricultural employment to total employment for the years 2000-2021; $A_{employment}$ change: Change in agricultural employment between 2000-2021 (%); $A_{employment}$ (2021): Agricultural employment rate for 2021 (%).

Table 6. OIC Convergence Clubs for Shares of Agricultural Employment

Clubs	**Countries**
Club 1 (5 Members)	| Burkina Faso | Chad | Mali | Mozambique | Niger |
Club 2 (2 Members)	| Gambia | Guinea-Bissau |
Club 3 (12 Members)	| Afghanistan | Albania | Azerbaijan | Bangladesh | Cameroon | Ivory Coast | Morocco | Nigeria | Pakistan | Sierra Leone | Sudan | Tajikistan |
Club 4 (8 Members)	| Benin | Comoros | Gabon | Indonesia | Mauritania | Somalia | Togo | Yemen |
Club 5 (6 Members)	| Egypt | Iraq | Libya | Senegal | Türkmenistan | Uzbekistan |
Club 6 (6 Members)	| Guyana | Iran | Kazakhstan | Kyrgyzstan | Tunissia | Türkiye |
Club 7 (5 Members)	| Algeria | Malaysia | Maldives | Suriname | Syria |
Club 8	| Jordan | Lebanon | Oman | Saudi Arabia |

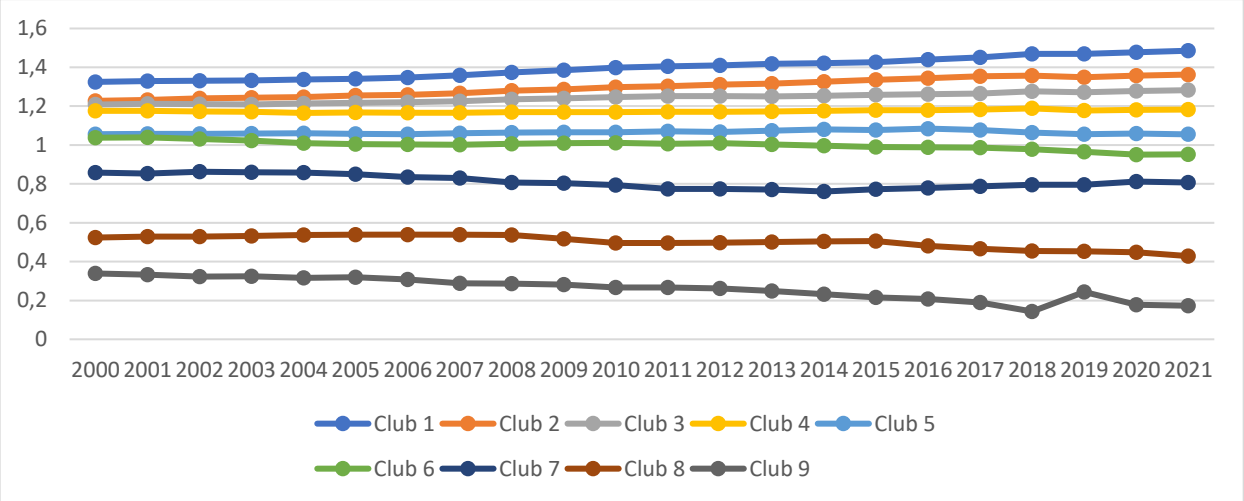
(4 Members)	
Club 9 (4 Members)	| Brunei-Darrussalam | Kuwait | United Arab Emirates |
Not Convergent Group	| Bahrain | Djibouti | Guinea | Palestine | Qatar | Uganda |

The 5 countries in the first club are those with the highest shares of agricultural employment in total employment. However, the analysis makes the grouping according to the trend of changes in the structure of agricultural employment over time along with this shares. In other words, while the agricultural employment shares of the countries in the first club are close to each other, the rates of change in the 20-year trends are also similar. Therefore, in a possible policy proposal concerning only agricultural employment, the countries in the first club can be assessed together. From another point of view, the 6 countries in the not converging group are not similar to others either in terms of employment shares or in terms of the direction and rate of change of this employment.

The share of agricultural employment is around 1-1.2 per cent in Bahrain, Djibouti and Qatar, 6.7 per cent in Palestine and 59.2 and 60.9 per cent in Guinea and Uganda, which are in the non-convergence group. Trends over time are also characterised by sudden increases and decreases. For example, the share of agricultural employment in Bahrain has been around 1 per cent. No other country shows such a convergence. In Uganda, the share of agricultural employment, which was 69.5 per cent in 2000, increases to 75.3 per cent in 2005, decreases to 66.1 per cent in 2012, increases to 71.9 per cent in 2013 and decreases to 62.9 per cent in 2021.Uganda, which is home to various ethnic and religious groups, has been the scene of ethnic, religious and political instability for many years. The environment of instability in the country worsened after the 2002 elections, and a relatively stable environment was achieved after the 2005 multi-party elections, directly affecting the

agricultural labor force, which is the main source of livelihood.[90]. Similarly, the major shifts that took place in these periods are not similar to those in any other country.

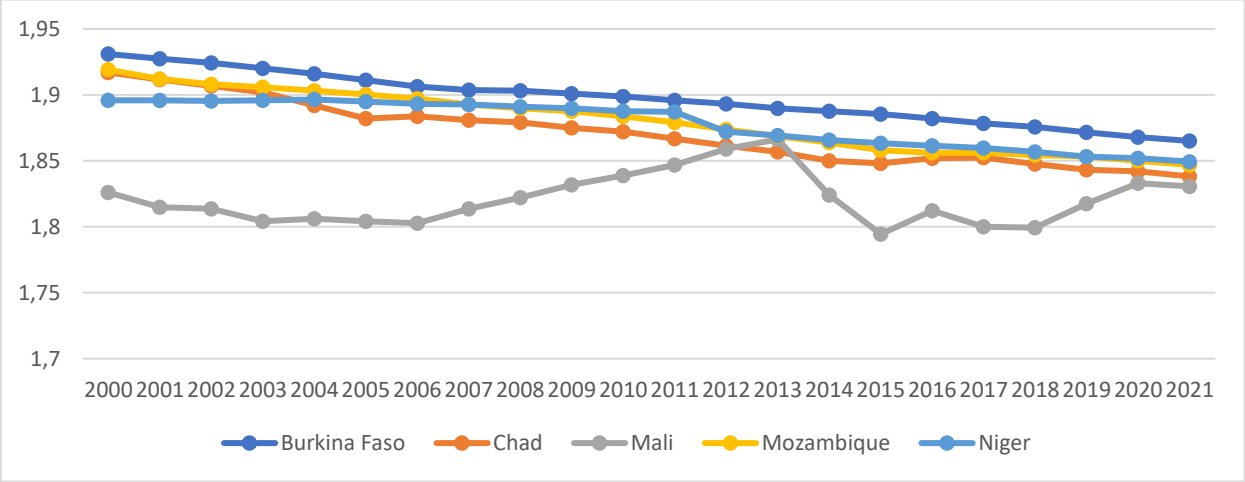
Figure 28. Relative Transition Paths of Clubs



The trajectory of the clubs in which countries' agricultural employment shares are located is shown in Figure 28. In this framework, a more detailed look at the countries in the clubs shows that the agricultural employment rates of Burkina Faso, Chad, Mozambique and Niger, which are in club 1, have been decreasing steadily. Mali, on the other hand, is close to the other 4 countries in its end-of-period rate, but follows a fluctuating path. At the baseline, Mali's agricultural employment rate started at a lower level than the other 4 countries. While Mali's agricultural employment rate was 67 percent in 2000, it increased by 0.7 percent to 67.7 percent in 2021.

[90] WB, (2023), "Employment share in Agriculture (% of total employment)-Uganda", (https://data.worldbank.org/indicator/SL.AGR.EMPL.ZS?locations=UG), (Date of access: 20.08.2023).

Figure 29. Relative Transition Paths of Countries in Club 1

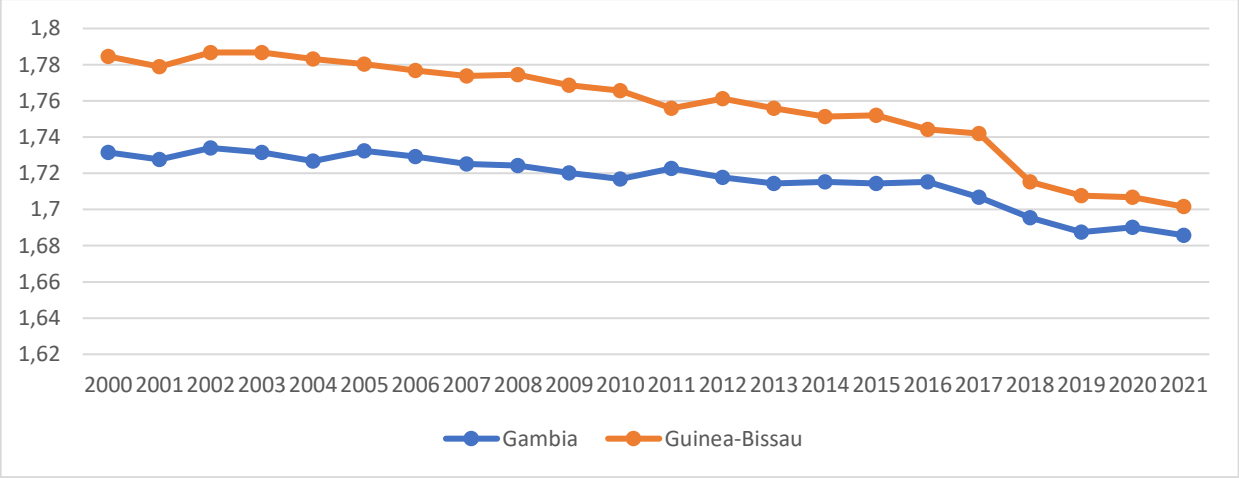


Because of its desert climate, 33 per cent of Mali's land can be used for agriculture, and the country has a trade surplus in agricultural products. The country, which grows and sells mainly sorghum and cotton lint in the Niger River basin, focuses on freshwater fishing, meat and milk production.[91]. The country, where 65 per cent of the population is under 25, is rich in gold mines. Yet the country has seen periodic improvements after the coups of 1991, 2012 and 2020, but the process of instability continues. Despite the lack of modern irrigation techniques and storage areas in Mali, where major investments have been made in the agricultural sector, productivity growth has reached 273 percent, but the disruption of agricultural production due to political instability obscures the country's true potential[92]. In 2015, in an environment of relative stability, the country made significant progress in

[91] SESRIC, (2023), "OIC Countries in Figures: Mali-Economic and Sectors", (https://www.sesric.org/cif.php?c_code=34), (Date of access: 15.09.2023).
[92] MFA, (2023), "Mali'nin Siyasi Görünümü", (https://www.mfa.gov.tr/mali-siyasi-gorunumu.tr.mfa), (Date of access: (15.09.2023).

reducing the level of undernourishment in line with the Growth and Poverty Reduction Strategy, but it regressed to its previous level as a result of the disruption of order[93].

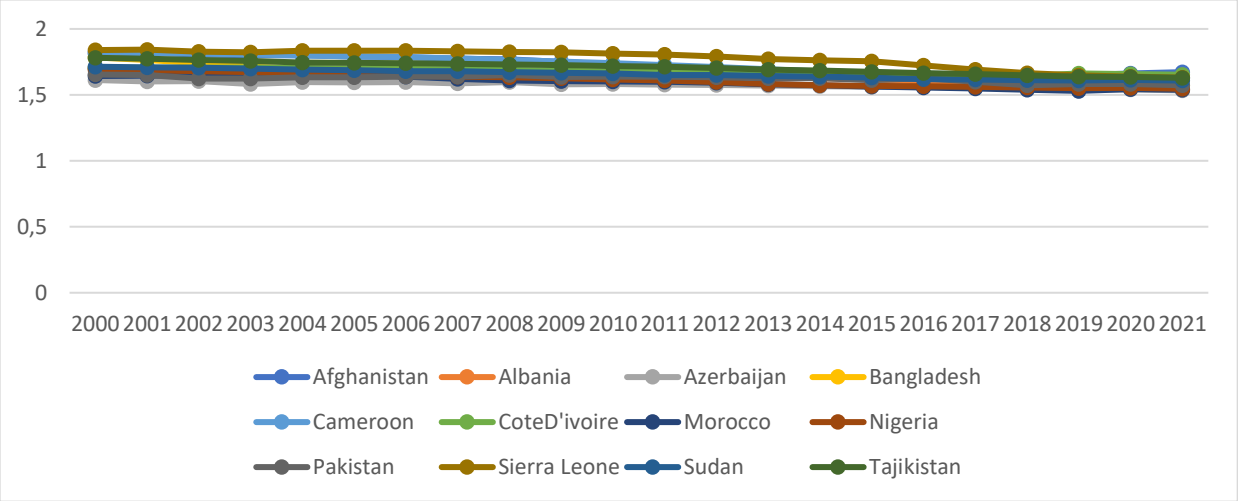
Figure 30. Relative Transition Paths of Countries in Club 2



Gambia and Guinea-Bissau in Club 2 are bordering countries located on the West African coast. With very similar climatic conditions, the countries have similar production structures in crop and meat production. While the average agricultural employment rate in Guinea-Bissau is 57.25 percent, it is 52.10 percent in Gambia. At the beginning of the analysis period, the rates were relatively distant from each other at 61 percent and 54 percent, respectively, but they converged during the period as a result of the decline of 10.6 percent in Guinea Bissau and 5.4 percent in Gambia. At the end of the analysis period, the agricultural employment rate declined to 49 percent in Gambia and 50 percent in Guinea Bissau, bringing the two countries quite close to each other.

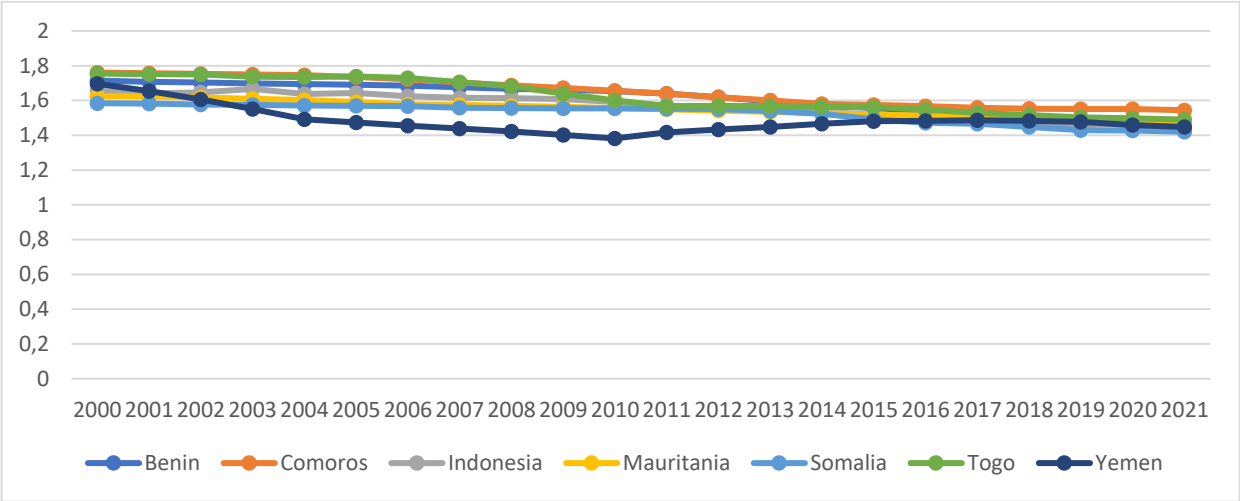
[93] FAO, (2017), "Country Fact Sheet on Food and Agriculture Policy Trends: Mali", p.2., (https://www.fao.org/3/i7617e/i7617e.pdf), (Date of access: 15.09.20239,

Figure 31. Relative Transition Paths of Countries in Club 3



Club 3 in Figure 31 comprises 12 countries. The countries' agricultural employment levels at the beginning of the period converged towards the end of the period, with an increasing tendency to decline. For example, Azerbaijan, Pakistan, Morocco and Albania are countries with different climates and continents, different natural resources and soil structure, different population and population structure and different geographical sizes. Albania is located in Europe, Azerbaijan in the Middle East, Pakistan in Asia and Morocco on the Mediterranean coast. Agricultural employment in Morocco and these countries at the beginning of the period was 51 per cent for Albania, 41 per cent for Azerbaijan, 44 per cent for Morocco and 42 per cent for Pakistan. The decline in agricultural employment over time was (16.1), (6.8), (9.4) and (7.6) percent in that order. Average agricultural employment rates were 44, 38, 40 and 42 percent, respectively. At the end of the analysis period, employment rates dropped to 35, 34, 35, 37 percent, respectively. In summary, agricultural employment rates at similar levels in countries with different structures show that they have a very similar pattern of employment, with a similar trend and consistency of decline compared with other countries.

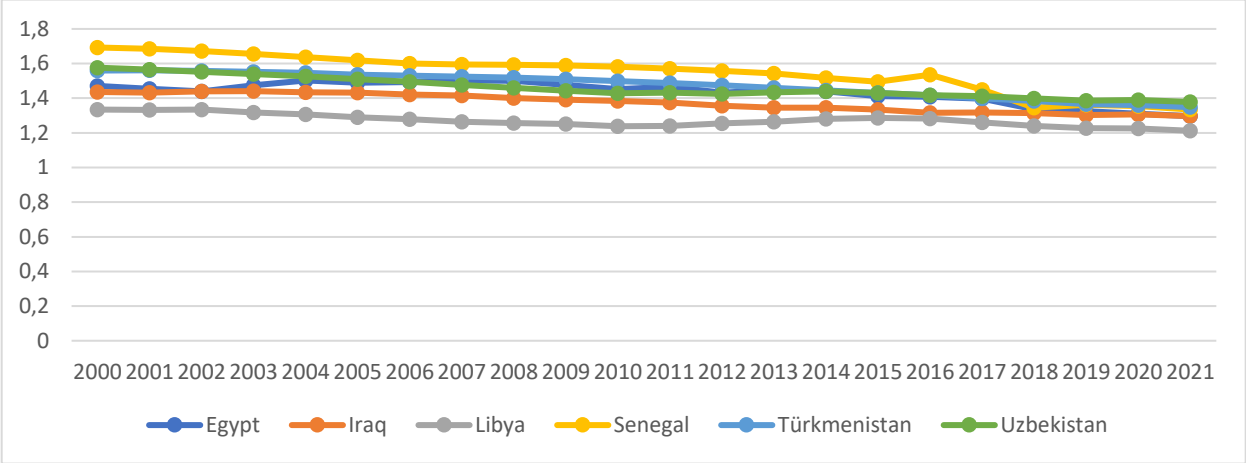
Figure 32. Relative Transition Paths of Countries in Club 4



The decline in the rate of agricultural employment in the countries in Club 4 follows a very similar course. Although Yemen remained below the club average with a decline in the agricultural employment rate between 2003 and 2013, it has been on an upward trend since then. Oil revenues account for about 70 percent of Yemen's GDP, while the rest comes from agricultural production. The average level of agricultural employment in the country is 31 percent, while the level at the beginning of the period was 50 percent. The level of employment, which started to decline in 2003, started to recover, reaching 27 percent in 2012. Climate change, ethnic conflicts and security concerns are pulling the agricultural sector away from a stable structure[94]. As a result of internal instability, a significant part of the population has become detached from production and has become dependent on humanitarian aid[95].

[94] FAO, (2017), "Country Fact Sheet on Food and Agriculture Policy Trends: Yemen", (https://www.fao.org/3/i4127e/i4127e.pdf) , p.1., (Date of access: 26.09.2023).
[95] MFA, (2023), "Yemen Ekonomisi", (https://www.mfa.gov.tr/yemen-ekonomisi.tr.mfa), (Date of access: 26.08.2023).

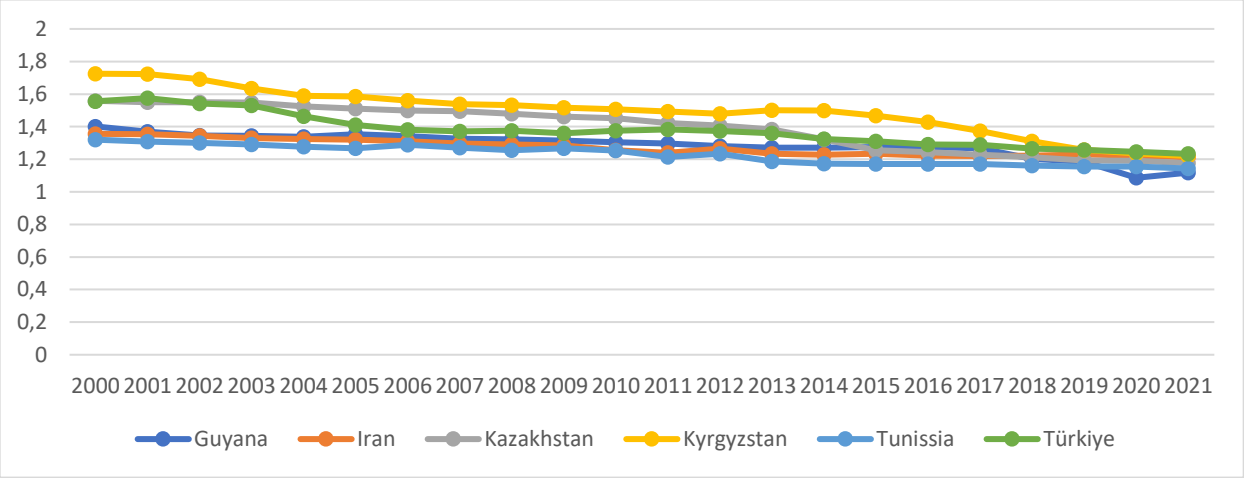
Figure 33. Relative Transition Paths of Countries in Club 5



The countries in Club 5, with the exception of Senegal's 2015-2017 breakdown, show a downward trend in agricultural employment consistent with each other. In Senegal, which entered a new era with the 2000 elections, the social unrest that started in the 2012 presidential elections relatively continued until the 2019 elections[96]. In the West African country with natural gas and oil deposits, despite the agriculture sector's 18 percent share in GDP, 75 percent of the young population and 69 percent of the total population are employed in the agricultural sector[97] . Agricultural production and agricultural employment are closely linked to stability and confidence in the semi-arid climate zone with this agriculture-based economy[98]. Access to water and irrigation, climate shocks and drought, and lack of access to land are seen as the most important obstacles to the agricultural sector and the inability to reduce poverty[99].

[96] MFA, (2023), "Senegal Siyasi Görünümü", (https://www.mfa.gov.tr/senegal-siyasi-gorunumu.tr.mfa), (Date of access: 26.08.2023).
[97] FAO, (2017), "Country Fact Sheet on Food and Agriculture Policy Trends: Senegal", (https://www.fao.org/3/i4841e/i4841e.pdf), p.1., (Date of access: 26.09.2023).
[98] MFA, (2023), "Senegal Siyasi Görünümü", (https://www.mfa.gov.tr/senegal-siyasi-gorunumu.tr.mfa), (Date of access: 26.08.2023).
[99] FAO, (2017), "Country Fact Sheet on Food and Agriculture Policy Trends: Senegal", (https://www.fao.org/3/i4841e/i4841e.pdf), p.1., (Date of access: 26.09.2023).

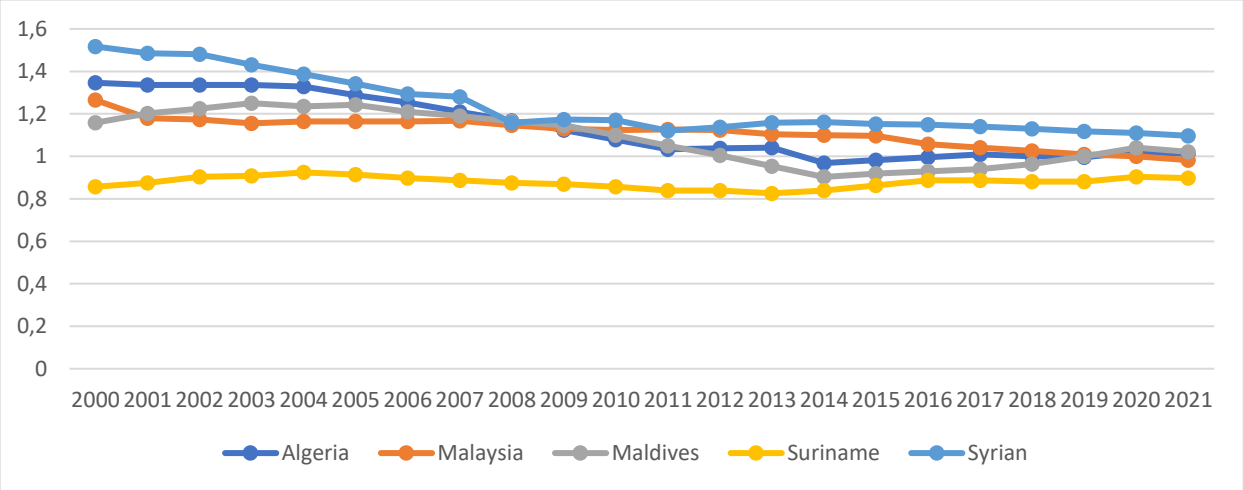
Figure 34. Relative Transition Paths of Countries in Club 6



Among the countries in Club 6, Kyrgyzstan's agricultural production to GDP ratio declined from 35 percent at the beginning of the period to 21 percent. The agricultural employment rate showed a higher decline, falling from 53 percent to 17 percent at the end of the period. In the post-2000 economic restructuring process, the gold mines and agricultural production are the country's main economic drivers, while malnutrition and related issues are seen as a priority of the country's efforts[100]. Agricultural land in the northern parts of the country accounts for 60 per cent of production, while the southern parts produce 30 per cent. Political and economic instability and climatic shocks have negatively affected the country's agriculture, where growth-oriented policies such as land reform and market-oriented production were implemented after 2000 to close this gap. Investment in the sector has been inadequate, modern technology has not been adopted, and the deterioration of pastures in particular has led to a decline in livestock numbers and a decline in the production and welfare of smallholders[101].

[100] FAO, (2017), "Country Fact Sheet on Food and Agriculture Policy Trends: Kyrgyz Republic", (https://www.fao.org/3/I8701EN/i8701en.pdf) , p.1., (Date of access: 26.09.2023).
[101] Ibid., FAO (2017), p.2.

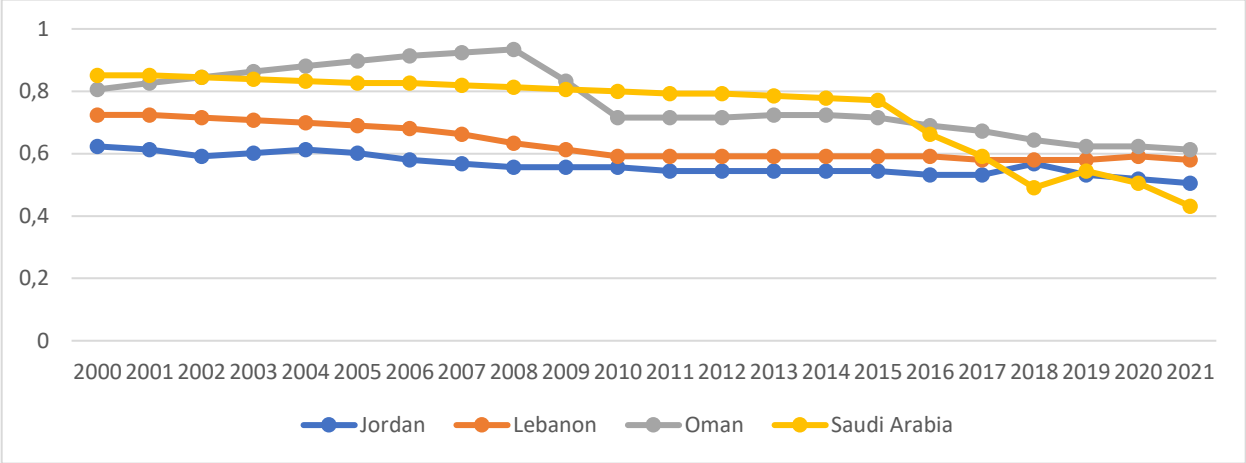
Figure 35. Relative Transition Paths of Countries in Club 7



Among the Club 7 countries, Suriname appears to have a level of agricultural employment below the Club average, but relatively maintained its level of change throughout the analysis period, while other countries showed a downward trend, approaching Suriname's level of agricultural employment at the end of the period. Among these countries, Syria, which had a high level of agricultural employment, experienced a relatively high break in the downward trend in 2004 and 2011 compared to the Club average. The Damascus Declaration of 2005 and social unrest escalated in 2011, resulting in the displacement or death of about 7 million people[102]. While agricultural production accounted for 25 percent of GDP in 2000, with agricultural employment at 33 percent, it started to decline in 2005. In 2008, agricultural employment dropped to 15 percent and the share of agricultural production in GDP fell to 19 percent. After 2014, the share of agricultural production in GDP remained around 20 percent, while agricultural employment continues to decline[103].

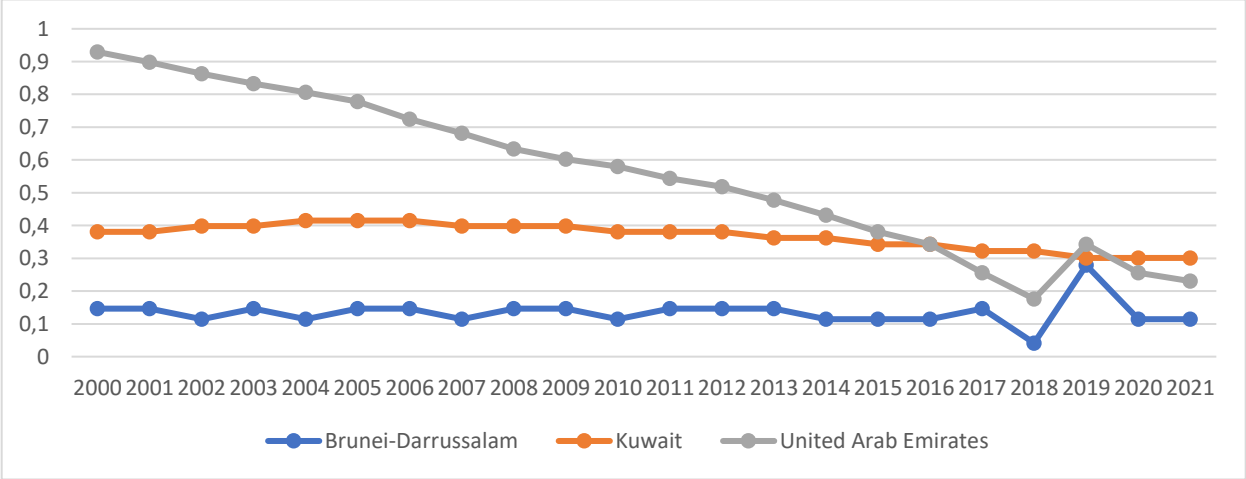
[102] MFA, (2023), "Suriye Siyasi Görünümü", (https://www.mfa.gov.tr/suriye-siyasi-gorunumu.tr.mfa), (Date of access: 26.08.2023).
[103] SESRIC, (2023), "OIC Countries in Figure: Syria: National Accounts", (https://www.sesric.org/cif.php?c_code=50), (Date of access: 26.08.2023).

Figure 36. Relative Transition Paths of Countries in Club 8



Among the Club 8 countries, the sharp decline in agricultural employment in Oman between 2008-2010 and the downward trend in Saudi Arabia after 2015 are notable. In the country where crude oil and its derivatives and nitrogen fertilizer exports are considered important income sources, it is believed that agricultural employment shifted to these sectors as a result of the revival of tourism and increased investments in the fishing sector. In 2008, despite increasing tourism revenues, the downward trend in agricultural employment and the decline in the share of agricultural production in GDP from 2.04 to 1.57 leads us to this interpretation.

Figure 37. Relative Transition Paths of Countries in Club 9



In club 9, Brunei, and Kuwait have relatively maintained their employment rates relative to the level at the beginning of the period. There was a period of instability in Brunei between 2017 and 2020. Agricultural employment increased significantly and returned to previous levels. In the United Arab Emirates (UAE), FAO launched a blue transformation programme to increase the efficiency of aquaculture products and their inclusion in the diet. The programme, which includes Bahrain, Oman, the UAE and Yemen, combines food security, economic growth and sustainable use of natural resources. It recommends increasing and diversifying aquaculture production for food security and healthy diets in the country, where climate-related investments in technology and innovation are shifting towards aquaculture production. In this context, the unwillingness of the population to engage in agricultural production in the UAE and the shift of agricultural employment from crop production to aquaculture production are considered to be influential in the decline of employment.

Pesticide in Agricultural Sector

Pesticide use in the OIC group shows an average increase of 27.56 percent compared to the beginning of the period. This increase is 30% for the world average and 4.18% for the EU average. Pesticide use in the OIC member countries varies considerably. While Oman, Mozambique, Cameroon, Burkina Faso, Cameroon, Burkina Faso and Brunei experienced the highest increases in pesticide use, Comoros, Guinea, Iran, Iraq, Libya, Mali, Niger, Pakistan, Tajikistan and Yemen experienced decreases. Although the reasons vary from country to country, the type of crops grown, input prices and national regulatory practices all have an impact on pesticide use.

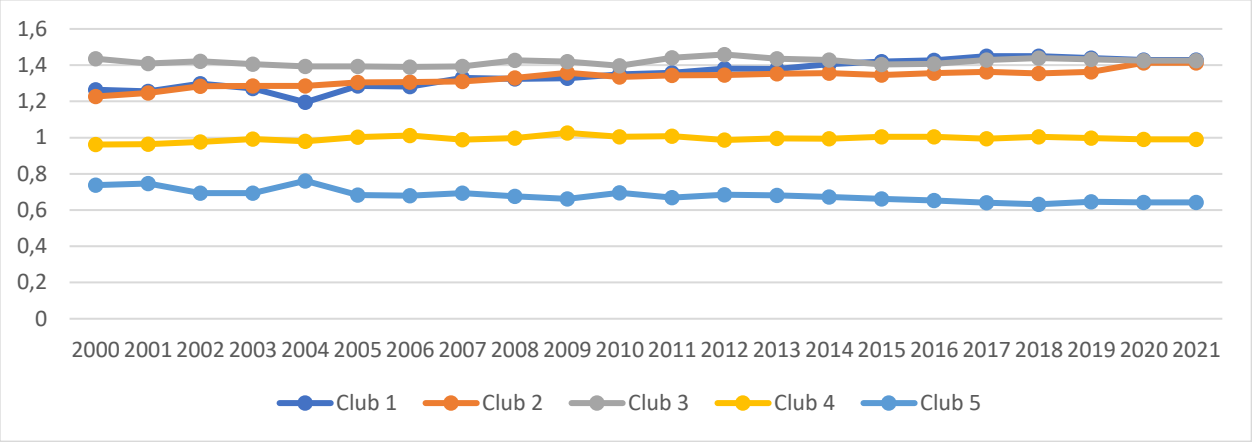
OIC member countries are divided into 6 clubs according to the use of pesticides. Countries in the first club are the countries with the highest increase in pesticide use in Table 6. Club 6 covers the countries with the largest decreases. Iran has not converged with any country in pesticide use. While detailed explanations on the change in pesticide use are provided in Table 6, pesticide use decreased in Comoros, Ivory Coast, Guinea, Iran, Iraq,

Libya, Mali, Mauritania, Niger, Pakistan, Tajikistan and Yemen compared to the beginning of the period.

Table 7. OIC Convergence Clubs for Pesticide Use

Clubs	**Countries**
Club 1 (6 Members)	| Burkina Faso | Cameroon | Kazakhstan | Malaysia | Togo | Türkiye |
Club 2 (4 Members)	| Bangladesh | Morocco | Oman | Saudi Arabia |
Club 3 (5 Members)	| Algeria | Egypt | Pakistan | Tunissia | Türkmenistan |
Club 4 (17 Members)	| Albania | Azerbaijan | Brunei-Darrussalam | Gambia | Guyana | Indonesia | Jordan | Kyrgyzstan | Lebanon | Libya | Maldives | Mozambique | Palestine | Senegal | Suriname | Syria | | Tajikistan |
Club 5 (12 Members)	| Bahrain | Chad | Ivory Coast | Guinea | Guinea-Bissau | Iraq | Kuwait | Mauritania | Niger | Qatar | Uganda | Yemen |
Club 6 (2 Members)	| Comoros | Mali |
Not convergent Group	| Iran |

Figure 38. Relative Transition Paths of Clubs



Regarding pesticide trade, it can be observed that almost all countries import this input[104]. Indonesia was an exporter until 2016, while Jordan and Malaysia were pesticide exporters in certain years. Therefore, countries' pesticide use is directly associated with input prices in the absence of input subsidies. In this context, the countries that use the most pesticides are given in Club 1. Bahrain, Guyana, Nigeria and Qatar are the countries that do not converge to any country in pesticide use.

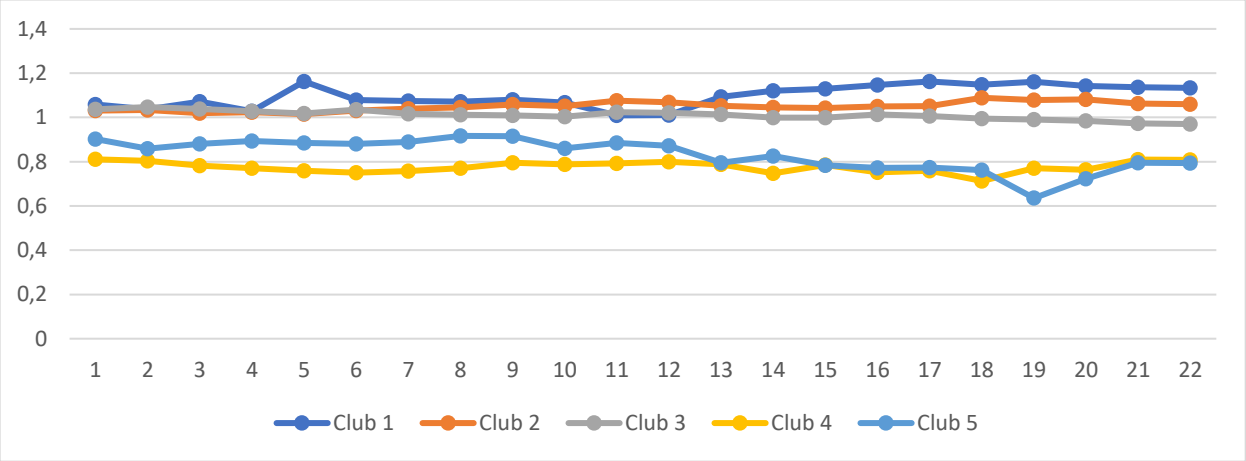
Figure 39. OIC Convergence Clubs for Pesticide Import

Clubs	**Countries**
Club 1 (6 Members)	| CoteD'iv oire | Indonesia | Malaysia | Mauritania | Mozambique | Türkiye |
Club 2 (12 Members)	| Algeria | Azerbaijan | Benin | Cameroon | Egypt | Kazakhstan | Kyrgyzstan | Maldives | Morocco | Pakistan | Uganda |
Club 3 (10 Members)	| Burkina Faso | Jordan | Kuwait | Lebanon | Oman | Palestine | Saudi Arabia | Senegal | Togo | Tunissia |
Club 4	| Brunei-Darrussalam | Comoros | Suriname | Yemen |

[104] FAOSTAT, (2023), "Pesticides Trade", (https://www.fao.org/faostat/en/#data/RT), (Date of access: 26.08.2023).

(4 Members)	
Club 5 (2 Members)	| Albania | Niger |
Not convergent Group	| Bahrain | Guyana | Nigeria | Qatar |

Figure 40. Relative Transition Paths of Clubs



Fertilizer and Seeds

The chemical fertilizer sector has grown by 12.75% over the last 10 years. Chemical fertilizer production increased by 50.11 percent and consumption by 47.38 percent. Russia, China, the USA and OIC member Morocco are the world's largest exporters of chemical fertilizers. In terms of volume, the average imports of OIC members were 4.88 times exports in 2020, 12.42 times in 2021 and 19.57 times in 2022. Chemical fertilizer prices, which started to rise with the pandemic, peaked with the Russia-Ukraine war and started to fall from July 2022. Nevertheless, import values per tonne were higher than export values on average in the OIC, except in 2022.

Figure 41. Summary of Fertilizer Foreign Trade

OIC Average[105]	2020	2021	2022
$X_{Fertilizer}$ / X_{Total}	% 35	%19	%14
$M_{Fertilizer}/M_{Total}$	%64	%56	%71
$X_{Ton/\$}$	305,31($)	406,07($)	658.77($)
$M_{Ton\$}$	480.39($)	453.34($)	545.81($)

Fertilizer use in the OIC group is generally increasing in line with rising production and the expansion of agricultural land, but remains well below the world average. In 2017, the world average of fertilizer use per hectare was 141.9 kg, while the OIC average was 85.9 kg. Fertilizer, which is associated with productivity growth, is the commodity most supported by governments among agricultural inputs. The situation in terms of productivity should be assessed together with agricultural mechanisation, and the advantageous position of the OIC group compared to the world average in terms of its impact on climate change should be taken into account.

Agricultural producers use two types of fertilizer: animal manure and chemical fertilizers. Manure is a by-product of animal husbandry and is a very valuable product in the life cycle, providing the nutrients needed by plants (nitrogen, phosphorus, potassium, copper and zinc) in an organic manner.[106]. It is recognised that higher yields in crop production are achieved by intensively feeding the soil and plants. The key is to match the amount of fertilizer to the type of crop. In other words, the amount of fertilizer to be used per crop is important, rather than per hectare[107]. It is also a free input on farms where livestock and

[105] Calculated from Ibid.
[106] Wageningen, (2023), "Manure Management", (https://www.wur.nl/en/article/manure-management.htm), (Date of access: 16.08.2023).
[107] P.J. Brandjes, J. de Wit, H.G. van der Meer, (1996), "Environmental Impact of Animal Manura Management", H.Van Kelun International Agriculture Centre, (https://www.fao.org/3/X6113E/x6113e00.htm#Contents), (Date of access: 20.08.2023).

crop production are combined. However, it is argued that phosphate and nitrate in manure that is applied directly to land without treatment pollute ground and surface water, and that ammonia and nitrogen emissions acidify soils and damage biodiversity. So manure is being processed into new energy sources or bio-based products, raising concerns about the environment and global warming. Even when farmers process their manure to a high quality, there are limits to the amount that can be used and it is sent to areas where there is a shortage. However, the use of livestock manure by farmers depends on the amount and price of chemical fertilizer.

To ensure food sovereignty, sustainability and self-sufficiency in agricultural production in OIC member countries, livestock and crop production should be maintained together. While this practice exists in some countries such as Nigeria, it is questionable in countries such as Türkiye where industrial livestock production has become a separate specialisation. It should be noted that the decoupling of livestock and crop production makes access to animal manure a cost factor for agricultural producers.

For the OIC group, the use of animal manure and chemical fertilizers was analysed separately. This was done in order to assess the contribution and cost of animal manure use to agricultural production and the pollution that occurs both before and after the use of animal manure in the OIC countries.

In Table 9, countries are grouped according to fertilizer use data in kilograms applied to soil and 12 different clubs are obtained. Animal manure data from FAOSTAT does not indicate whether manure is applied per crop or per hectare. In this analysis, it is assumed that fertilizer is used according to the needs of the crops grown due to financial difficulties and agricultural production traditions in the OIC group, which is mainly dominated by small producers, but since the SESRIC report provides data on fertilizer use per hectare, it is assumed that fertilizer is applied per hectare[108]. FAO presents animal manure data by estimating nitrogen (N) content. Country-based data were obtained based on the

[108] SESRIC, (2020),"Agriculture and Food Security in OIC Countries" (https://sesricdiag.blob.core.windowpnet/sesric-site-blob/files/article/748.pdf), p.11.

Intergovernmental Panel on Climate Change (IPCC) Guidelines using the animal stock statistics of the countries. In the study; N released to nature through manure use (as the sum of evaporation and leaching), N released to pasture (as the sum of evaporation and leaching) were utilized from data.[109].

Table 8. OIC Convergence Clubs for Manure Application to Soils

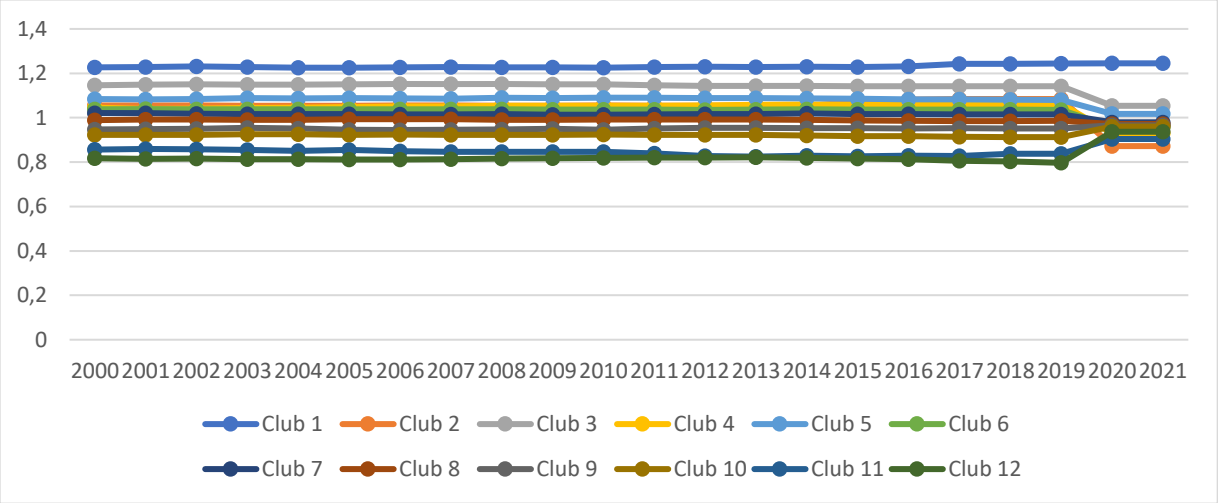
Clubs	**Countries**
Club 1 (2 Members)	| Indonesia | Pakistan |
Club 2 (4 Members)	| Bahrain | Bangladesh | Iran | Uzbekistan |
Club 3 (2 Members)	| Kazakhstan | Nigeria |
Club 4 (6 Members)	| Chad | Malaysia | Sierra Leone | Tajikistan | Türkiye | Türkmenistan |
Club 5 (3 Members)	| Afghanistan | Burkina Faso | Uganda |
Club 6 (6 Members)	| Albania | Cameroon | Mali | Morocco | Niger | Togo |
Club 7 (7 Members)	| Algeria | Ivory Coast| Egypt | Guinea | Mozambique | Saudi Arabia | Senegal |
Club 8 (7 Members)	| Azerbaijan | Benin | Iraq | Lebanon | Somalia | Tunissia | Yemen |
Club 9 (4 Members)	| Guinea-Bissau | Guyana | Kuwait | Mauritania |

[109] FAOSTAT, (2023), "Livestock Manure", (https://www.fao.org/faostat/en/#data/EMN), (Date of access: 24.08.2023).

Club 10 (5 Members)	| Brunei-Darrussalam | Gabon | Libya | Syria | United Arab Emirates |
Club 11 (2 Members)	| Gambia | Palestine |
Club 12 (2 Members)	| Djibouti | Qatar |
Not convergent Group	| Comoros | Jordan | Kyrgyzstan | Oman | Suriname |

In fertilizer clustering, where 5 countries did not converge with any other country, the animal fertilizer use rates of the 12 groups of countries at the beginning of the period appear to be higher than the rates at the end of the period. The general trend is that countries are reducing their use of animal fertilizers and turning to chemical fertilizers. Considering the analyses made in the sub-headings related to chemical fertilizers produced according to nitrogen, potash and phosphate contents, it is noteworthy that the rate of use of nitrogen-containing chemical fertilizers between the clubs tends to increase, while other types of chemical fertilizers do not experience significant changes. Therefore, OIC member countries have partially compensated for the decreasing trend in the use of animal fertilizers with nitrogen-based chemical fertilizers and partially reduced the use of fertilizers.

Figure 42. Relative Transition Paths of Clubs



Data on the processing of manure left on pasture and the application of treated manure to the soil were computed from FAO data[110]. The rate of processing of manure left on pasture is 23.51 percent in the OIC average, while the world average is 40.51 percent, the EU average is 232.84 percent and the Netherlands average is 410.02 percent. The rate of use of the processed manure on soil is 91.12 percent in the OIC average, 79.99 percent in the world average, 75.35 percent in the EU average and 73.13 percent in the Netherlands average. Although this ratio varies among OIC countries, it is observed that the EU, which stands out with its agricultural production, and the Netherlands in particular, is processing and predominantly using animal manure. In the OIC group, the opposite is the case. Rates of animal manure utilization are mentioned in the discussion of country-specific clubs.

Table 9. Some Indicators Related to Manure

Country	**P(C)**	**F (C)**	**M (C)**	**M(T)**	**M(A)**	**F (ha)**	**M (ha)**	**P (ha)**
Afghanistan		1.264.52	15.96	20.34	89.93	0.01	9.18	0.000

[110] FAOSTAT, (2022), "FAOSTAT Domain Livestock MAnure. Dataset Information: Livestock Manure", (https://fenixservices.fao.org/faostat/static/documents/EMN/EMN_e.pdf), (Date of access: 24.08.2023).

Albania	145.64	225.22	-28.67	92.55	72.99	0.09	59.57	0.001
Algeria	139.12	68.69	54.63	4.86	95.09	0.02	2.92	0.001
Azerbaijan	265.09	5267.25	44.98	6.33	90.35	0.03	6.87	0.000
Bahrain	5.66	476.48	201.77	26.01	99.47	1.14	198.82	0.000
Bangladesh	389.16	94.46	59.76	23.11	93.83	0.23	28.08	0.000
Benin		219.85	66.42	9.94	92.20	0.01	4.42	0.000
Brunei	878.10	5.51	86.76	118.03	97.53	0.19	989.10	0.000
Burkina Faso	998.09	203.88	94.75	8.28	92.60	0.01	9.14	0.000
Cameroon	1243.41	80.08	9.32	10.28	93.04	0.01	5.60	0.000
Chad	0.00		231.11	2.27	90.25	0.00	7.76	0.000
Comoros	-95.71		4.93	4.02	91.67	0.00	2.48	0.000
Ivory Coast	-4.87	170.59	87.03	10.13	94.15	0.03	3.78	0.000
Djibouti	0.00		1.36	2.49	90.05	0.00	396.63	0.000
Egypt	130.23	26.46	-36.08	5.91	87.85	0.51	10.11	0.000
Gabon	0.00	2.204.54	12.83	56.37	94.61	0.02	10.61	0.000
Gambia	114.60	-57.09	40.49	4.17	88.90	0.00	2.51	0.000
Guinea	-51.99	564.31	194.93	4.29	88.46	0.00	3.45	0.000
Guinea Bissau	97.59		64.10	18.26	93.16	0.00	23.05	0.000
Guyana	58.29	76.01	19.99	61.77	94.73	0.04	13.96	0.000
Indonesia	0.00	161.79	106.71	77.29	83.75	0.20	27.60	0.000
Iran	-37.67	-23.07	-10.65	30.16	97.34	0.08	19.61	0.000

Iraq	-48.18	-26.14	24.91	6.30	94.97	0.05	2.78	0.000
Jordan	22.06	-15.31	64.50	6.45	98.51	0.11	15.98	0.000
Kazakhstan	379.17	345.27	128.96	61.36	71.63	0	5.20	0.000
Kuwait	0.00	1.328.69	64.36	21.29	99.71	0.46	449.64	0.000
Kyrgyzstan	1.72	-0.15	64.87	56.56	72.45	0.02	29.11	0.000
Lebanon	0.00	-35.59	54.63	19.57	98.76	0.25	44.67	0.000
Libya	-71.90	-53.56	77.74	4.11	97.01	0.03	3.04	0.000
Malaysia	-8.45	35.69	65.15	118.94	88.90	1.82	85.60	0.000
Mali	-92.80	499.10	149.06	3.48	90.57	0.02	4.42	0.000
Mauritania	-32.44		34.64	2.67	93.30	0	20.50	0.000
Mozambique	1190.80	343.06	42.58	22.17	93.92	0.01	5.49	0.000
Niger	-64.31	129.45	122.41	3.19	89.58	0	1.52	0.000
Nigeria		265.97	69.48	7.80	93.96	0.01	4.56	0.000
Oman	3653.01	327.47	97.43	2.59	89.82	0.42	31.03	0.000
Pakistan	-57.43	61.99	81.87	29.76	93.26	0.13	20.86	0.000
Palestine	6.70		-0.25	6.62	98.10	0	13.50	0.000
Qatar	0	900	192.26	5.08	98.87	0.17	41.85	0.000
Saudi Arabia	139.93	-22.16	44.25	7.71	98.87	0.09	5.56	0.000
Senegal	17.54	111.70	47.53	5.74	97.72	0.01	5.29	0.000
Sierra Leone			145.47	6.63	94.43	0	2.45	0
Somalia			-3.73	2.82	92.34	0	18.51	0

Sudan	65.32	125.67	5.23	3.68	88.96	0.01	4.20	0.000
Suriname	114.63	37.03	-46.47	62.36	96.90	0.17	32.71	0.000
Syria	8.88	-91.53	15.32	2.19	90.08	0.04	1.23	0.000
Tajikistan	-49.82	812.47	137.76	75.57	69.09	0.03	55.84	0.000
Togo	343.55	-64.25	119.88	16.90	94.88	0.01	5.09	0.000
Tunissia	148.70	31.81	3.11	7.67	96.39	0.05	5.14	0.000
Türkiye	60.35	40.31	46.65	6.20	91.16	0.10	3.16	0.000
Turkmenistan	0	206.64	96.84	46.81	76.44	0.15	36.66	0.000
Uganda	0	153.84	150.79	9.80	91.14	0	9.14	0.000
UAE	0	-10.18	118.06	3.46	97.94	0.72	44.96	0.000
Uzbekistan	0	40.03	153.98	85.75	68.95	0.20	47.34	0.000
Yemen	-91.50	-19.01	44.00	3.00	94.05	0.01	7.91	0.000
OIC (Average)	*27.56*		*67.17*	*23.51*	*91.12*	*0.07*	*46.62*	*0.000*
Europe	4.18	10.32	-19.04	232.84	75.35	0.08	26.56	0.000
World	30	48.66	26.98	40.15	79.99	0.12	19.04	0.000
Netherlands	-0.94	-33.21	-6.30	410.02	73.13	0.31	280.49	0.011

The variables in the tables are as follows;

F(C) : Change in the use of chemical fertilizers consisting of Nitrogen, Phosphate and Potash at the beginning and end of the period (%)

M (C): Changes (%) in Manure left on Pasture at the beginning and end of the period,

P (C) : Change in pesticide use at the beginning and end of the period (%)

M (T) : Manure Treated (%), 20-year average.

M (A): MAnure Applied to soil (5), 20-year average.

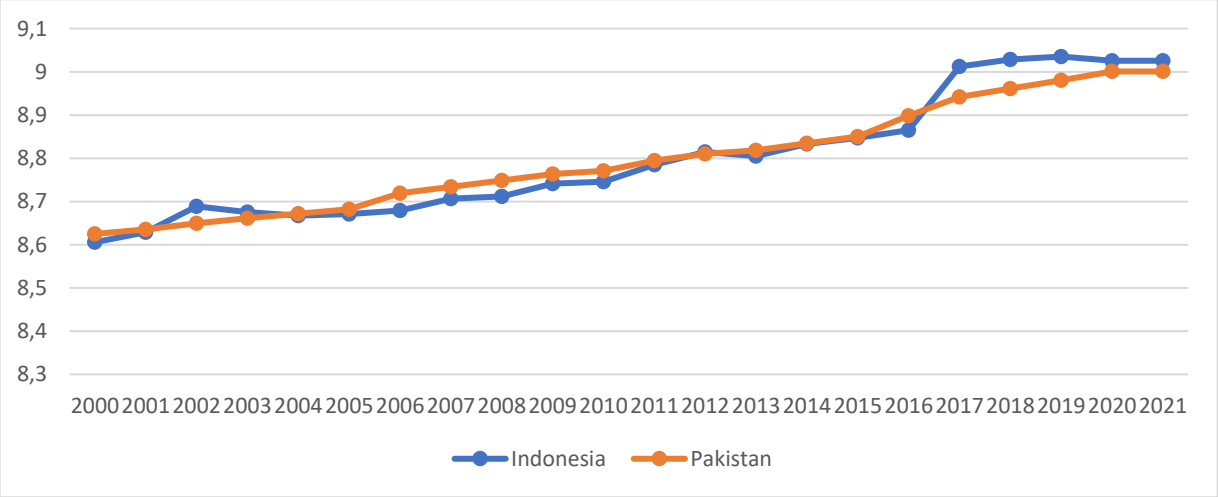
F (ha) : Chemical fertilizer use per hectare, (kg/ha)

M (ha): Chemical fertilizer use per hectare, (kg/ha)

P (ha): Pesticide use per hectare, (kg/ha)

As can be observed in Table 10, the average use of animal manure in the OIC group is 91.12 percent, which is above the world and EU average. A similar interpretation can be made for animal fertilizer per hectare. While the OIC average is 46.62 kg of animal fertilizer per hectare, the world average is 19.04 kg/ha. This can be explained by the increasing amount of fertilizer left on pasture in OIC countries. Looking at the change at the beginning and end of the period, it is seen that the OIC average is above the world average with an increasing trend of 67.17 percent. However, the amount of animal manure processed by OIC member countries is well below the world average, and almost all processed manure is disposed of on land. Although this situation varies from country to country, the general trend is towards an increase in the use of animal manure. After this general assessment, a closer look at the clubs shows that the use of animal manure is increasing in Indonesia and Pakistan, which are in the first club and use the most intensive fertilizer per product among the OIC countries.

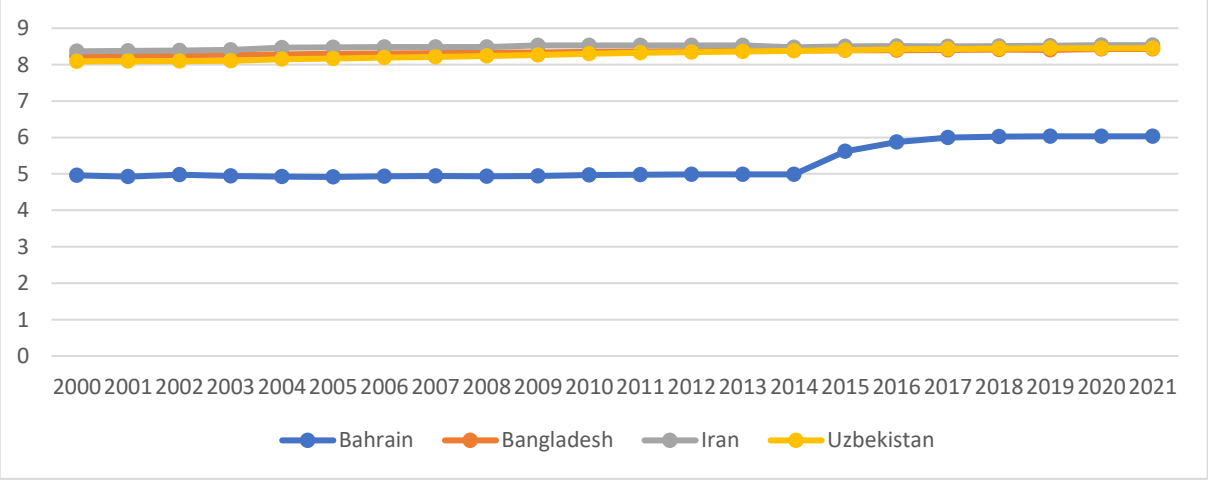
Figure 43. Relative Transition Paths of Countries in Club 1



Indonesia and Pakistan have set targets to increase agricultural production and self-sufficiency under the food security programme. The amount of manure produced and processed in Indonesia is increasing. In 2000, the amount of manure was 704,333,918 tonnes, of which 72.52 per cent was processed into 510,808,842 tonnes of fertilizer. On the other hand, 79 per cent of the processed fertilizer is disposed of in the soil. The same data for Indonesia show that in 2021, 84 percent of the 1,455,927,609 tonnes of fertilizer was processed and 84 percent of the processed fertilizer was used in the soil. The land data also show that Indonesia's agricultural area is constantly increasing, with a corresponding increase in production and fertilizer use.

The food security strategies adopted in Indonesia in 2005 and Pakistan in 2007 are based on supporting smallholder producers with inputs to replace imported staple foods. In particular, fertilizer is supported at very high levels to increase productivity.

Figure 44. Relative Transition Paths of Countries in Club 2



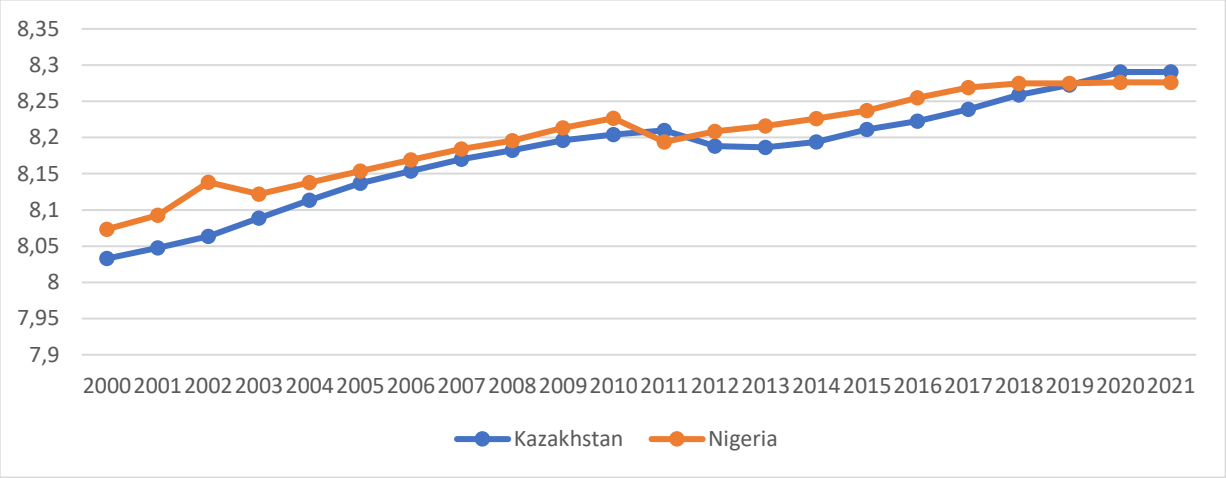
Bahrain differs from the other three countries in Club 2. At the beginning of the period, it lagged behind other countries in terms of the rate of animal manure applied to the soil, but it approached the club average with the increase in the amount of fertilizer used after 2014. After 2015, Bahrain showed an increase of 306 percent in the amount of fertilizer processed compared to the previous year and an increase of 80 percent in 2016 compared

to the previous year. This increase in the amount of manure processed also affected the amount of manure applied to the soil. The rate of disposal of processed animal manure to soil is 97.92 percent in Bahrain. As can be seen from Table 6, Bahrain experienced an increase of 201.77 percent in the amount of animal manure applied to the soil.

Agricultural production in Bahrain, an island state in one of the world's driest regions, accounts for about 1 per cent of GDP. Livestock accounts for a significant proportion of agricultural production. With a very small agricultural population and structural problems in agricultural production relations such as tenancy, Bahrain supports livestock production, but is unable to prevent a shift away from agricultural production and reduce its dependence on agricultural imports[111]. As a member of the Gulf Cooperation Council, it is part of the strategy to diversify the economy and improve public services. In 2016, Saudi Arabia and the United Arab Emirates signed a regional agreement to increase value-added taxes by 5 percent, creating public spending space for governments in their budgets[112]. Thus, they have been able to tolerate the food vulnerability caused by declining food supply and exacerbated water scarcity due to increasing urbanization and population growth, which are the main problems of the NENA region, where Bahrain is located. However, the region, and Bahrain in particular, has been trying to mitigate its nutritional problems by focusing on sustainable structural transformations and infrastructure improvements through cereal production supports and subsidies[113].

[111] FAO, (2008), Country Profile: Bahrain", Food and Agriculture Organizations of the United Nations, FAO AQUASTAT Reports, p.1-18 (3).
[112] Dickson, Malcolm, (2022), "Regional Review on Status and Trends in Aquaculture Development in the Near East and North Africa", FAO Fisheries and Aquaculture Circular No: 1232/5,, p.6.
[113] Ibid., Dickson, Malcolm (2022), p7

Figure 45. Relative Transition Paths of Countries in Club 3



In Club 3, similar to Club 1, the steady upward trend of animal fertilizer is observed. While the rate of animal manure use, which started at 8.5 percent in the first club, rose to 9 percent at the end of the period, club 3, which includes Nigeria and Kazakhstan, fluctuates between 8-8.3 percent.

Since 2000, Kazakhstan has been implementing public investment and support programmes to revitalise agriculture and increase production. The programme, which includes veterinary services and subsidised loans, allocates 33 per cent of the budget to the livestock sector. As of 2013, livestock breeding has been identified as a priority sector in the support programmes, which have been reorganised through cooperatives, and high subsidies have been provided to improve the quality of breeding animals and supply high quality fodder[114]. With the approval of the Beef Export Potential Development Program in the same year, high-yield breeding cattle breeding was expanded through reimbursements and reduced costs of high-quality feed[115]. In this framework, changes are observed in the amount of animal manure in accordance with the number of livestock. Kazakhstan processes 61 percent of animal manure on average and disposes 72 percent of the processed manure

[114] Ibid., FAO, (2017), p.3.
[115] Ibid., FAO, (2017), p.6.

to the soil. In the country where the increase in animal manure is 129 percent, there was a decrease in the amount of animal manure disposed to pasture and processed manure in 2012 and 2014, and a decrease in the amount of animal manure disposed to soil. Kazakhstan's consecutive 147 and 148 percent increase in organic farming practices in 2011 may have contributed to this decline. The country's 222 percent increase in the use of nitrogen-containing chemical fertilizers between 2011 and 2012, combined with the fact that organic agriculture is crop-based fertilization instead of soil-based fertilization, and that organic agriculture uses green manure, hurmic acid, peat and compost in addition to animal manure[116].

As the largest rice producer in Africa and with an average agricultural employment share of 41 percent, hunger is still among the most important problems in Nigeria. In this context, Nigeria has set out to make the agricultural sector profitable and agricultural production stable by creating the Nigerian Vision 2020 program[117]. In the country, where many programmes and plans have been implemented on issues such as zero hunger, social protection, economic recovery and growth, agriculture and food security, agricultural production has been supported through water management, rural infrastructure, technology transfer and, in particular, increased use of fertilizer. Although livestock production is very important for agricultural growth, it does not cover domestic consumption and leads to import dependency. A break was observed in 2011. Despite a steady increase in the amount of fertilizer applied to the country's pastures, the amount of animal manure processed fell by 93 per cent that year, while the use of chemical fertilizers increased by 239 per cent. In 2015, the avian influenza (H5N1) virus caused poultry losses, but livestock and manure production continued to increase[118].

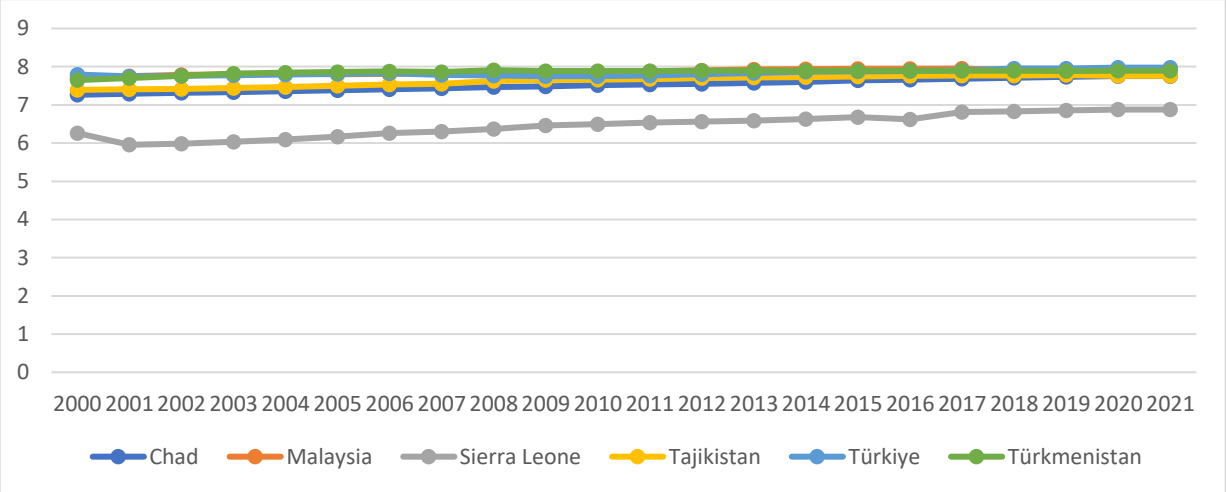
[116] Yetkin, Mehmet Ali, (2010),"Organik Gübreler ve Önemi", Samsun İl Tarım Müdürlüğü Çiftçi Eğitimi ve Yayım Şubesi, (https://samsun.tarimorman.gov.tr/Belgeler/Yayinlar/Kitaplarimiz/organik_gubreler_ve_onemi.pdf), p.1-24 (3).

[117] FAO, (2017), "Country Fact Sheet on Food and Agriculture Policy Trends: Nigeria", (https://www.fao.org/3/i7675e/i7675e.pdf), p.2., (Date of access: 26.09.2023).

[118] FAO, (2016), "Stopping Avian Influenza in Togo", (https://www.fao.org/in-action/stopping-avian-influenza-togo/en/), (Date of access: 26.08.2023)

In club 4, where six countries, including Türkiye are represented, the rate of animal manure use fluctuates between 6-8 percent. Except for Sierra Leone, the other countries tend to maintain very close and stable levels of animal manure use. Sierra Leone started the period at 6 percent, below the club average, and increased its use of animal manure to a higher level than the other club countries, reaching the club average at the end of the period. The West African country with a tropical climate grows distinct crops such as cassava, pady rice, gren coffee, etc. and has different levels of fertilization needs compared to other club countries. In the country where chemical fertilizers are not used, there have been significant increases in the amount of fertilizer applied to pasture, except for the decrease in 2001. Especially after 2008, the rapid expansion of poultry farming within the scope of food security has increased fertilizer production[119]. Despite the relatively moderate upward trend in the rate of manure processing, the increase in the amount of chicken manure increased the amount of manure processed and the amount of manure applied to the soil.

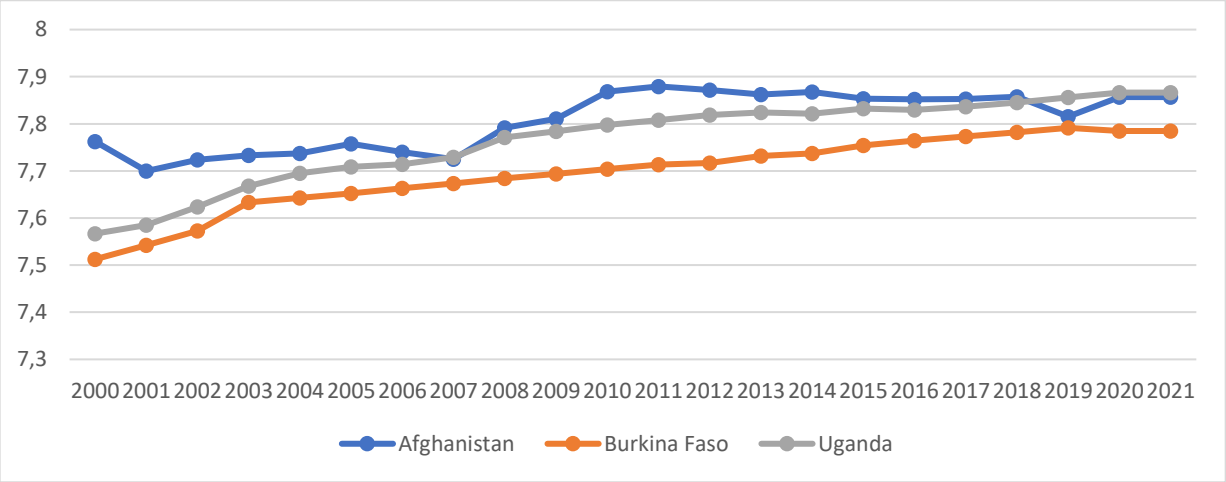
Figure 46. Relative Transition Paths of Countries in Club 4



[119] UNDP, (2023), "Eco-friendly Rechargeable Hatchery: An Innovation to Improve the Poultry Farming Ecosystem in Sierra Leone", (https://www.undp.org/sierra-leone/blog/eco-friendly-rechargeable-hatchery-innovation-improve-poultry-farming-ecosystem-sierra-leone), (Date of access: 26.08.2023).

Of the 3 countries in Club 5, Burkina Faso started using animal manure at 7.5 percent and increased it to 7.7 percent. Similarly, Uganda maintained its steady upward trend from 7.6 percent to 7.8 percent. Afghanistan maintained 7.8 percent of animal fertilizer use at the beginning and end of the period, but intra-period fluctuations are relatively high. Livestock stock showed significant decreases of 84 percent in 2001, 99 percent in 2006, 96 percent in 2012 and 96 percent in 2019, and significant increases of 115 and 101 percent in 2010-2011.

Figure 47. Relative Transition Paths of Countries in Club 5

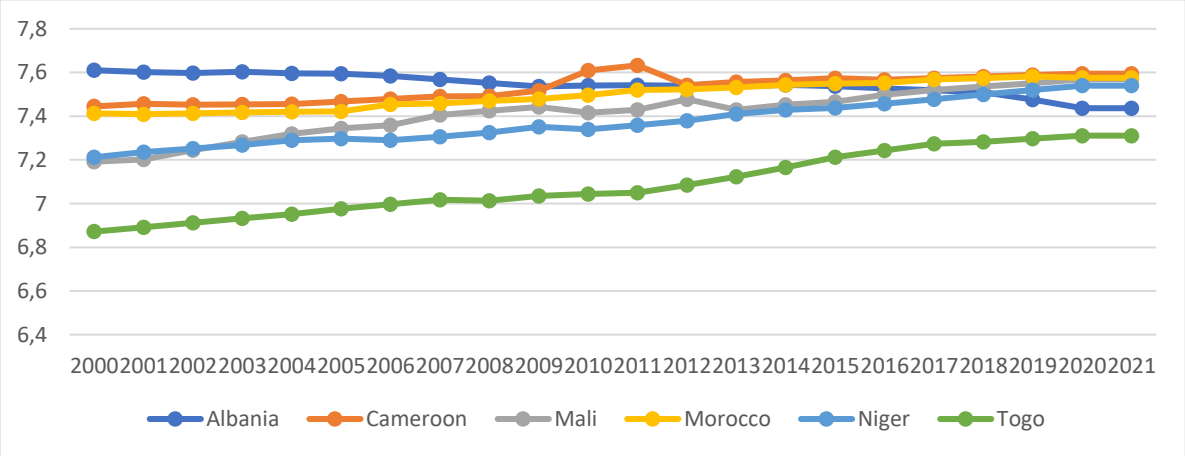


Afghanistan is a country where political stability and crisis are intertwined. Livestock production in Afghanistan is an important source of income, especially for smallholder farmers, and an important gateway to food and nutrition[120]. However, the continuity of production is also closely linked to external factors such as political stability and epidemics. A transitional government was set up in 2001 after the post-Soviet occupation, and political reconciliation was achieved in 2020 as a result of the last presidential elections in 2019. The 2004 Development Programme for Afghanistan, the 2007 and 2011 Summits and the 2019 Balkans Conference are some of the positive developments for Afghanistan[121]. Large-scale

[120] FAO, (2023), "Afghanistan Newsletter, Issue 32, (https://www.fao.org/3/cc6892en/cc6892en.pdf), p.2, (Date of access: 26.08.2023).
[121] MFA, (2023), "Afganistan'ın Siyasi Görünümü", (https://www.mfa.gov.tr/turkiye-afganistan_siyasi-iliskileri.tr.mfa), (Date of access: 26.09.2023).

vaccination and veterinary field visits by FAO against Lumpy Skin Disease (LSD) in cattle, measures against animal wastage due to Crimean-Congo haemorrhagic fever (CCHF), medicines and measures against foot-and-mouth disease, promotion of poultry farming, vaccination, development and expansion of livestock farms, facilitation of feed and market opportunities are considered important for the protection of livestock assets[122]. During periods of stability when these supports yield results, fertilizer production also changes depending on the number of livestock.

Figure 48. Relative Transition Paths of Countries in Club 6

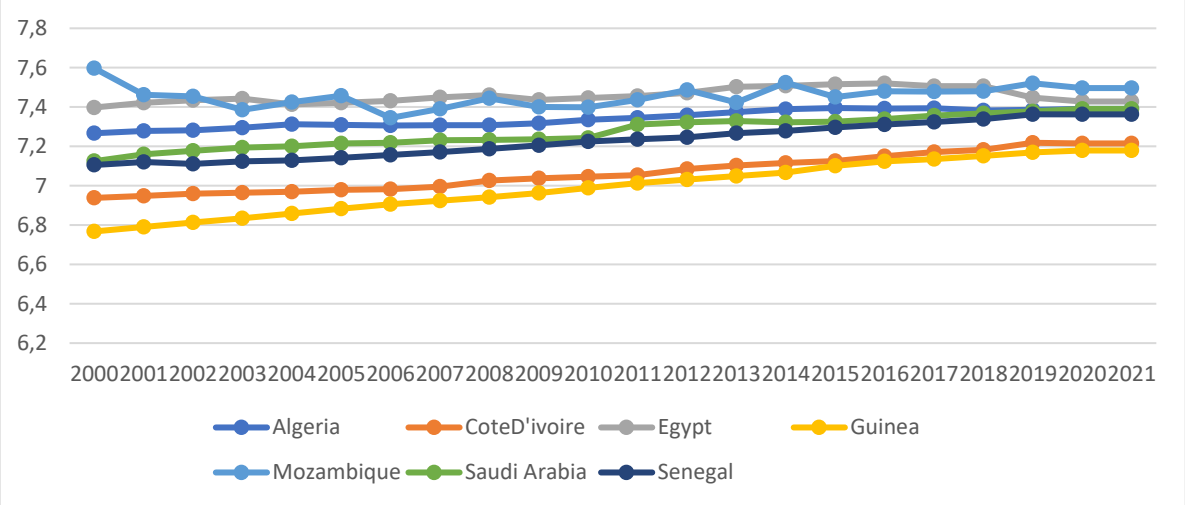


Togo stands out in Club 6. In the country where agricultural producer households make their livelihoods mainly through poultry farming, the (H5N1) virus known as avian influenza became an epidemic in February 2006, causing serious poultry losses in 10 African countries, including Burkina Faso, Ivory Coast, Ghana, Niger, Nigeria and Cameroon. With the support provided through FAO, this disease was managed in advance and the capacity to respond to the outbreak before it spread was improved, preventing massive losses in livestock stocks[123]. In addition, in parallel with the expansion of arable land in Togo, the government's subsidised prices for agricultural inputs have further increased the amount of

[122] FAO (2023), "Afghanistan Newsletter, Issue 32, (https://www.fao.org/3/cc6892en/cc6892en.pdf), p.2, (Date of access: 26.08.2023), p.3.
[123] FAO, (2016), "Stopping Avian Influenza in Togo", (https://www.fao.org/in-action/stopping-avian-influenza-togo/en/), (Date of access: 26.08.2023)

land under cultivation. The subsidisation of agricultural inputs, supported by security measures, and the increase in cultivated area have also led to increased use of fertilizer, which has a direct impact on productivity. From this point of view, although Togo is in the club range of 6.8-7.6 percent in the use of animal fertilizer in agricultural production, it is quite close to other club countries in terms of end of period value.

Figure 49. Relative Transition Paths of Countries in Club 7

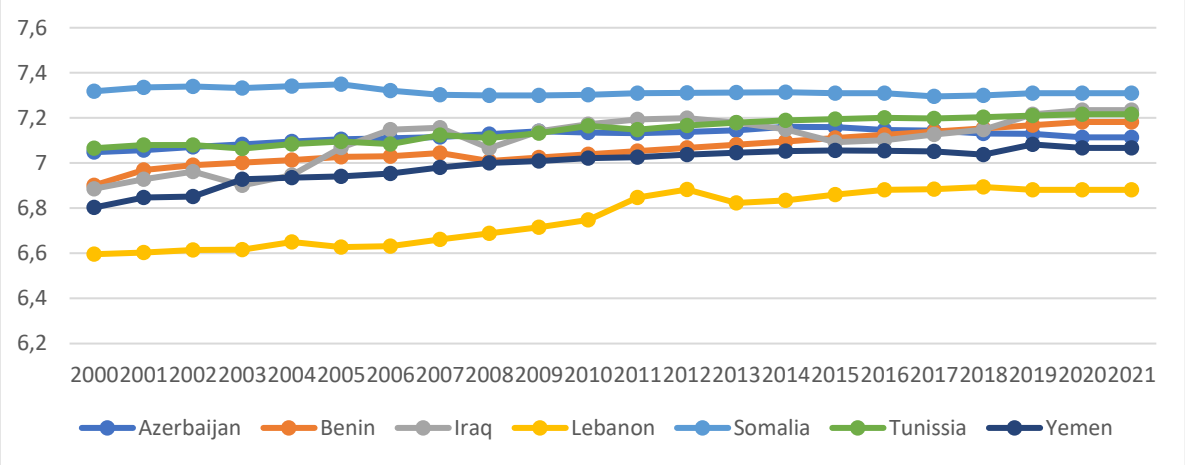


Mozambique stands out among the Club 7 countries. Significant food aid and development assistance has been provided to the country, which began a period of restructuring in the 2000s. The National Agricultural Investment Plan aimed to reduce hunger, the Green Revolution Strategy aimed to increase the sustainability of agricultural production and the welfare of producers through direct access to markets, and national food security and nutrition programmes aimed to increase food security[124]. Mozambique's overall agricultural policy aims to move away from subsistence production to enterprises of a scale that can compete in international markets. Producers growing maize, cassava and rice benefit from input subsidies[125]. The country also experiences frequent natural disasters,

[124] FAO, (2017), "Country Fact Sheet on Food and Agriculture Policy Trends: Mozambique", (https://www.fao.org/3/i5931e/i5931e.pdf), p.2., (Date of access: 26.09.2023).
[125] Ibid., FAO (2017), p.3.

such as the floods of 2008 and 2015, which caused millions of people to suffer. As such, Mozambique differs from the other club countries, not in terms of the overall trend, but in terms of the upward and downward path of the cyclical patterns.

Figure 50. Relative Transition Paths of Countries in Club 8



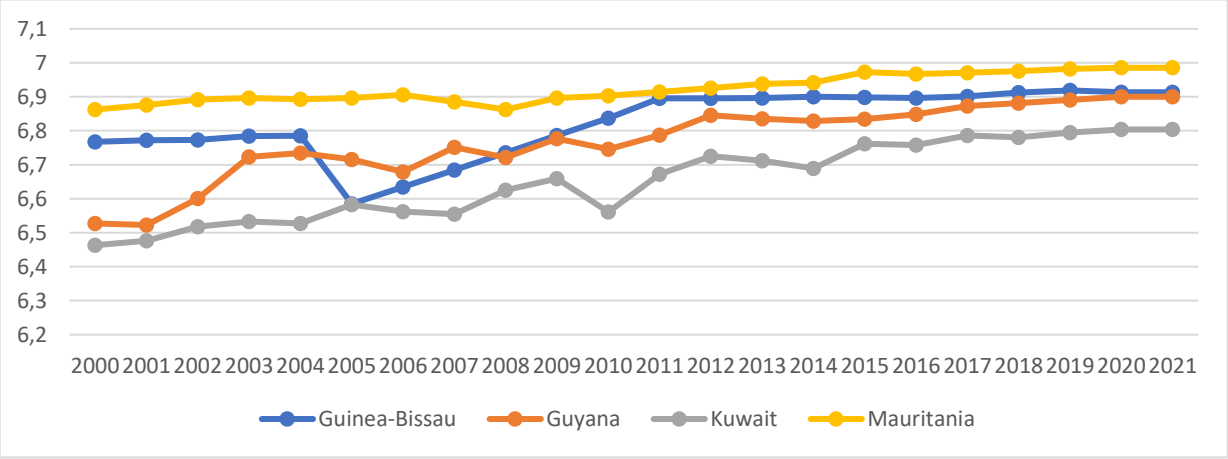
Lebanon's use of animal manure is below the club average, but the upward trend is noteworthy. Combined with the increase in agricultural land use, land use has increased steadily, except for certain periods. This leads to an increase in fertilizer use under normal circumstances. For example, animal fertilizer production increased by 26 percent in 2010-2011 and 8 percent in 2011-2012. Chemical fertilizer use increased by 167 percent. In the same period, the increase in agricultural areas was 102 percent. Agricultural production is not the dominant economic activity in Lebanon. In the country where agricultural employment averages 4 percent over the period, there are regional disparities. In some rural areas, agriculture is the only source of livelihood for the poorest households[126].

In addition, refugees displaced by the instability in Syria and Palestine who arrive in Lebanon, representing more than 20 per cent of the total population, exacerbate food stress in these rural areas. Refugees from Syria, in particular, are concentrated in the main

[126] FAO, (2023), "FAO in Lebanon: Lebanon at a Glance", (https://www.fao.org/lebanon/fao-in-lebanon/lebanon-at-a-glance/fr/), (Date of access: 29.08.2923).

agricultural areas in the north of the country, putting pressure on arable and pasture land. Instability in Syria has disrupted exports of agricultural inputs to Lebanon and Lebanese exports to Syria, increasing production costs[127]. In this context, the proportion of forested areas in Lebanon started to decrease in 2010, while agricultural areas started to increase steadily. It is inferred that the government has approved the use of forested areas as agricultural land in order to prevent possible internal instability. This has resulted in an increase in the use of animal fertilizers as the main input for production.

Figure 51. Relative Transition Paths of Countries in Club 9



An examination of Club 9 reveals that Kuwait, Guinea-Bissau and Guyana have a variable structure in animal fertilizer use. Despite the periodic fluctuations of the countries, their end-period values stabilised after 2011 and converged on an upward trend. In Kuwait, whose main source of income is oil, agriculture accounts for an average of 0.40 per cent of GDP, while agricultural employment accounts for 2.3 per cent of total employment. The population employed in agriculture is predominantly expatriate, while farm owners have other sources of income[128]. Considering that the share of crop production in total agricultural production, including fisheries, is 23 percent, small changes in very limited cultivation areas

[127] Ibid., FAO (2023).
[128] FAO, (2008), "Country Profile-Kuwait", (https://www.fao.org/3/ca0343en/CA0343EN.pdf), p.3, (Date of access: 29.08.2023).

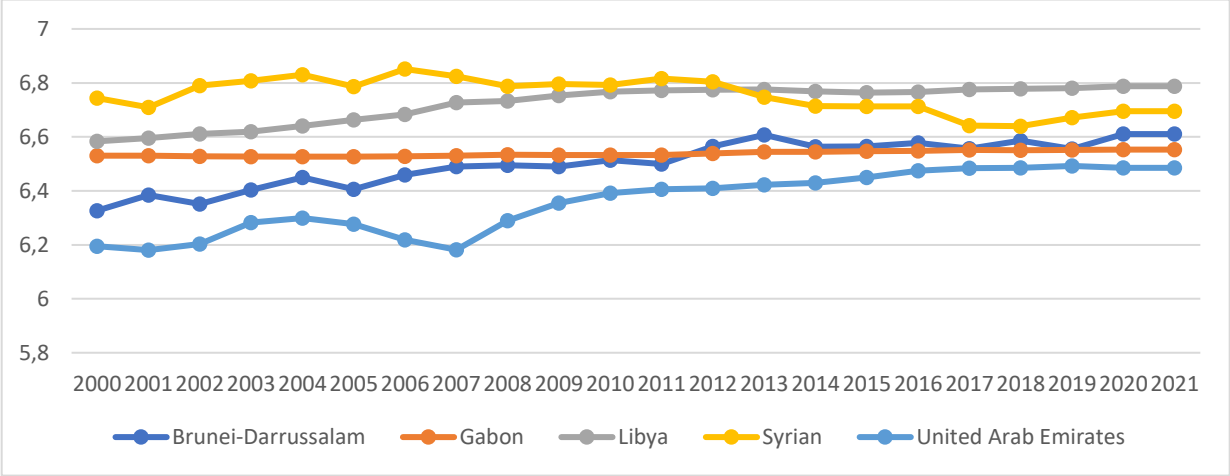
are reflected as significant differences[129]. Agricultural land in Kuwait is in a steady decline. From 13 percent in 2001, agricultural areas decreased to 8 percent in 2020. However, the use of animal fertilizer in the country, which tends to increase productivity, increased by 219 percent compared to the beginning of the period, and the fertilizer applied per hectare increased from 290 kg/ha to 795 kg/ha. Chemical fertilizer use, on the other hand, declined from 13 percent to 8 percent. This is thought to be related to the increasing livestock production in the country.

In Guinea Bissau, there is a decline in the use of animal fertilizer between 2004-2011. On the other hand, the rate of agricultural area continues to increase. In the country where the increase in animal stock also continues steadily, animal fertilizer is not among the foreign trade goods and there is no use of chemical fertilizers in the country. Therefore, it is thought that the sudden decline in animal fertilizer use in the country, which has recently experienced the 2005 presidential election, the 2009 short-term instability and the 2012 coups, may be due to regional inaccessibility problems.

Club 10 shows that countries were relatively stable and experienced a slight decrease in animal manure use towards the end of the period. In Syria, a downward trend is noticeable as of 2012. It is thought to be a reflection of the instability in the country. As of this date, FAOSTAT data shows a decrease in animal stock and the amount of fertilizer processed. These decreases also affect the amount of fertilizer applied to the soil.

[129] Ibid., FAO, (2008).

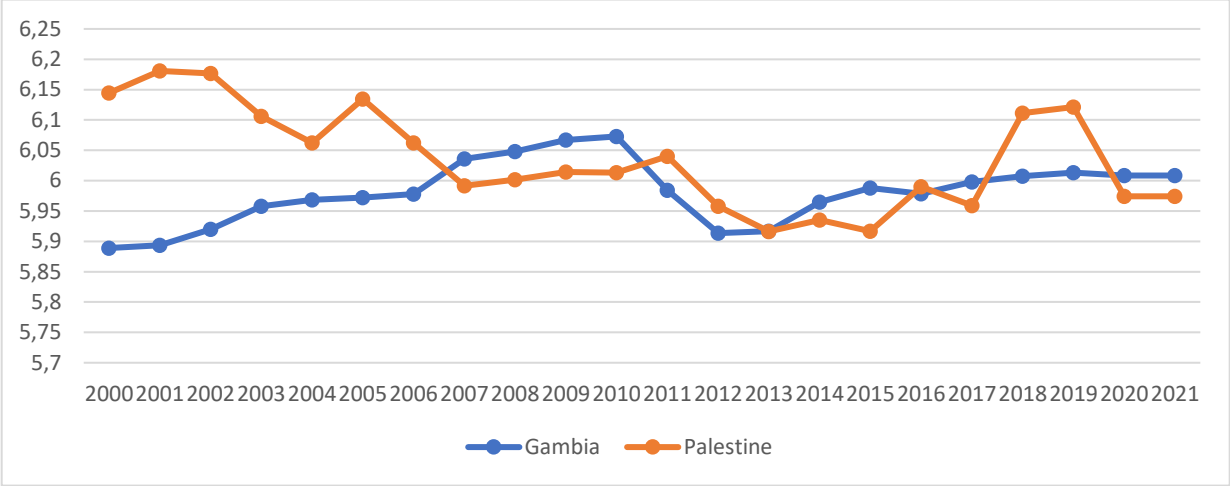
Figure 52. Relative Transition Paths of Countries in Club 10



In Club 11, Palestine and The Gambia are the two countries in which end-of-period values converge, albeit following a rather volatile course. Considering that agriculture in the Palestinian territories is predominantly carried out in Gaza and the West Bank[130], border separation, blockade and conflict prevent access to productive areas, which hampers food security and production stability[131]. In a country where one unit of input has a 9-fold impact on output, those engaged in crop and livestock production face difficulties in access to water and land. Conflicts have caused significant damage to the agricultural sector, and the avian flu in 2006 and bombings of agricultural input warehouses have increased the stress in production[132].

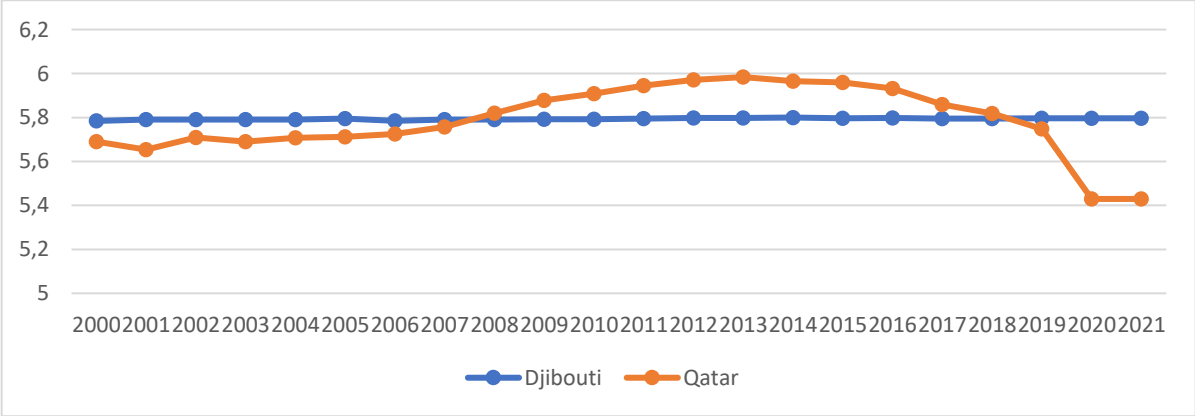
[130] FAO, (2008), "Country Profile-Occupied Palestinian Territory", (https://www.fao.org/3/CA0348EN/ca0348en.pdf), p.5, (Date of access: 29.08.2023).
[131] FAO, (2022), "Palestine", (https://www.fao.org/3/cc0366en/cc0366en.pdf), p.1, (Date of access: 29.08.2023).
[132] Ibid., FAO, (2022), p.2.

Figure 53. Relative Transition Paths of Countries in Club 11



While Qatar in Club 12 followed a parallel course with Djibouti, which converged and maintained its stability in the rate of animal fertilizer use at the beginning of the period, this gap started to widen between 2008-2018 and started to fall below Djibouti. In Qatar, fertilizer production and agricultural areas dependent on animal production are increasing, but animal fertilizer use is decreasing. This is partly due to the increasing use of chemical fertilizers.

Figure 54. Relative Transition Paths of Countries in Club 12



In addition to the production and cost advantage of animal manure, livestock houses and manure storage facilities are considered to be a source of ammonia emissions. Nitrogen (N) in solution in manure is said to evaporate and pollute the air, and if it is poured into the ground, it is said to be absorbed and pollute the groundwater and is recommended to be used together with chemical fertilizers[133]. It is believed that in today's world, where there is a strong orientation towards the use of chemical fertilizers, it is important to make policy choices by taking into account the pollution levels and cost conditions before and after animal manure, before making the choice of polluting fertilizer.

The fundamental problem for agricultural producers in the production and use of chemical fertilizers, which have begun to be produced and applied with environmental concerns in mind, is cost. At the beginning of the study, information was presented on the market power of some producers in chemical fertilizer production. For most countries, the fact that this basic input is imported in addition to domestic production and fluctuations in foreign currency prices have a direct impact on local producer costs and agricultural product prices.

Nitrogen-containing fertilizers are the most widely used fertilizers among OIC member countries with 71 percent, which is the period average in chemical fertilizer use. Table 11 shows the clubs of the countries according to their utilization rates of nitrogen fertilizers during the period. The average rate of phosphate-containing fertilizer use is 22 percent, while potash-containing fertilizer use is 7 percent. Countries are divided into 7 clubs according to their chemical fertilizer use. In the OIC group, data on the use of chemical fertilizers in Chad, Comoros, Djibouti, Guinea-Bissau, Mauritania, Palestine, Sierra Leone, Somalia could not be obtained. However, while some countries have experienced very serious increases in the use of chemical fertilizers, some countries have experienced

[133] P.J. Brandjes, J. de Wit, H.G. van der Meer, (1996), "Environmental Impact of Animal Manura Management", H.Van Kelun International Agriculture Centre, (https://www.fao.org/3/X6113E/x6113e00.htm#Contents), (Date of access: 20.08.2023).

high decreases. Except for some periodic fluctuations, it is seen that the clubs have a certain stability and maintain their levels from the beginning of the period.

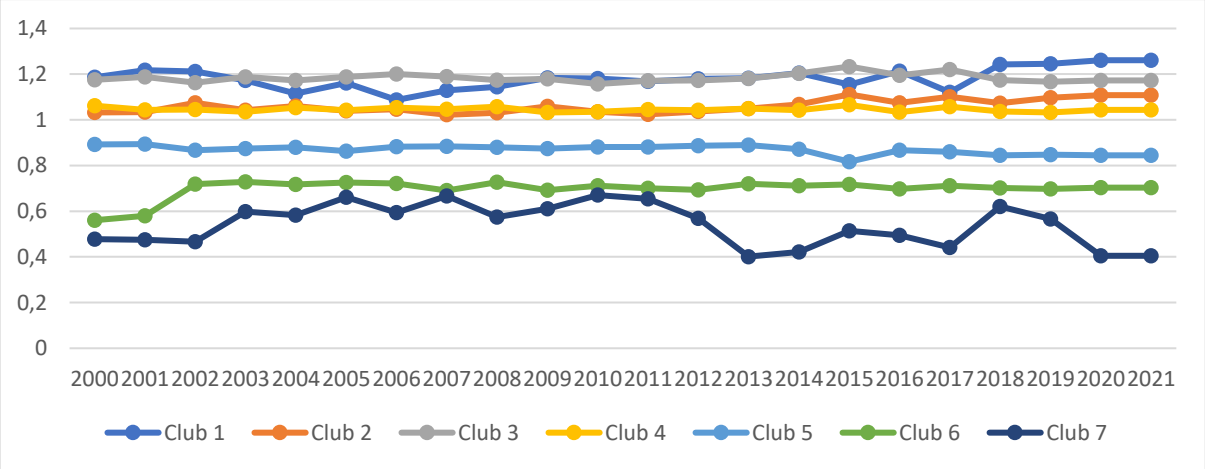
Table 10. OIC Convergence Clubs for Nitrogen Use

Clubs	**Countries**
Club 1 (5 Members)	| Azerbaijan | Benin | Indonesia | Nigeria | Pakistan |
Club 2 (6 Members)	| Bangladesh | Egypt | Gabon | Mali | Senegal | Tajikistan |
Club 3 (5 Members)	| Afghanistan | Iran | Kazakhstan | Türkmenistan | Uzbekistan |
Club 4 (14 Members)	| Albania | Algeria | Burkina Faso | Cameroon | Ivory Coast| Guinea | Guyana | Iraq | Jordan | Malaysia | Morocco | Mozambique | Saudi Arabia | Tunissia |
Club 5 (13 Members)	| Kuwait | Kyrgyzstan | Lebanon | Libya | Maldives | Niger | Oman | Suriname | Syria | Togo | Uganda | United Arab Emirates | Yemen |
Club 6 (2 Members)	| Bahrain | Qatar |
Club 7 (3 Members)	| Brunei-Darrussalam | Gambia |
Not Convergent Group	| Türkiye |

Considering Figure 47, which depicts the general roadmap of the clubs, it is noticeable that they are relatively consistent with the exception of club 7. The periodic decreases in club

1 and club 5 are in the opposite direction with club 2 and club 4. Hence, it is worth taking a more detailed approach to the clubs.

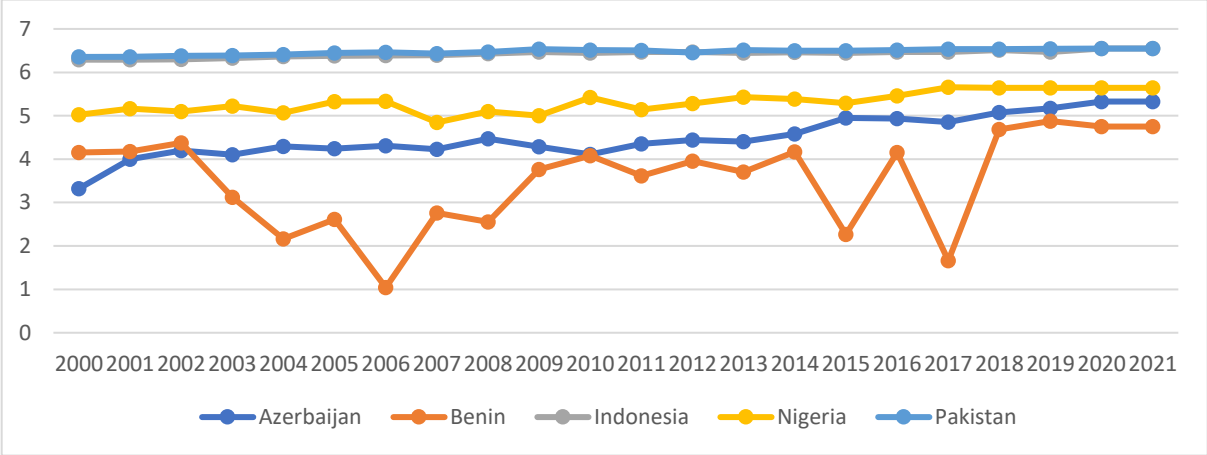
Figure 55. Relative Transition Paths of Clubs



Among the countries in Club 1 with the highest chemical input utilization rate, Benin stands out with its periodic decreases. In Benin, the rate of chemical fertilizer use between the start and end of the period increased by 219.85 percent. For nitrogen-based fertilizers, this increase was 293.786 percent. For phosphate fertilizers, the increase was 147 percent, while for potash it was 196 percent. Benin's Action Plan for Democracy and Population Growth aims to achieve a balanced and sustainable increase in the country's territory in order to improve people's living conditions. Some incentives have been put in place to attract major investment in agriculture, a priority for the government[134]. In this context, the strategy is to increase input support to increase agricultural production and productivity, increase the stability of livelihoods and production systems, strengthen agricultural knowledge and education, and increase public and private sector financing. In this regard, the use of animal and chemical fertilizers on agricultural and irrigated land in the country is increasing.

[134] FAO, (2023), "FAO au Benin", (https://www.fao.org/benin/programmes-et-projets/nos-programmes/fr/), (Date of access: 29.08.2023).

Figure 56. Relative Transition Paths of Countries in Club 1



In Indonesia, one of the other countries in the club, the government's food sovereignty and self-sufficiency program provides fertilizer input support to improve the welfare of small producers and sustainability of agricultural production. In 2016, this support was increased by 25 percent compared to 2014. This support is higher for chemical fertilizer, and subsidized chemical fertilizer subsidies can reach up to 75 percent of the market price, accounting for half of the agricultural support budget[135].

In Pakistan, the strategy of food production and self-sufficiency to increase food security is at the forefront and the use of phosphate fertilizers is subsidized by the government under the support package launched for the agricultural sector in 2015[136].

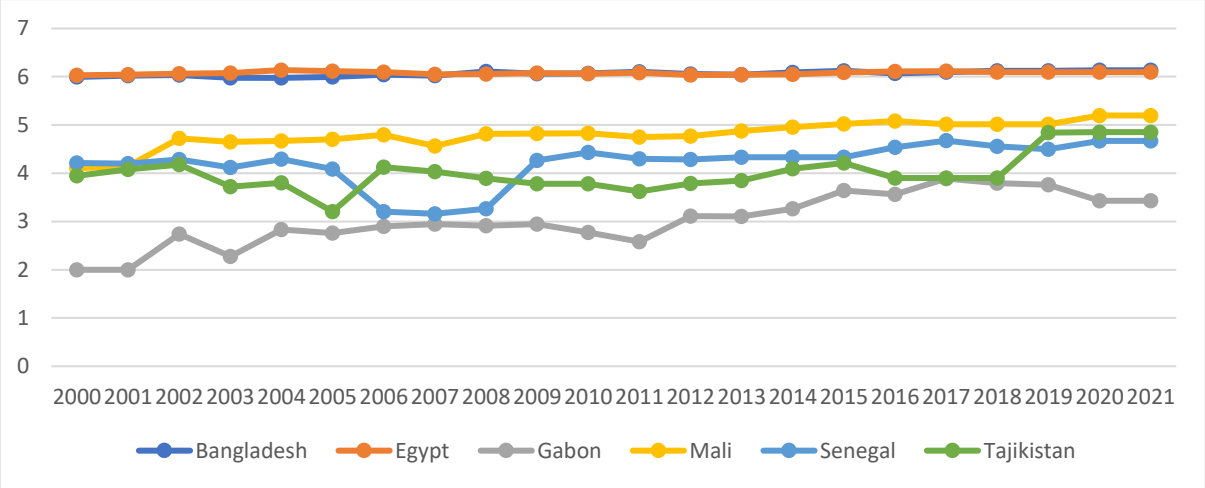
An analysis of the countries in Club 2 shows an increase in the use of chemical nitrogen-based fertilizers, except for Gabon, Senegal and Tajikistan. In Mali, a stable trend is observed except for the initial period. In Mali, the government launched the "Rice Initiative" in response to the 2008-2009 food crisis. Subsidized seed and fertilizer were provided to reduce dependence on imports of Mali's staple food crop, and cheap credit was provided for

[135] FAO, (2017), "Country Fact Sheet on Food and Agriculture Policy Trends: Indonesia", (https://www.fao.org/3/i7696e/i7696e.pdf), p.2., (Date of access: 15.09.2023).

[136] FAO, (2017), "Country Fact Sheet on Food and Agriculture Policy Trends: Indonesia", (https://www.fao.org/3/i6054e/i6054e.pdf), (Date of access: 24.08.2023).

machinery and extension services. In 2009, the country allocated 18 percent of the budget to fertilizer subsidies to support wheat, sorghum and millet production[137].

Figure 57. Relative Transition Paths of Countries in Club 2



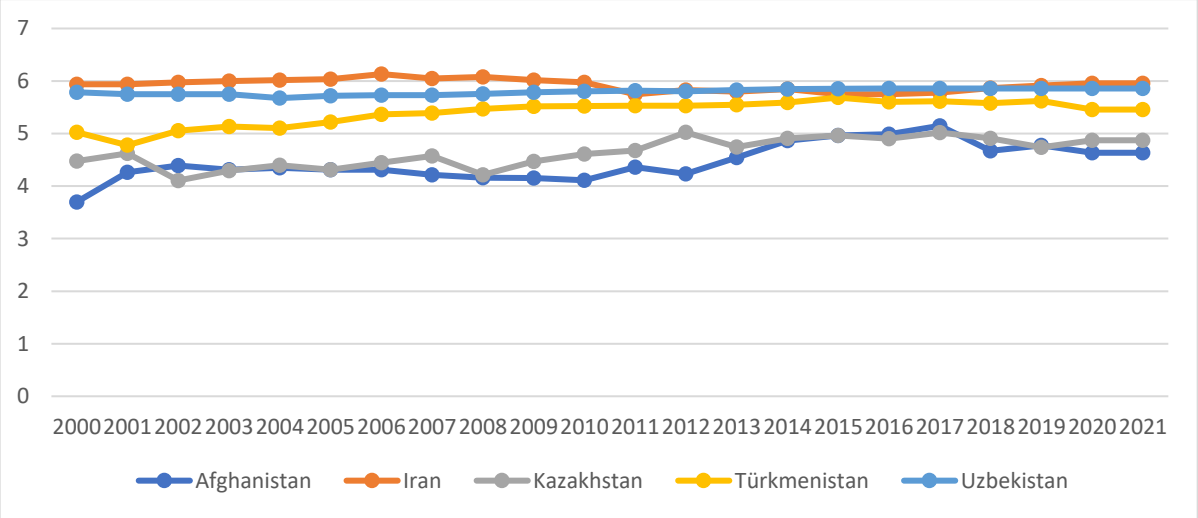
In Senegal, the Agro-Sylvo-Pastoral Orientation Law (LASP) was adopted in 2004, and many plans and programs for strengthening agriculture were subsequently put in place. The goals of wealth creation, sustainable growth, stable peace and confidence are associated with agriculture[138]. Self-sufficiency in rice and onion production, improving the quality of peanuts, out-of-season cultivation of fruits and vegetables (greenhouse cultivation) have been prioritized in competitive and sustainable agriculture[139]. In order to avoid the problems experienced during the 2007-2008 food crisis, input subsidies and cheap credit were provided to encourage production to meet domestic consumption[140].

Various plans and programs have been prepared to develop the agricultural sector in Gabon, covering agricultural investment, nutrition, horticulture, fisheries and aquaculture.

[137] FAO, (2017), "Country Fact Sheet on Food and Agriculture Policy Trends: Mali", (https://www.fao.org/3/i7617e/i7617e.pdf), p.3., (Date of access: 15.09.2023).
[138] FAO, (2015), "Country Fact Sheet on Food and Agriculture Policy Trends", (https://www.fao.org/3/i4841e/i4841e.pdf), p.2, (Date of access: 29.08.2023).
[139] Ibid., FAO (2015).
[140] Ibid., FAO, (2015), p.3.

Cooperatives have been encouraged, with a focus on forest fisheries and livestock development[141].

Figure 58. Relative Transition Paths of Countries in Club 3



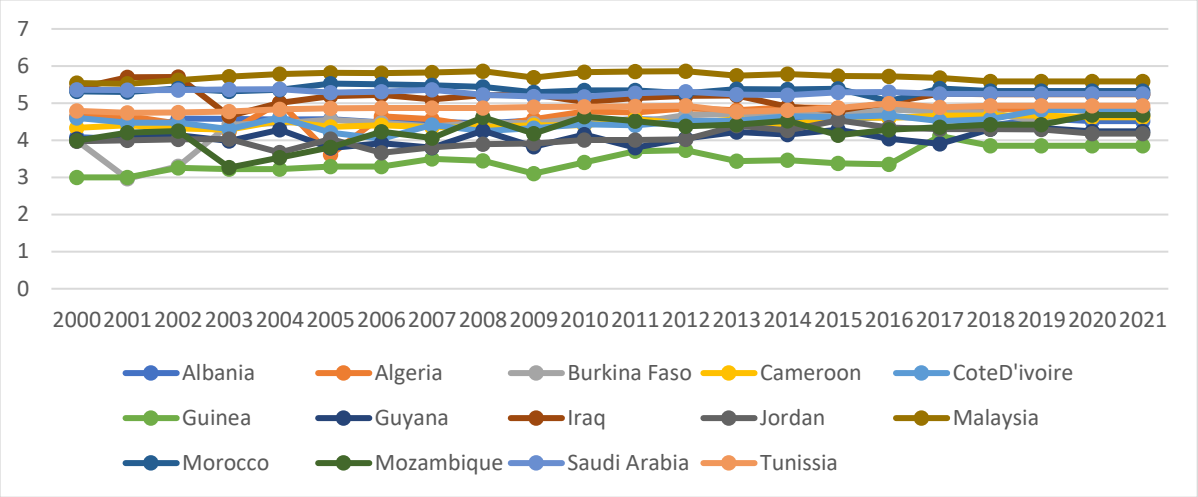
In Club 3, Afghanistan and Kazakhstan are the two countries with low deviations from the club average. Considering that these deviations coincide with the food price hikes of 2008 and 2013, it will be realized that they are due to agricultural input cost increases. Afghanistan's use of nitrogen-based fertilizers increased sharply and steadily between 2012 and 2017, and decreased thereafter. As Afghanistan's rural population has grown, agricultural producers have begun to cultivate smaller plots of land, but increased rural migration and production exceeding population growth have increased food insecurity in the country. After the end of the Soviet occupation, the country experienced an environment of relative stability until 2011, with positive developments in livestock, horticulture and cereal production as a result of agricultural development policies and the 2006 Master Plan[142]. Within the framework of development plans, strategic plans and national development

[141] FAO, (2019), "Le Gabon et la FAO: Promouvoir les Chaines de Valeur Durables Pour Une Securite Alimentaire et Nutritionnelle Renforcee", (https://www.fao.org/3/az983f/AZ983F.pdf), p.2., (Date of access: 29.08.2023).
[142] FAO, (2018), "15 Years in Afghanistan: Special Report: 2003-2015", (https://www.fao.org/3/ca1433en/ca1433en.pdf), pxviii, (Date of access: 29.08.2023).

strategies, emphasis was placed on infrastructure services such as irrigation networks through public-private partnerships. Increasing wheat and grain production, improving the production of industrial crops, and increasing livestock production have been achieved through land reforms, the development of irrigation infrastructure and management, and farmer subsidies. The biggest investment in support to farmers in Afghanistan has been the creation of a market for genetically modified seeds, which has been channeled through the private sector[143]. Subsidies, advertising, the 2009 seed law, and trips to Türkiye and India were organized to convince agricultural producers to use industrial seeds, which are being substituted for traditional seeds with arguments of high productivity and durability[144]. It was pointed out that Türkiye and India were chosen because they are countries that grow similar crops in similar ecosystems, but as is widely recognized in Türkiye, these seeds are able to sustain their productivity through the use of chemical fertilizers and pesticides. Chemical seed production, which has been established and supported by various funds, is dependent on other chemicals. The sustainability of agricultural production in Afghanistan therefore depends on the use of chemical inputs. As a result, the use of chemical fertilizers in the country continues to increase.

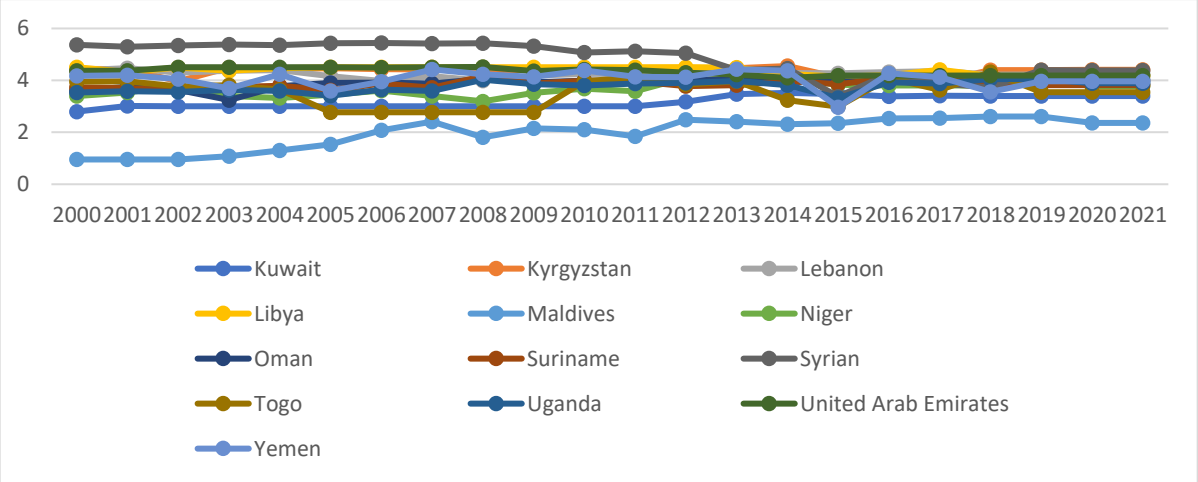
[143] Ibid., FAO, (2018), p.11-14.
[144] Ibid., FAO, (2018), p.17.

Figure 59. Relative Transition Paths of Countries in Club 4



Among the countries in Club 4, Guinea is relatively stable and has a value around the club average, except for the decreases in 2008, 2013 and 2017.

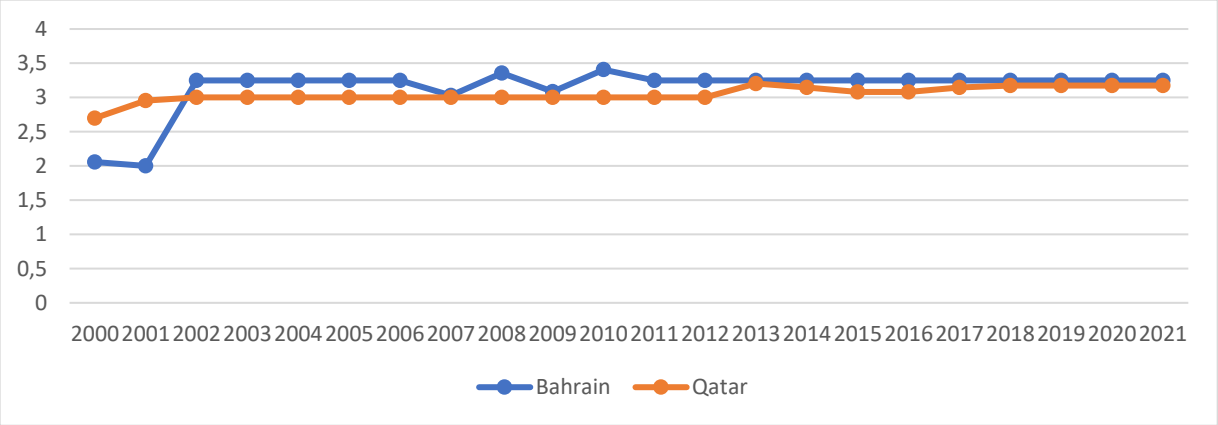
Figure 60. Relative Transition Paths of Countries in Club 5



A look at Club 5 reveals a relatively fluctuating structure for Yemen among countries with the exception of the decline in Maldives in 2015. However, the Maldives is developing on a tourism economy, obtains protein through fisheries and aquaculture, and depends on

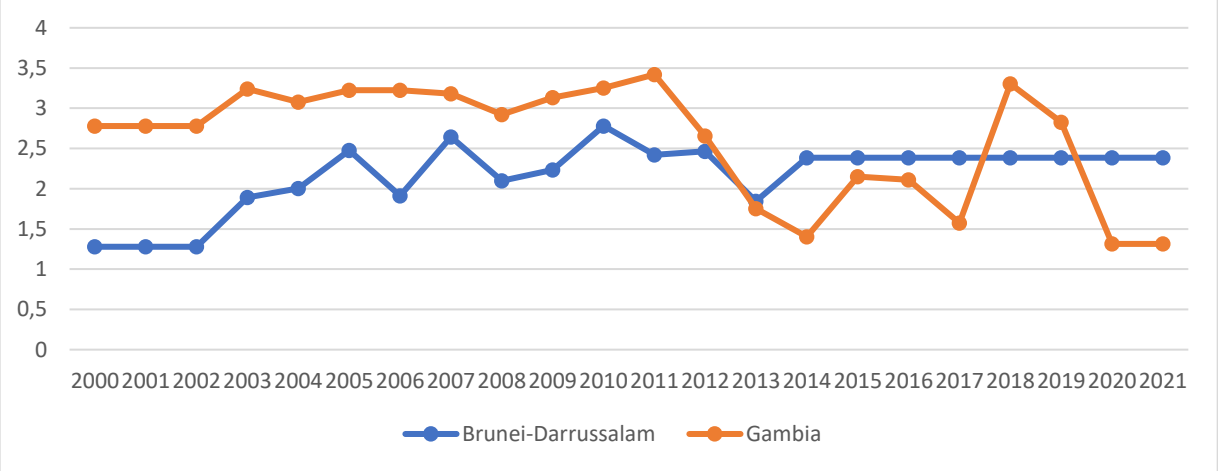
imports in plant products. In a country where animal manure is not used at all and nitrogen-based chemical fertilizers average 188.11 kg, very small changes can be reflected as significant fluctuations. For example, in the year in question, nitrogen fertilizer use declined from 256.49 kg to 203.12 kg.

Figure 61. Relative Transition Paths of Countries in Club 6



Bahrain and Qatar, the neighboring island countries in Club 6, have very similar economic structures. In countries where fisheries and aquaculture are the main sources of agricultural production and oil revenues are the main source of income for the economy, the use of chemical fertilizers remains stable.

Figure 62. Relative Transition Paths of Countries in Club 7



Brunei and Gambia in Club 7 are the countries with the lowest nitrogen fertilizer consumption. Brunei has an agricultural structure with high use of animal manure. In the country where an average of 0.19 tons of chemical fertilizer is used per hectare, 918 tons of animal manure is used per hectare. On a yearly basis, chemical fertilizer use decreases in years when there is an increase in animal fertilizer use. For instance, in 2006, the total amount of animal manure applied to the soil per hectare was 1,408.74 tons, while the total amount of chemical fertilizer was 0.15 tons, of which 82 tons was nitrogen fertilizer. For 2005, the same figures were 1,272.44 and 0.31 tons, respectively. For 2007 it was 1,029.27 and 0.38 tons. In short, animal and chemical fertilizers act as substitutes for each other in Brunei.

The use of phosphate and potash-based chemical fertilizers other than nitrogen fertilizers is not explained in detail by country, but a club analysis is included to give an idea about input trends. It should be noted that the use of chemical inputs is related to financial well-being, unless there is binding legislation in domestic law. For this reason, OIC agricultural producers, who are predominantly low-income agricultural producers, prefer the use of animal fertilizers. Therefore, except in some countries where large corporations dominate the market in agricultural production, chemical fertilizers and pesticides can be used as long as input subsidies and other agricultural supports are available.

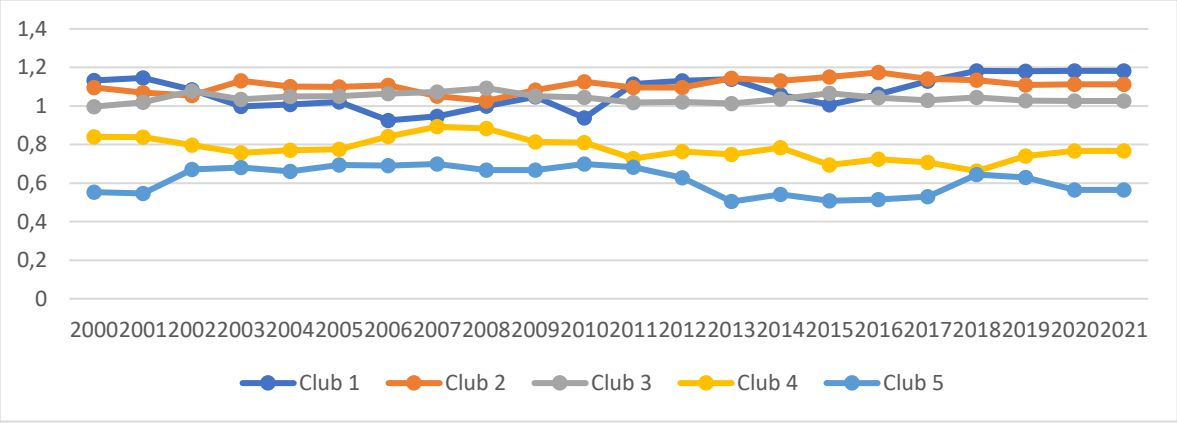
Countries are divided into 6 clubs in the use of phosphate-based chemical inputs. Countries in the first club are those that have a dominant share in the use of phosphate-based fertilizers. In the grouping based on this input, Indonesia has not converged to any country. Indonesia's end-of-period phosphorus fertilizer use increased by 360 percent compared to the start of the period. This rate is 568 percent for nitrogen fertilizer and 568 percent for potash fertilizer, while the total chemical fertilizer average is 162 percent. It can be concluded that Indonesia uses chemical fertilizers according to the crop, not according to the soil, within the framework of its self-sufficiency strategy in crops, especially rice, which is emphasized within the framework of food security.

Table 11. OIC Convergence Clubs for Potash Use

Clubs	**Countries**
Club 1 (5 Members)	| Albania | Bangladesh | Benin | Guinea | Malaysia |
Club 2 (12 Members)	| Burkina Faso | Ivory Coast | Egypt | Guyana | Kuwait | Morocco | Nigeria | Pakistan | Senegal | Togo | Türkiye | Uzbekistan |
Club 3 (12 Members)	| Algeria | Azerbaijan | Cameroon | Gabon | Iran | Iraq | Mali | Mozambique | Oman | Saudi Arabia | Uganda || United Arab Emirates |
Club 4 (6 Members)	| Jordan | Kazakhstan | Lebanon | Tajikistan | Tunissia| Türkmenistan |
Club 5 (6 Members)	| Brunei-Darrussalam | Libya | Niger | Suriname | Syria | Yemen |
Club 6 (2 Members)	| Bahrain | Gambia |
Not Convergent Group	| Indonesia |

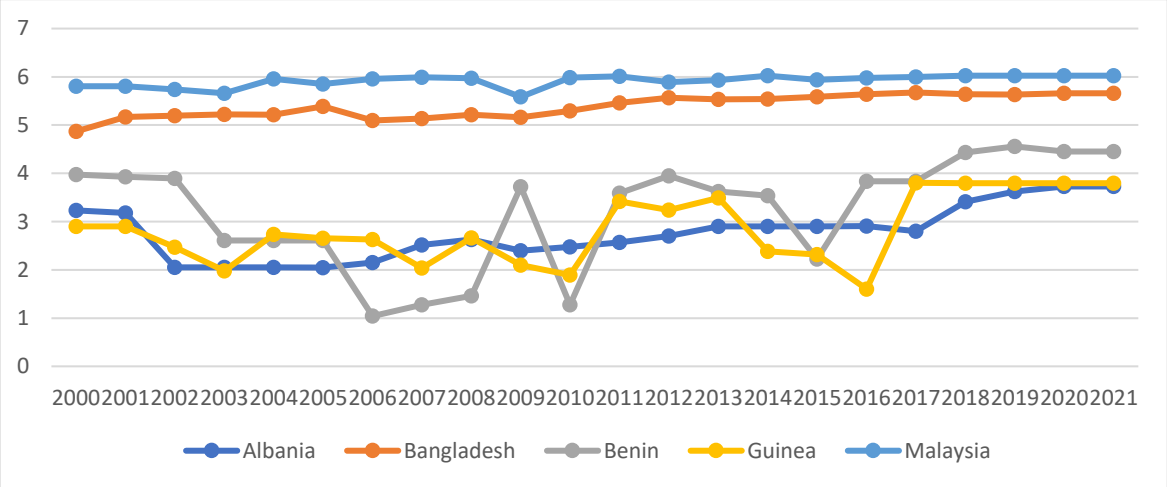
A closer look at the development maps of the countries shows that Club 4 and Club 5 follow a relatively more fluctuating course. However, a detailed inspection of the clubs reveals that countries experienced a significant decrease in the use of potash fertilizers due to input cost increases during the 2008-2009 food crisis.

Figure 63. Relative Transition Paths of Clubs



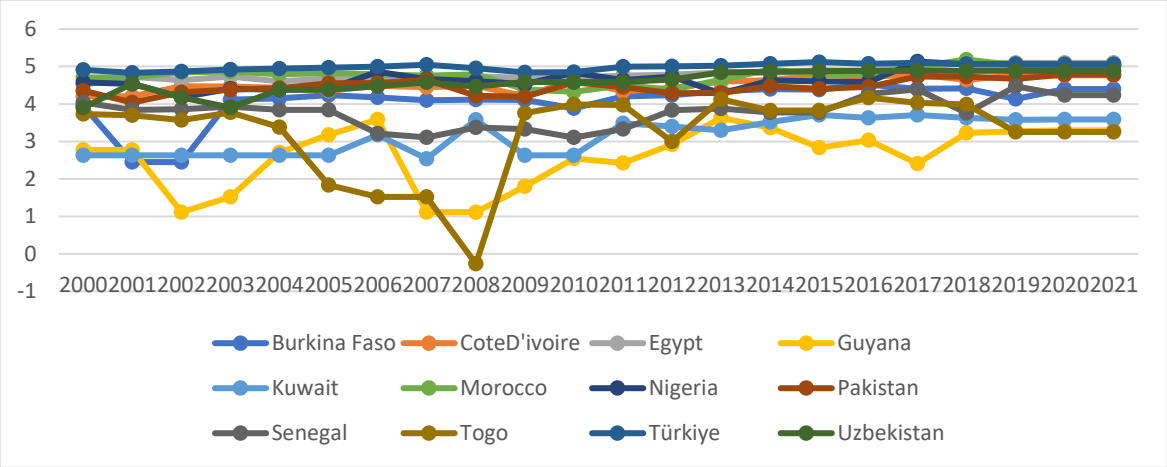
In Club 1, Malaysia and Bangladesh are stable in potash fertilizer use. Albania is also relatively stable, albeit at the lower end of the club average. Benin and Guinea are quite volatile. For instance, in Benin, potash fertilizer was not used at all in 2004 and 2017, while it was hardly used in 2003, 2006, 2007 and 2015. Similarly in Guinea, fertilizer use was almost negligible in 2006, 2010, 2014, 2016, while in other years there was an excessive use. A similar pattern applies to phosphorus fertilizer usage. While this is attributed to the fertilizer aid provided to the country, it is also the source of the extreme volatility.

Figure 64. Relative Transition Paths of Countries in Club 1



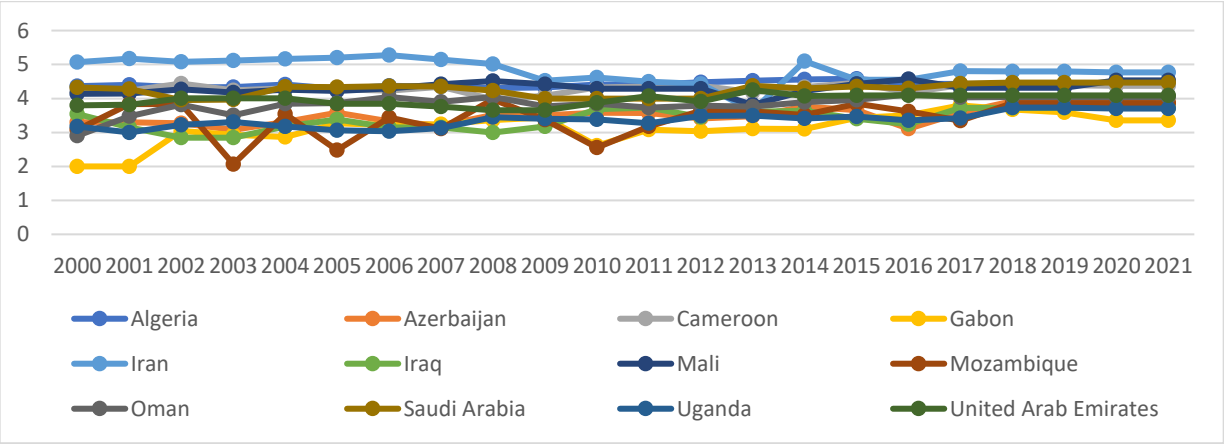
Among the countries clustered in Club 2, Togo and Guyana are the standouts. In Togo, the use of phosphorus fertilizer was almost zero in the 2005-2008 period, which covered the 2008 food crisis. In 2014, this fertilizer was also used at a very low level. In Guyana, fertilizer use dropped significantly between 2007 and 2009 and in 2015 and 2017.

Figure 65. Relative Transition Paths of Countries in Club 2



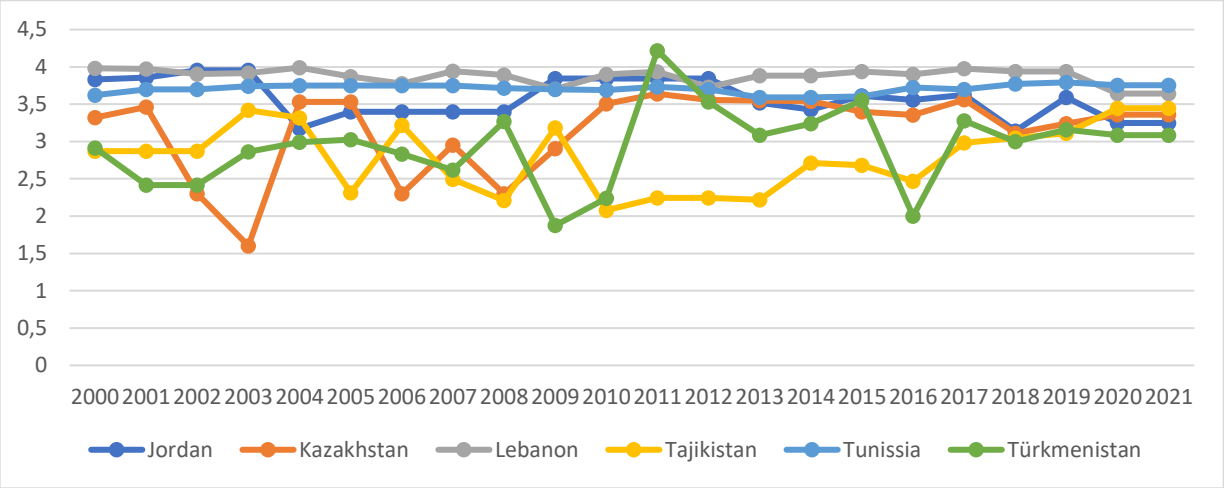
Club 3 follows a relatively stable course. Mozambique, which followed a more fluctuating pattern compared to the club average, used phosphorus-based chemical fertilizers at very low levels in 2005, 2007, 2009, 2013, 2016 compared to previous years.

Figure 66. Relative Transition Paths of Countries in Club 3



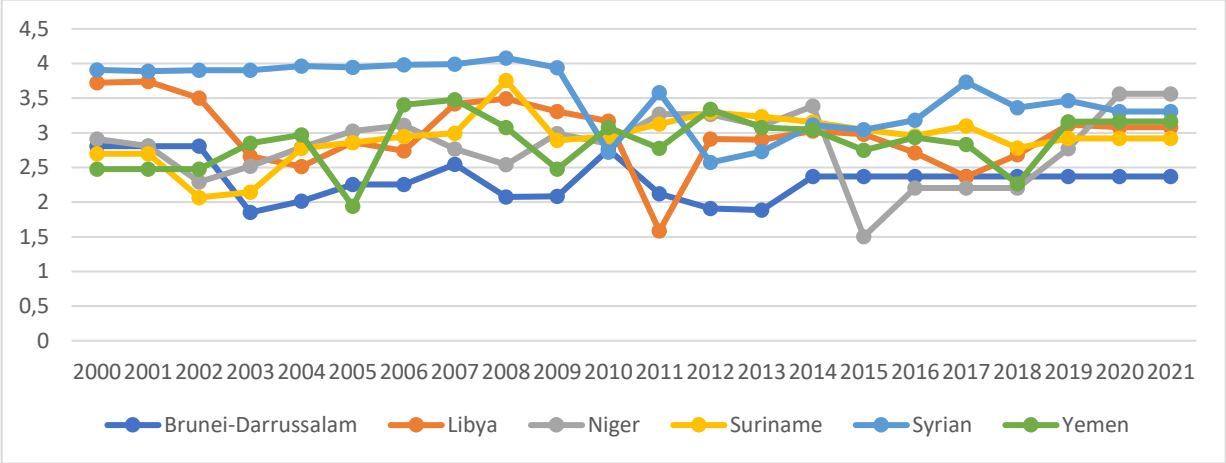
In Club 4, the fluctuating trends of the Asian countries Kazakhstan, Tajikistan and Turkmenistan are prominent. In this group, where fertilizer use is generally low, the average animal manure applied per hectare in Kazakhstan is 5.20 tons, while total chemical fertilizer is 0.0027 tons. The same figures are 55.84 tons and 0.03 tons for Tajikistan and 36.66 tons and 0.15 tons for Turkmenistan. In Turkmenistan, the use of potash fertilizers is higher compared to phosphorus fertilizers.

Figure 67. Relative Transition Paths of Countries in Club 4



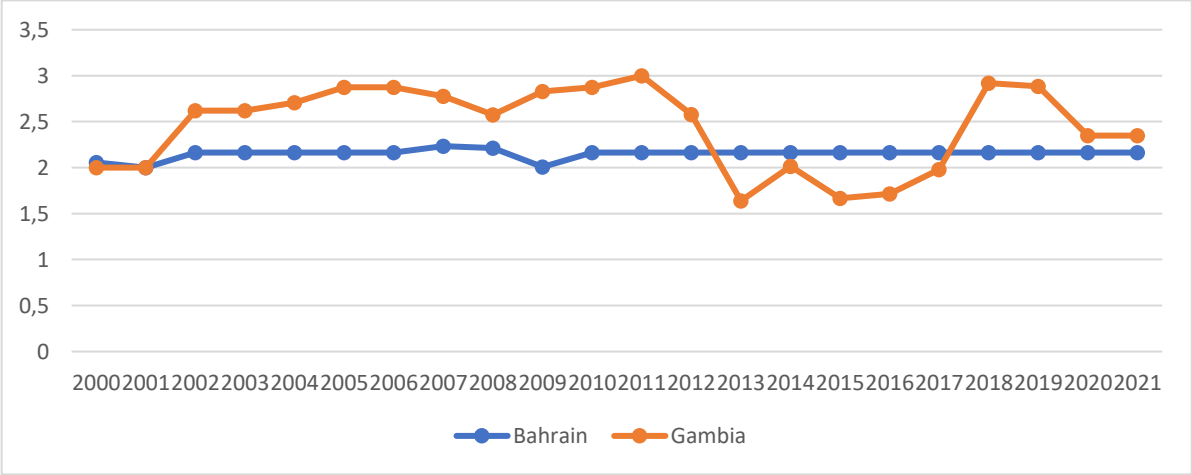
In Club 5, Syria has reduced its use of potash-based fertilizers due to the instability that started in 2011. Similarly, Libya has recently faced internal instability, and fertilizer use has fluctuated due to both a decrease in production areas and financial difficulties.

Figure 68. Relative Transition Paths of Countries in Club 5



The fluctuating course of Bahrain and Gambia in Club 6 draws attention to Bahrain's stable structure while Gambia's fluctuating course is noteworthy. Gambia, which used relatively higher levels of potash fertilizer than Bahrain in the 2001-2012 period, exhibits the opposite outlook after 2012 until 2018.

Figure 69. Relative Transition Paths of Countries in Club 6



In the clustering according to phosphorus fertilizer use, countries are divided into 5 clubs. Türkiye and Azerbaijan were in the not convergent group and did not converge with

other countries. In general, the first 3 groups have very close levels of phosphorus fertilizer use, while club number 5 has relatively lower levels of phosphorus fertilizer use.

Table 12. OIC Convergence Clubs for Phosphate Use

Clubs	**Countries**
Club 1 (6 Members)	| Bangladesh | Benin | Gabon | Guinea | Indonesia | Pakistan |
Club 2 (7 Members)	| Afghanistan | Ivory Coast | Egypt | Kazakhstan | Mali | Nigeria | | Uzbekistan |
Club 3 (13 Members)	| Albania | Algeria | Burkina Faso | Cameroon | Iran | Iraq | Malaysia | Morocco | Mozambique | Saudi Arabia | Senegal | Togo | Tunissia |
Club 4 (13 Members)	| Brunei-Darrussalam | Guyana | Jordan | Kuwait | Kyrgyzstan | Libya | Niger | Oman | Suriname | Syria | Tajikistan | Uganda | United Arab Emirates |
Club 5 (2 Members)	| Bahrain | Gambia |
Not Convergent Group	| Azerbaijan | Türkiye |

On average, the course of the clubs over the period is relatively stable. However, a detailed analysis reveals a similar picture to the use of potash fertilizers.

Figure 70. Relative Transition Paths of Clubs

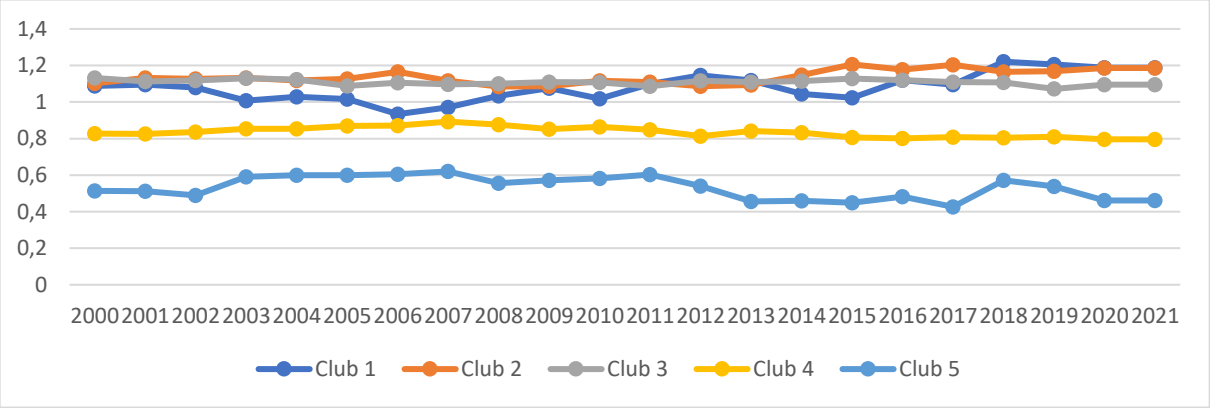
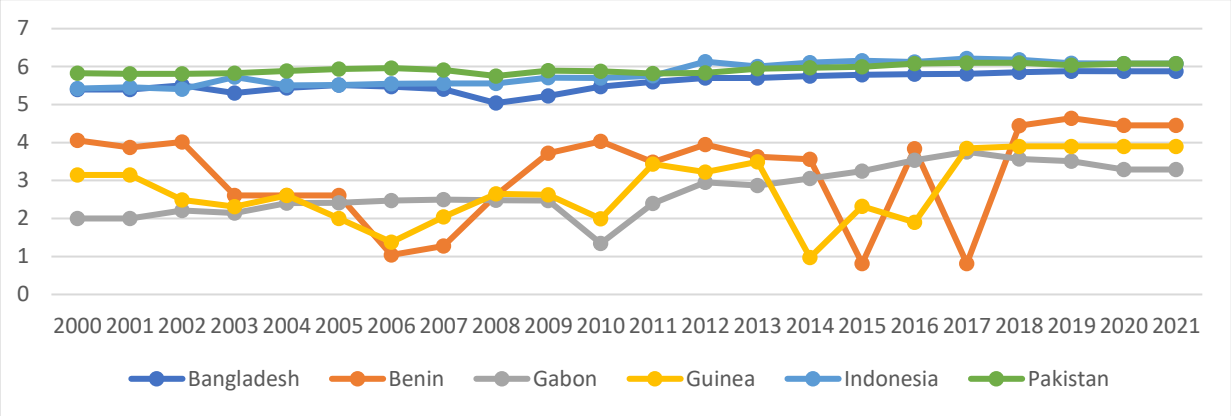
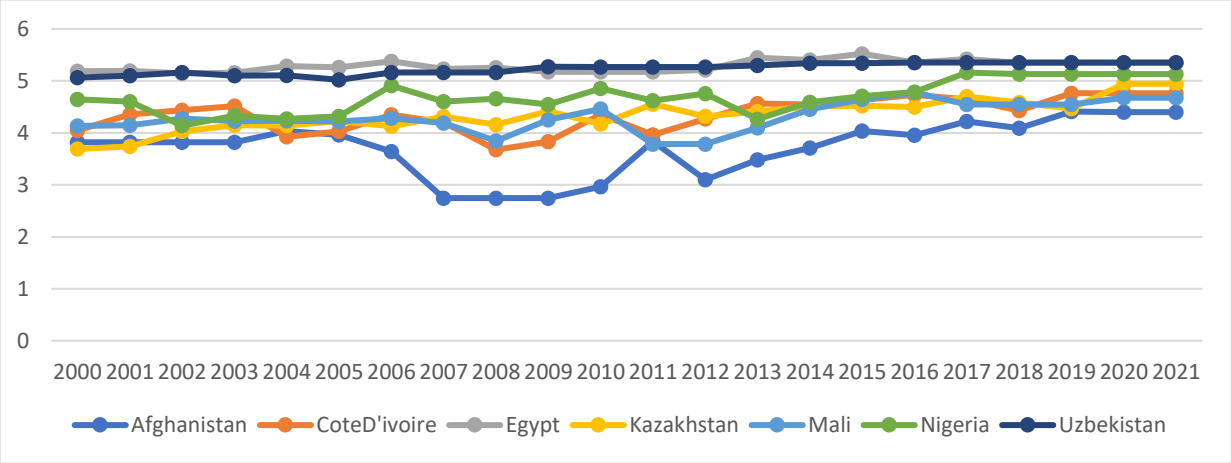


Figure 71. Relative Transition Paths of Countries in Club 1



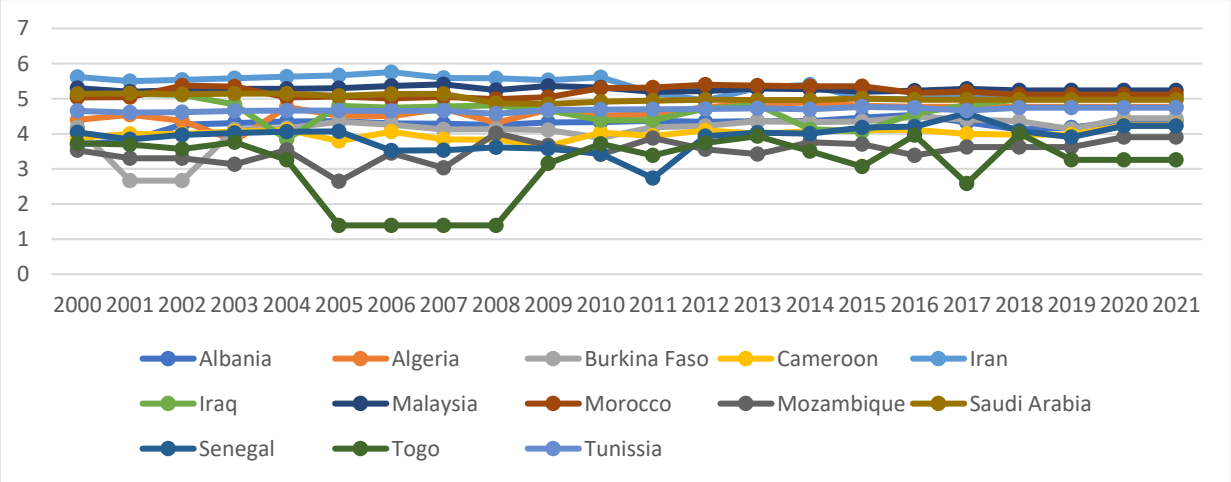
In Club 1, Benin, Guinea and Gabon have relatively more volatile phosphorus fertilizer use. While Benin and Guinea have similar decreasing and increasing trends, Gabon differs and shows a more stable stance compared to the two countries. Evaluating countries according to political stability and the type of company dominant in the agricultural sector can be informative in terms of explaining sudden ups and downs.

Figure 72. Relative Transition Paths of Countries in Club 2



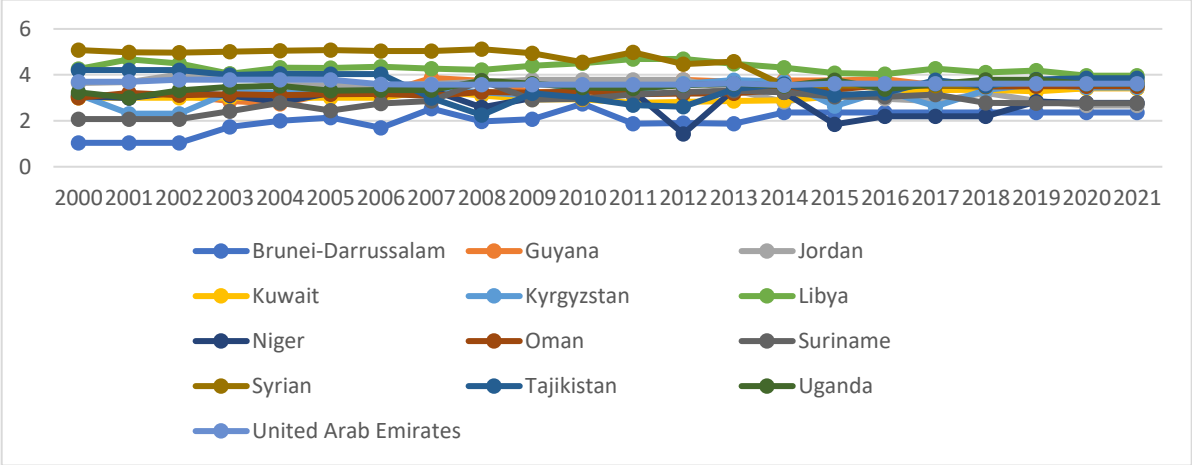
Club 2 shows a relatively stable trend in phosphorus fertilizer use, except in Afghanistan. In Afghanistan, fertilizer use varies according to the seed industry, the intensified migration wave as a result of political instability, and crop group.

Figure 73. Relative Transition Paths of Countries in Club 3



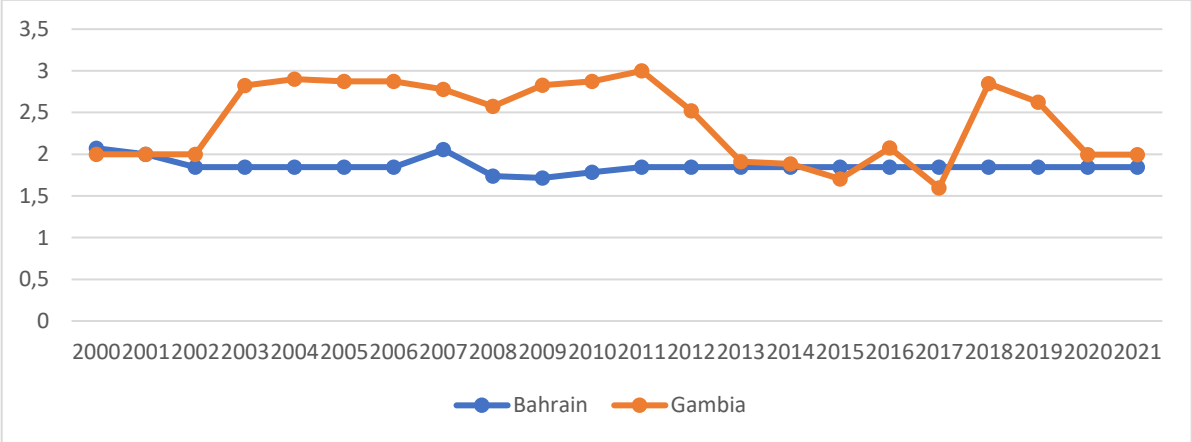
In Club 3, Togo's significant decrease in the use of phosphorus fertilizers during the food crisis period is of particular interest.

Figure 74. Relative Transition Paths of Countries in Club 4



The phosphorus fertilizer use levels of the countries in Club 4 are relatively consistent and quite similar to each other.

Figure 75. Relative Transition Paths of Countries in Club 5



Gambia and Bahrain in Club 5 have very similar patterns and levels of potash fertilizer use. This shows that the phosphorus and potash fertilizer use structure of the two countries is similar. It should be noted that Gambia also exhibits a similar trend in the use of nitrogen fertilizers at similar rates.

The most important change in seed which is an essential agricultural input, is the establishment of industries dominated by private companies in countries such as

Afghanistan and Turkiye, while in some other countries the use of those is directed through input subsidies. In this framework, since country-based data on seeds are not available, an assessment cannot be made within the framework of club convergence analysis, but a perspective is presented from the information available in the literature.

Seeds are the main input of agricultural production and quality and healthy seeds are also the determinants of productivity. The selection and use of appropriate seed increases yield by preventing harvest losses, reducing the costs and increasing the benefits of agricultural production by reducing the use of fertilizers, pesticides and water, which are other basic inputs[145].

Although the share of seeds in the agriculture-food chain is relatively low in terms of price, the opposite is the case in terms of value added. The share of seed in inputs and its value as an economic product is even higher in the production of cereals, which do not require much labor, especially for small-scale agricultural producers who want to increase their resilience and resistance to adverse shocks[146].

Especially after the agricultural agreement process, industrial production and trade are shaped by the type and quality of the seed. While the use of ancestral seeds by agricultural producers comes to the forefront in terms of input and production sustainability, certified seeds are advantageous in terms of productivity and in some countries to receive input support.

In the international industrial seed trade, also known as certified seed, companies originating from Netherlands, France, USA, Germany and Denmark are in the leading position with an export share of 60 per cent. Among the world seed imports, Türkiye, which is the largest seed importer among the OIC members, has a share of 1.5 per cent; Algeria, Morocco,

[145] Dede, İlknur, (2023), "Ensuring the Sustainability of Agricultural Inputs to Combat Food Insecurity in the OIC Member Countries", T.C. Tarım ve Orman Bakanlığı, (https://www.comcec.org/wp-content/uploads/2023/05/4-2023-BRIEFING-EN-ILKNUR-REV.pdf), (Date of access: 09.09.2023).
[146] Dede, (2023), ibid.

Pakistan, Egypt and Saudi Arabia have a share of 0.5 per cent[147]. While the use of ancestral seeds by agricultural producers comes to the forefront in terms of input and production sustainability, certified seeds are advantageous in terms of productivity and input subsidy in some countries.

OIC member countries are developing initiatives within COMCEC for international industrial seed production, agricultural sustainability and food security in the face of adverse external shocks. Cooperation and solidarity among member countries are sought through best practices in effective seed management and distribution.

In addition, seeds are among the first implementations in the field of biotechnology. In 1993, following the first gene modifications made with the aim of ending hunger with higher vitamin content, more nutritious and more fatty seeds, production processes increased rapidly and in 1999, the world-scale cultivation increased by 50 per cent and its use in plant production increased 23 times[148]. Currently, gene modified seeds according to the needs of the pharmacological sector are progressing with the integration of agriculture, food and pharmaceutical sectors[149]. From plant breeding to fermentation, many plant and animal production is carried out by hybridisation through biotechnology applications, that is, genetically modified. Seeds with altered herbicide, pest and virus tolerance and animals[150] with altered genetic modification have negative impacts on health and sustainability of production, environmental pollution, eradication of traditional production techniques and agricultural memory, increasing share of agricultural imports and foreign dependency.

Credit to Agriculture Sector

Financing is a necessary tool for mechanisation and investments that will increase agricultural production. However, it is important that this instrument is made available to

[147] Dede, İlknur, (2023), "Ensuring the Sustainability of Agricultural Inputs to Combat Food Insecurity in the OIC Member Countries", T.C. Tarım ve Orman Bakanlığı, (https://www.comcec.org/wp-content/uploads/2023/05/4-2023-BRIEFING-EN-ILKNUR-REV.pdf), (Date of access: 09.09.2023).
[148] Dede, (2023), ibid., p.46
[149] Dede, (2023), a.g.g., p.45
[150] TUSİAD, (2000), p.41-51.

small-scale agricultural producers under favourable conditions or with subsidies in order to ensure that producers are guided by public policies, that small producers retain their means of production and that income inequality does not grow. If governments wish to provide such a support mechanism to agricultural producers, publicly-led institutions such as agricultural credit cooperatives, public banks or farmers' unions offer preferable conditions compared to private markets. This can be through different means such as interest rates, collateral, repayment period or diversification. When public policies abandon protectionist policies in line with the WTO Agreement on Agriculture, agricultural producers borrow under market conditions, and in developing countries where financial markets have not reached a relatively sufficient degree of financialisation, they may resort to non-market borrowing. In both cases, small producers generally lose their means of production. The reason for this is that in the developing agricultural production-dominated economic structure, which the OIC geography also predominantly has, producers generally cannot reach sufficient income levels even before expanding or modernising their production units, and they borrow in order to continue production.

Credits allocated to agricultural production in the OIC group are presented in Table 13[151].

Table 13. Credits to Agriculture Sector

Country	**Credit to Agriculture (%)**	**Country**	**Credit to Agriculture (%)**
Afghanistan	2.46	Malaysia	2.31
Albania	1.54	Maldives	4.70
Azerbaijan	4.21	Mali	14.86
Bahrain	0.19	Morocco	4.08

[151] FAOSTAT, (2023), "Investment- Credit to Agriculture", (https://www.fao.org/faostat/en/#data/IC), Date of access: 20.08.2023.

Bangladesh	0.19	Mozambique	7.41
Benin	2.78	Niger	0.78
Burkina Faso	2.95	Nigeria	3.97
Ivory Coast	4.40	Oman	0.47
Egypt	1.71	Pakistan	9.15
Gabon	8.84	Senegal	2.58
Gambia	7.01	Sudan	17.91
Guinea-Bissau	2.02	Suriname	2.85
Guyana	10.11	Syrian	18.74
Indonesia	6.15	Tajikistan	18.09
Iran	14.25	Togo	0.35
Iraq	12.81	Tunusia	5.17
Jordan	1.56	Türkiye	1.72
Kazakhstan	3.68	Turkmenistan	9.63
Kyrgyzstan	12.06	U.A.E.	0.30
Lebanon	1.08	Yemen	1.68

Calculations obtained from FAOSTAT data include average values for the years 2000-2021. However, although the series cannot be found in their entirety and for all countries, it

is intended to be presented in the study to provide a perspective. The share of agricultural loans reflects the share in total loans. While the averages of the available country data are used, data before 2002 for Bangladesh, 2005 for Azerbaijan, 2007 for Albania, 2008 for Afghanistan, Iraq and Tajikistan, 2009 for Kazakhstan and 2010 for Lebanon were not accessible. Data are available for Yemen until 2014 and for Iran until 2015. In this context, OIC credit average is calculated as 5.60 per cent for 40 countries. The EU average for agricultural loans is 2.43 per cent, while the world average is 2.42 per cent.

Another alternative to debt is to increase the scale and technology of production through foreign direct investments. This is a structure in which advantages and disadvantages are intertwined. In economies where the level of development and control of markets is significant, large-scale investments can provide competitive advantages without monopolistic structures. It can also provide cheap food and employment opportunities to consumers and positive contributions to the public sector through infrastructure investments, foreign trade revenues and taxes, and can propagate internal stability as a positive externality. On an opposite path, however, small and medium-scale producers who retain ownership of the means of production may be pushed out of the system, deepening crises of poverty and hunger. These investments can be analysed in detail and policy options can be discussed by looking at the origin countries.

Government Expenditures

Agriculture share of government expenditures is obtained from the Agriculture Sector in the functional classification of IMF's government finance statistics. [152]. Public expenditures in agriculture and livestock, forestry, fishing and hunting, and environmental protection are composed of the following items;

[152] FAO, (2022), "Government Expenditure", (https://fenixservices.fao.org/faostat/static/documents/IG/IG_e.pdf), p.1, (Date of access: 30.08.3023).

- Management of agricultural public services, protection, rehabilitation and extension of arable land, agrarian reform, regulation and supervision;
- All kinds of activities related to flood control, irrigation and drainage, including loans, subsidies, construction and operation,
- All services related to farms, such as management, veterinary, pest control, etc., provided from public funds,
- Compensation, grants, support, loans, subsidies and all other payments to farmers, all kinds of R&D, extension and information services;
- Protection of forest reserves, afforestation activities, fire fighting, issuance of logging licenses and all other services related to forests;
- Supervision, regulation and issuance of fishing licenses for freshwater, coastal and ocean fisheries,
- Construction, operation, support, extension and stocking of fish hatcheries, commercial fishing and hunting related activities
- Environmental expenditures include waste management, wastewater management, air, soil, groundwater protection, noise and radiation control, biodiversity, fauna and flora protection and all other environmental expenditures.[153]

In this context, countries' fields of activity related to agricultural production vary. For instance, landlocked OIC member countries do not have coastal and ocean fisheries, while some countries do not have forested areas. The shares of sectors, such as livestock breeding, may be the dominant mode of production in countries with arid climates.

Another difference is in the organization of countries. Some countries are governed by centralized government, others by decentralized or state governments. In some countries, local governments have fiscal autonomy and the freedom to spend and raise revenue independently of the center, while in others, local governments are subject to the administrative and financial tutelage of the central government, whose authority extends

[153] FAO, (2022), "Government Expenditure", (https://fenixservices.fao.org/faostat/static/documents/IG/IG_e.pdf), p.1-2, (Date of access: 30.08.3023).

over the entire territory[154]. To avoid this confusion, FAOSTAT divides the statistics into consolidated general government and central government budget. Most countries report their expenditure statistics as central government without any level distinction. Thus, central government refers to the organizational unit that includes both the institutional units and their controlled non-profit organizations, extra-budgetary units and social security funds, as well as the legislative-executive-judicial powers at the national level[155].

Table 14. OIC Convergence Clubs for Government Expenditure in Agriculture

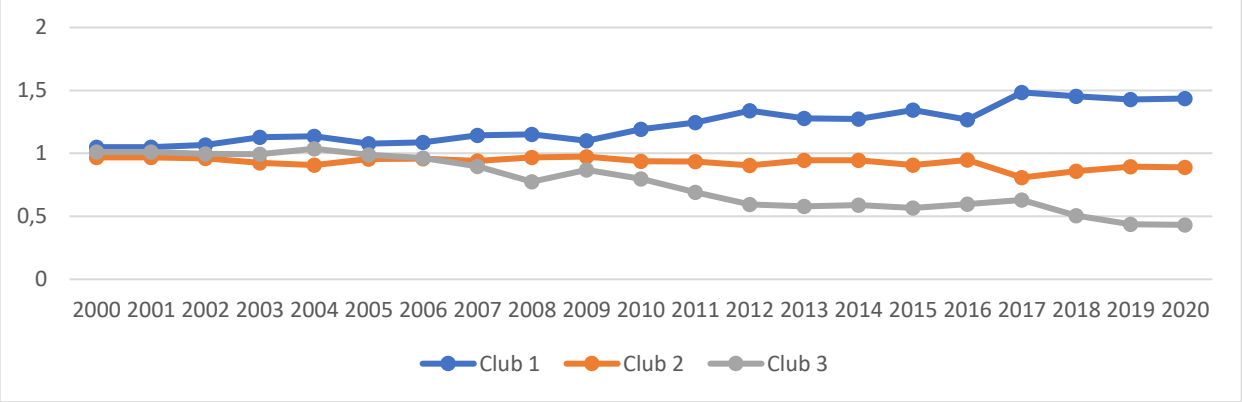
Clubs	**Countries**
Club 1 (9 Members)	| Afghanistan | Bangladesh | Burkina Faso | Guyana | Indonesia | | Kazakhstan | Mali | Mauritania | Togo |
Club 2 (16 Members)	| Albania | Algeria | Azerbaijan | Ivory Coast | Guinea | Guinea-Bissau | Iran | Malaysia |Morocco | Nigeria | Suriname | Tunissia | Türkiye | Uganda | Uzbekistan |
Club 3 (13 Members)	| Egypt | Kyrgyzstan |Mozambique | Niger |

It can be observed that OIC member countries are divided into 3 clubs in the grouping formed by examining the public expenditures of the central states obtained from FAOSTAT

[154] Ibid., FAO, (2022), p.3
[155] Ibid., FAO, (2022), p.3

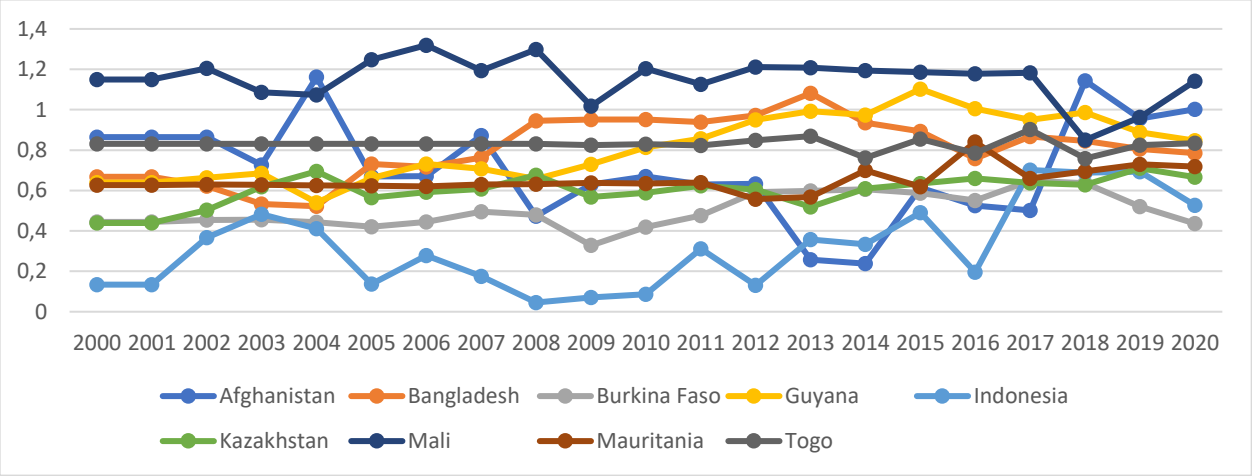
as a percentage of total expenditures. Accordingly, countries converge between club 1, where public expenditure levels are the highest, and club 3, where public expenditure levels are the lowest. However, only the share of agricultural expenditures in the total expenditures of the countries is presented and GDP differences are not evident. For example, in a country with an annual national income above the OIC average, even if the agricultural sector is allocated a high share in terms of amount, it may appear relatively low in terms of ratio. Alternatively, a country with a high share of foreign aid in its budget may allocate more resources to the agricultural sector than another country that allocates a share from its own tax revenues. Therefore, what is intended to be conveyed in this context is the relative weight of the agricultural sector for that economy and the degree to which the government supports/protects the sector.

Figure 76. Relative Transition Paths of Clubs



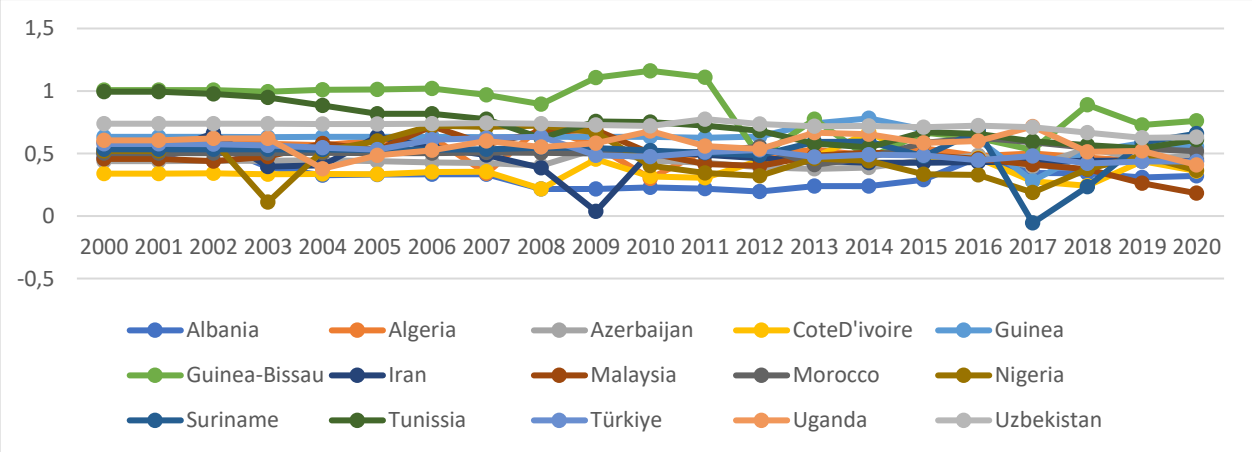
In this context, Figure 76, which shows the general trends of the clubs, shows that the initial levels of agricultural public expenditures of the countries grouped in the 3 clubs are quite close to each other, but towards the end of the period, expenditures diverged and the clubs drifted apart from each other. Since this study does not provide information on the public expenditure legislation and constitutional organization of the 57 OIC member countries, it is assumed that all public expenditures represent the central government.

Figure 77. Relative Transition Paths of Countries in Club 1



Countries in Club 1 have the highest public expenditure. Within the Club, Mali allocates an average of 15 percent of its budget to the agricultural sector. For 2021, this ratio was 13.84, while Mali's GDP in quantity was US$ 19,157,055,766. In other words, in 2021, US$2,651,336,518 was allocated to the agricultural sector by Mali's central government. Considering the same data for Indonesia, which is at the bottom of the club average, the average of agricultural public expenditures for the period was 2.37 percent and the expenditure share for 2021 was 3.36 percent, while the size of the country in current dollars is US$ 1,186,092,991,320. In terms of quantity, this is US$ 39,852,724,508.

Figure 78. Relative Transition Paths of Countries in Club 2

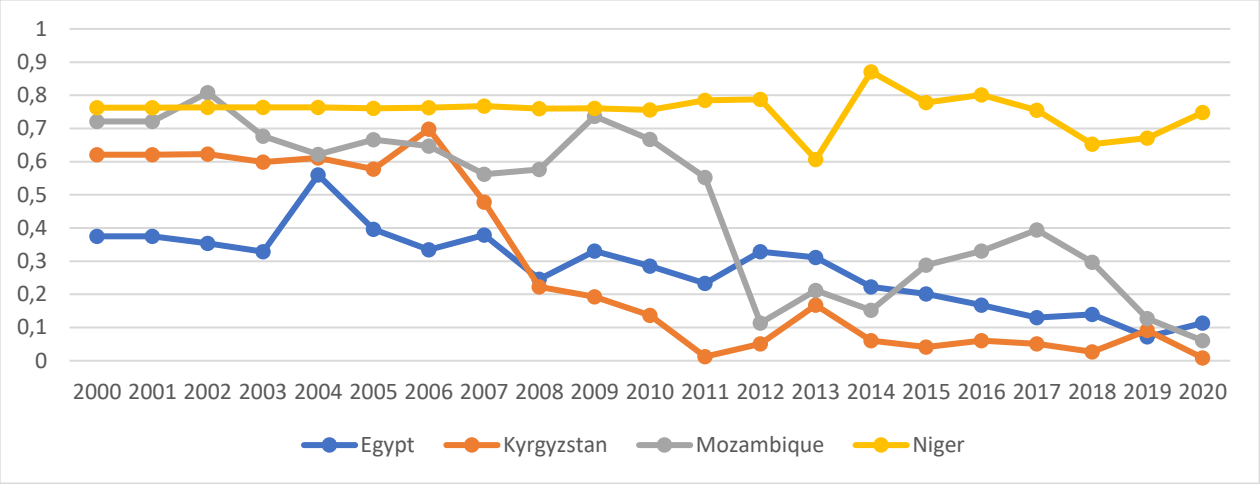


The countries in Club 2 can be evaluated in a similar way. Periodic sudden fluctuations can be explained by taking into account the economic and political stability circumstances of the countries. For example, Nigeria in 2003, Iran in 2009, and Suriname in 2017 experienced large declines. Guinea Bissau, on the other hand, experienced a significant increase in the share of public spending allocated to the agricultural sector in 2010. For example, in Nigeria, the political struggle for dominance in the delta region is reflected in the elections[156]. In Nigeria, where the 2003 elections took place, the temporary post-election instability hints that financial resources were being allocated to internal security services by the new government. Similarly, examples such as the temporary internal instability created by the protests and demonstrations following the presidential elections in Iran in 2009[157], or the relative stability created by the military intervention in Guinea Bissau in 2009[158] when the president was assassinated and the military intervened in the new elections and seized power.

Among the countries in Club 3, it is noteworthy that the share of the agricultural sector in public expenditures fell sharply in Mozambique and Kyrgyzstan. In Kyrgyzstan, the internal instability that has been going on since the 1990s turned into small-scale conflicts in 2006[159] and the ethnic conflicts[160] that broke out in the south of the country after a series of reforms in Kyrgyzstan in 2010 both create instability and cause public resources to be diverted to ensure social peace.

[156] BBC, (2007), "Nijerya'da Siyaset, Çeteler ve Petrol", (https://www.bbc.co.uk/turkish/fooc/story/2007/02/070223_niger.shtml), (Date of access: 30.08.2023).
[157] BBC, (2018), "İran'da Protestolar: 2009'dan Bu Yana Ne Değişti Ne Değişmedi?", (https://www.bbc.com/turkce/haberler-dunya-42541951), (Date of access: 30.08.2023).
[158] FIDH, (2012), "Guinea-Bissau: 2010-2011", International Federation for Human Rights, (https://www.fidh.org/en/region/Africa/guinea-bissau/GUINEA-BISSAU-2010-2011), (Date of access: 30.08.2023).
[159] BBC, (2006), "Kırgızistan'da Çatışma Çıktı", (https://www.bbc.co.uk/turkish/news/story/2006/11/061107_bishkek.shtml)
[160] MFA, (2010), "No:130, 12 Haziran 2010, Kırgızistan'daki Olaylar Hk.", (https://www.mfa.gov.tr/no_-130_-12-haziran-2010.tr.mfa), (Date of access: 30.08.2023).

Figure 79. Relative Transition Paths of Countries in Club 3



In the country where terrorist acts increased after the civil war, the rivalry between the two major political poles kept the environment of instability alive and the country came to the brink of civil war as of 2013[161]. On the other hand, the cash transfers to the country through the project to increase the capacity of agricultural producers within the scope of combating climate change covering the years 2016-2019, in which natural gas reserves are found, seem to have increased the public shares transferred to the agricultural sector [162].

Regarding the share of agricultural public expenditures, SESRIC has calculated an index called Agriculture Orientation Index (AOI). In its 2020 report, SESRIC presents the "Agriculture Orientation Index" (AOI). The index, which is closely related to the topics of poverty and malnutrition, is calculated as (Government expenditure in agriculture / Agricultural value added in GDP). A value greater than 1 indicates that the agricultural sector receives a larger share of public expenditures compared to its economic value. A value equal to 1 indicates that the public sector can remain neutral in terms of expenditure policies towards agriculture, while a value less than 1 indicates a lower orientation towards

[161] AA, (2017), "Afrika'nın Yükselen Sesi Mozambik", (https://www.aa.com.tr/tr/dunya/afrikanin-yukselen-ekonomisi-mozambik/823303), (Date of access: 30.08.2023)
[162] FAO, (2023), "FAO in Mozambique:Project List", (https://www.fao.org/mozambique/programmes-and-projects/project-list/en/), (Date of access: 30.08.2023).

agriculture.[163]. This value is above 1 only for Qatar and is below 1 for other OIC member countries. In fact, for countries other than Guyana, Türkiye, Bangladesh, Ivory Coast, Burkina Faso, the index decreases further over time. Guyana, Ivory Coast and Burkina Faso are expected to reach an index value of 1 by 2030.[164]. In other words, public expenditures on the agricultural sector do not seem to be effective in economic terms. However, within the scope of food sovereignty and food security, small agricultural producers should not be deprived of public support, especially taking into account poverty and hunger targets. In particular, negative shocks that increase food costs, such as the pandemic, input price increases and oil price increases, change household expenditure shares and the restriction of the mobility of the labor force working in agriculture contributes to poverty. Accordingly, it seems necessary for agricultural and food production that small agricultural producers in the OIC geography, where the share of agricultural labor force is high, should not lose their income and their current jobs should be protected.[165].

In line with this information, the flow of the text requires an analysis of agriculture value added share of GDP. Nevertheless, the study focuses on agricultural inputs that affect agricultural sustainability and the sustainability of these inputs. Therefore, the analysis will proceed on other agricultural inputs related to production and the analysis on agricultural production and its value added will be included in the following sections of the study.

Agriculture Infrastructure

Although irrigated agricultural lands are addressed under the topics of level of water stress and water use efficiency, irrigation excluding rainfall requires mechanization and infrastructure investment, and is therefore addressed under a separate section.

[163] SESRIC, (2020), "Towards the Achievement of Prioritised Sustainable development Goals in OIC Countries", Organisation of Islamic Cooperation, p.21.
[164] SESRIC, (2020),.ibid.,p.21.
[165] SESRIC, (2020),.ibid., p.22.

Land area equipped for irrigation refers to the agricultural area equipped and utilized with infrastructure and equipment for irrigating crops. Land area equipped for irrigation includes fully controlled and partially controlled irrigation using surface irrigation, rainfall irrigation or zonal irrigation methods. Partially controlled irrigation, also called flood irrigation, involves the diversion of excess water to crops to control runoff from wetlands and valley floors[166]. The value given as "Actually irrigated area" means the physical size of the irrigated area is calculated once, i.e. even if the area is irrigated more than once in rotation plantings, it is calculated only once.[167]. The data are collected by FAO by survey method and given in units of (1000 ha).

When analyzing countries according to the size of irrigation infrastructure, it should be taken into account that the geographical conditions of each country are different. Flat regions with rich surface water resources and mountainous regions like Kyrgyzstan with rich surface water resources have different irrigation infrastructure costs. Alternatively, the amount of water used and the amount of water infrastructure is not the same in relatively water-scarce countries with favorable climatic conditions and countries with arid desert climates fed by a single water source. In this context, the countries grouped according to the diversity that may occur in this context converge to each other by being divided into 9 different groups.

Countries in the not convergent group are similar to other OIC member countries by differentiating in terms of factors affecting irrigation infrastructure such as water resources, landforms, geographical uniformity, level of financing and technology, crop pattern and quantity produced.

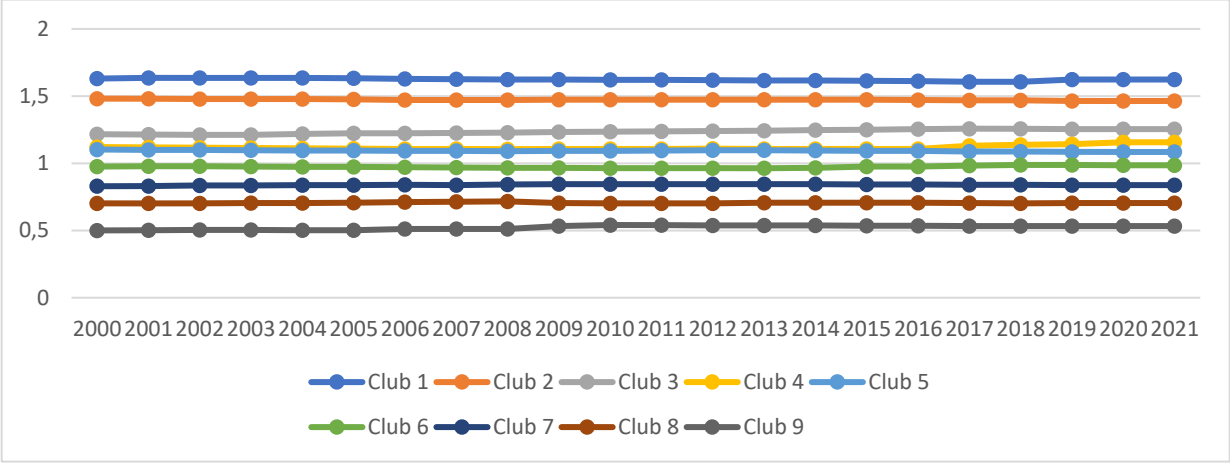
[166] FAO, (2023), "Land Use: Definitions and Standrts", (https://www.fao.org/faostat/en/#data/RL), (Date of access: 15.09.2023).
[167] Ibid., FAO, (2023).

Table 15. OIC Convergence Clubs for Land Equipped Irrigation

Clubs	**Countries**
Club 1 (3 Members)	| Bangladesh | Indonesia | Iran |
Club 2 (7 Members)	| Afghanistan | Algeria | Egypt | Iraq | SaudiArabia | Türkiye | | Uzbekistan |
Club 3 (4 Members)	| Kazakhstan | Morocco | Palestine | Türkmenistan |
Club 4 (3 Members)	| Kyrgyzstan | Niger | Tajikistan |
Club 5 (3 Members)	| Libya | Malaysia | Mali |
Club 6 (3 Members)	| Albania | Nigeria | Oman |
Club 7 (5 Members)	| Burkina Faso | Guyana | Jordan | Mozambique | Senegal |
Club 8 (9 Members)	| Benin | Ivory Coast | Guinea | Kuwait | Lebanon | Mauritania | Qatar | Suriname | United Arab Emirates |
Club 9 (4 Members)	| Cameroon | Chad | Gambia | Sierra Leone |
Not Convergent Group	| Azerbaijan | Bahrain | Gabon | Guinea-Bissau | Pakistan | Somalia | Syria | Togo | Tunissia | Uganda | Yemen |

Figure 80, which identifies the general trends of clubs, suggests that there are no obvious changes in the average size of areas with irrigation infrastructure over the 20-year period. However, when clubs are examined in detail, intra-club differences emerge.

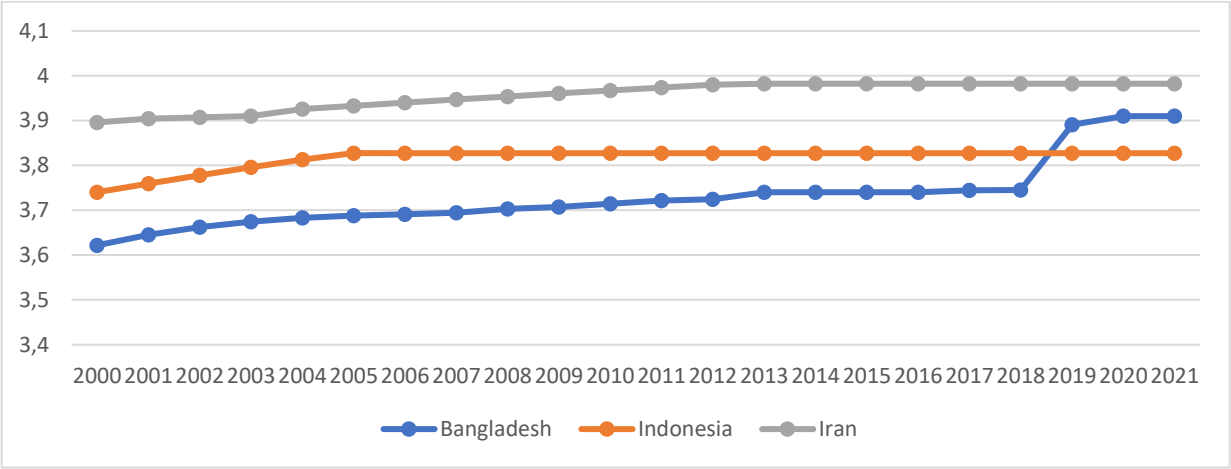
Figure 80. Relative Transition Paths of Clubs



While the proportion of agricultural land with irrigation infrastructure remains at baseline levels until 2018 in the 3 countries in Club 1, Bangladesh's progress towards infrastructure is noteworthy and shows a tendency to progress from baseline to good status. Bangladesh has been focusing on irrigation since the mid-2000s, directing investments and funds towards effective and efficient irrigation methods. The country's objectives for irrigation infrastructure include improving the water management and distribution system, increasing the efficiency of surface water irrigation in the south of the country, making treatment plants more efficient to reduce saltwater intrusion, and rehabilitating rivers to divert their flow to the south[168]. In this framework, various projects and programs have been implemented since 2007. In this respect, the size of the area with irrigation infrastructure at the end of the period of Banlagesh increased by 94 percent compared to the beginning of the period, and in 2019, when the most significant leap was experienced, there was an increase of 40 percent compared to the previous year.

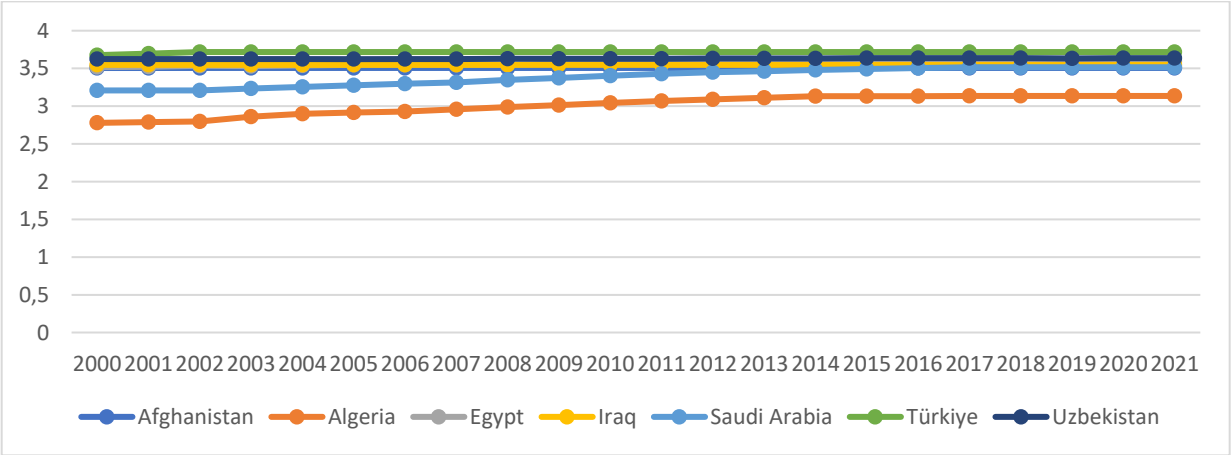
[168] FPMU, (2015), "National Food Policy Plan of Action and Country Investment Plan: Monitoring Report 2015", (https://www.fao.org/3/az470e/az470e.pdf), p.41., (Date of access: 30.08.2023).

Figure 81. Relative Transition Paths of Countries in Club 1



The irrigated agricultural areas of the countries in Club 2 are increasing steadily and in harmony. Countries that are close to each other in terms of initial level are converging in terms of the tendency to increase the proportion of irrigated area by the end of the period.

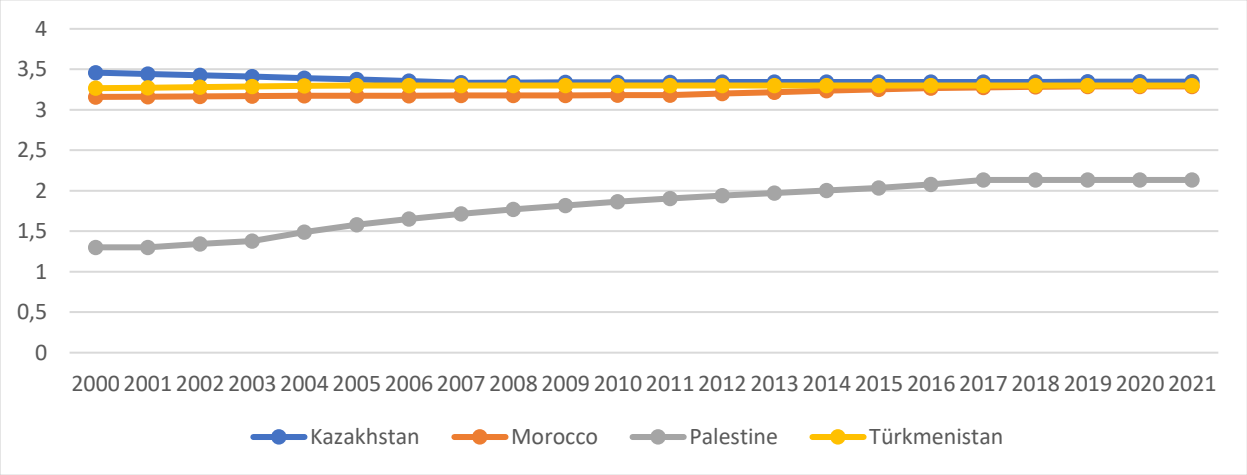
Figure 82. Relative Transition Paths of Countries in Club 2



Among Club 3 countries, Kazakhstan, Turkmenistan and Morocco are quite similar to each other and have similar tendencies. Palestine differs slightly from the group countries. In the previous sections on water and fertilizer as inputs, it was noted that Palestine faces some unresolved problems as a result of instability in the occupied territories and blockades

due to border separation. Similar issues also apply to irrigation infrastructure. The irrigated areas of the country, which generally show an increasing trend, are being supported with large budgets through international organizations, country and region-based funds. Due to the geographical location of Palestine, investments in the country are also important for many programs and projects that will be beneficial in the region. For example, a 2018-2022 project to reduce wastewater for irrigation and ecosystems aims to reduce water scarcity, food insecurity and nutritional stresses in the Near East and North Africa.

Figure 83. Relative Transition Paths of Countries in Club 3

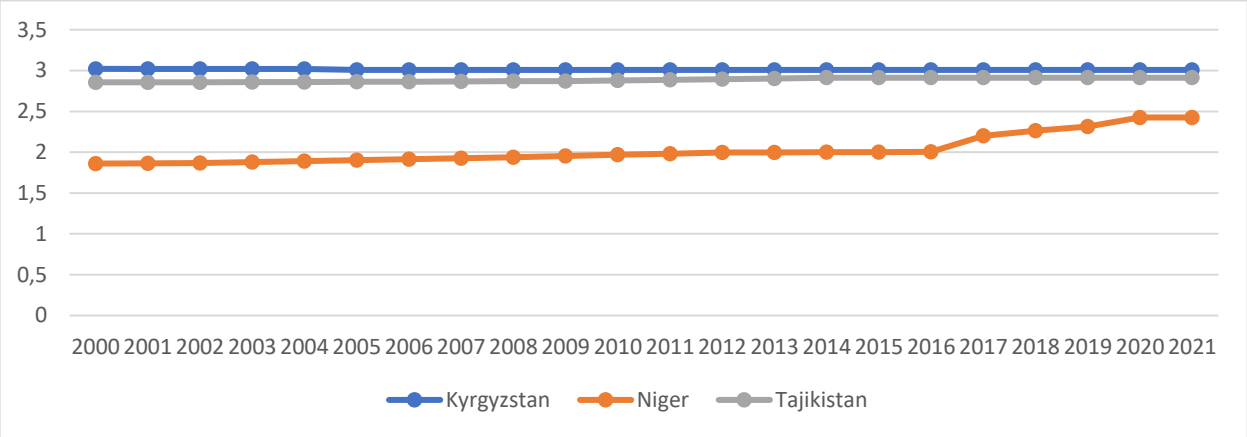


Although Kyrgyzstan and Tajikistan are quite close to each other among the Club 4 countries, it is observed that Kyrgyzstan experienced a slight decrease in irrigated areas due to global warming, while Tajikistan experienced a slight increase in irrigated areas and approached Kyrgyzstan. Niger, on the other hand, is increasing the proportion of irrigated areas with irrigation infrastructure and is approaching the average of the other two countries. Nigeria is among the countries that have increased support to the agricultural sector through various funds. In this regard, within the scope of a project launched in 2015, fertilizers, easy access to finance, product warehouses, and new techniques for irrigation have been introduced to increase agricultural production and sustainability.[169]. After the

[169] FAO, (2017), "Le Niger et la FAO", (https://www.fao.org/3/bc031f/bc031f.pdf), p.2., (Date of access: 30.08.2023)

implementation, which saw significant increases in sorghum and millet production, a high-budget fund was established, enabling farmer federations and unions to follow developments and make them accessible to producers[170].

Figure 84. Relative Transition Paths of Countries in Club 4

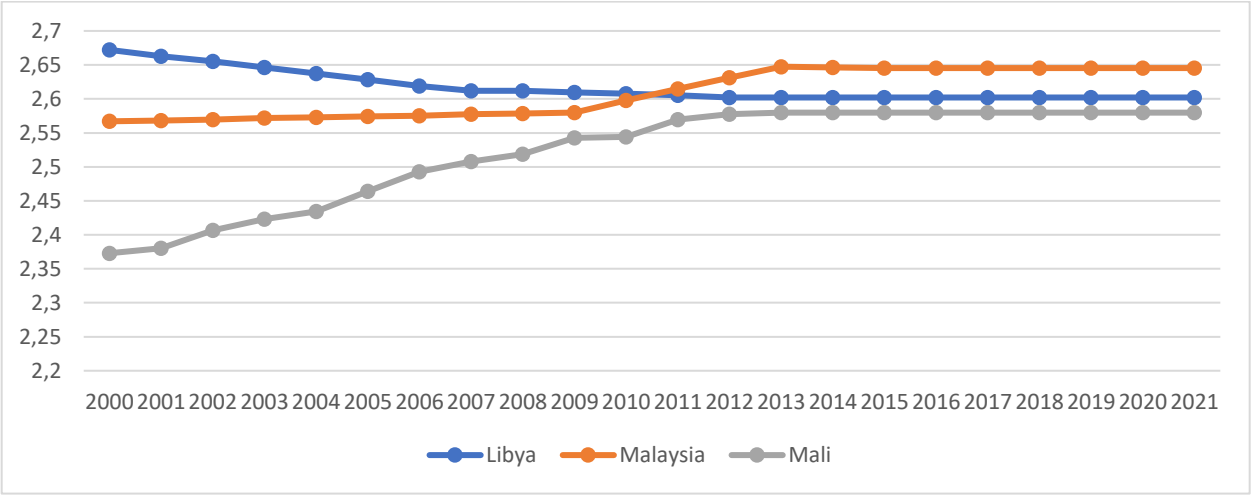


The 3 countries in Club 5 started at different levels and converged to each other in 2009-2010. The irrigated area size of Libya, which is included in the club, decreased between 2006-2010. Malaysia, which has less irrigated area than Libya, increased its irrigated area in the same period. Mali, on the other hand, rapidly increased its irrigated area size, which was lower than the two countries, and approached the group average by 2011. Mali's relatively better performance is attributed to the construction of the Niger River irrigation canals, modernization and renovation of irrigation canals with World Bank funding during the 1990s, and the climate change action plan adopted in 2011. The country has improved water management by utilizing the UNFCCC green Climate and Adaptation Fund to mitigate the negative impacts of climate change[171].

[170] Ibid., FAO, (2017).

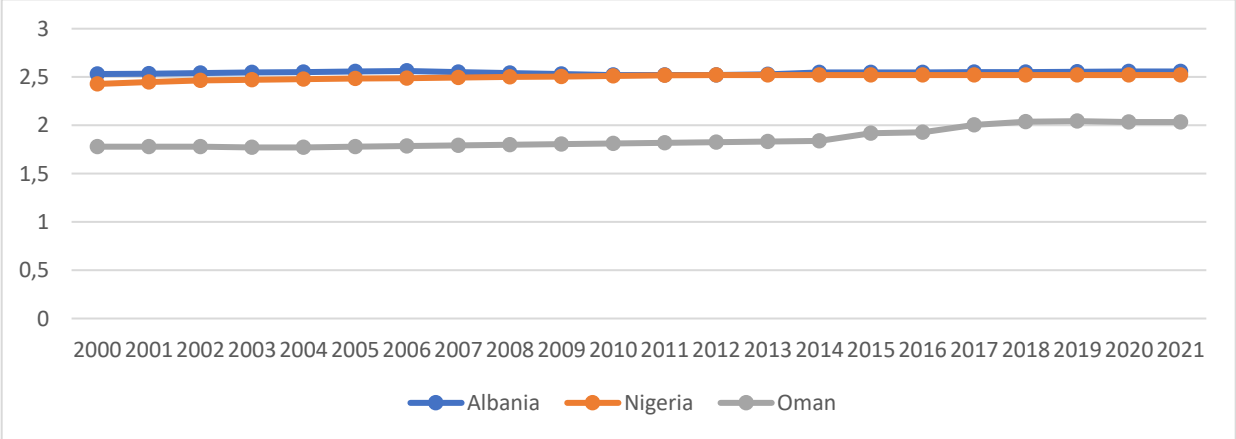
[171] FAO, (2017), "Country Fact Sheet on Food and Agriculture Policy Trends", (https://www.fao.org/3/i7617e/i7617e.pdf), p.4., (Date of access: 15.09.2023).

Figure 85. Relative Transition Paths of Countries in Club 5



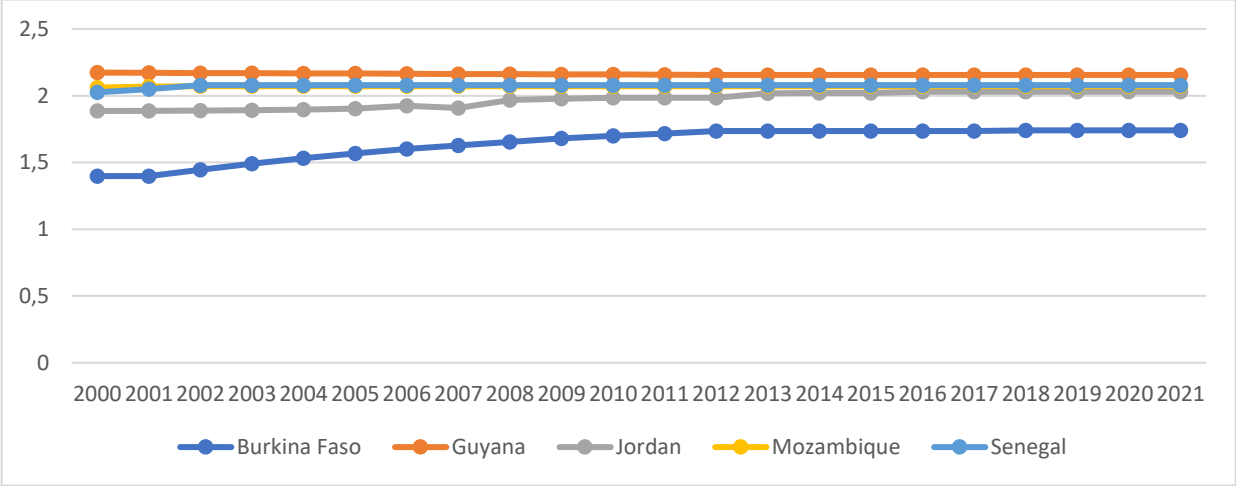
All 3 countries in Club 6 show a similar trend in irrigated land area. Albania and Nigeria are very close to each other. Oman, which started the period at relatively lower levels, follows a similar path. Only the increase in irrigated area is more significant than in the other two countries.

Figure 86. Relative Transition Paths of Countries in Club 6



In Club 7, Burkina Faso started slightly behind the group average compared to the rest of the countries, and accelerated its investments until 2008, moving slightly closer to the group average by the end of the period.

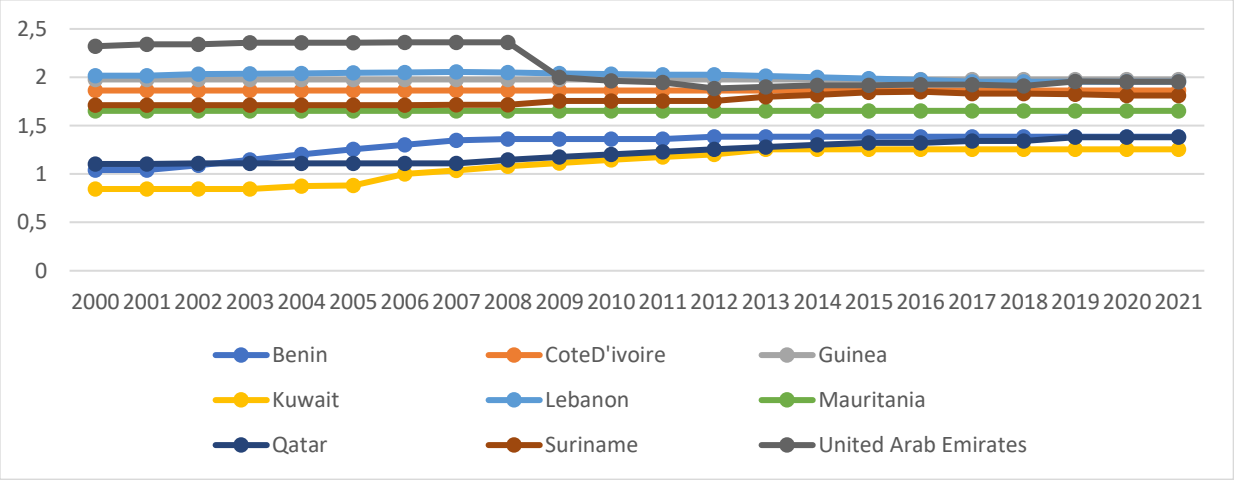
Figure 87. Relative Transition Paths of Countries in Club 7



Club 8, with the largest number of countries, remains relatively steady like the other clubs. The United Arab Emirates' agricultural irrigated area, which was higher in 2009, showed a downward trend to the group average. A detailed analysis of this decline shows a 28 percent decrease in the country's agricultural area. Accordingly, cropland decreased by 63 percent, land under permanent crops by 80 percent and land area equipped for irrigation by 57 percent. The reason for this decline, as frequently mentioned in previous chapters, is the decline in the UAE's share of agricultural employment and the increase in livestock and aquaculture production on agricultural farms. The number of livestock increased by an average of 60 percent from 65,179 in 2008 to 103,909 in 2009[172].

[172] FAOSTAT, (2023), "Crops and livestock products", (https://www.fao.org/faostat/en/#data/QCL), (Date of access: 30.08.2023)

Figure 88. Relative Transition Paths of Countries in Club 8

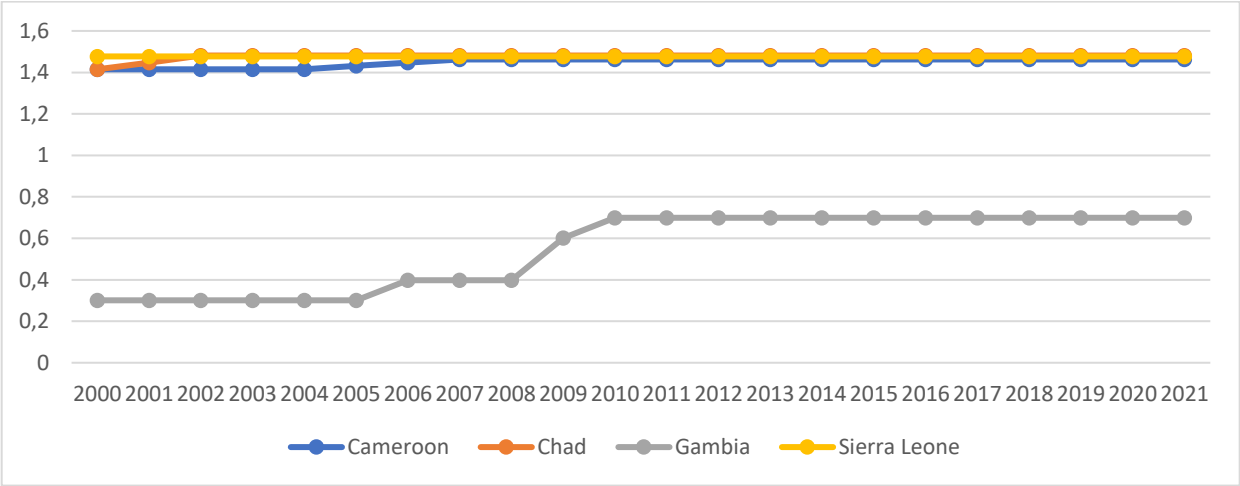


Alongside this, in line with the level of water stress input, the UAE has moved closer to the other group countries by increasing its irrigable area within the framework of its 2051 food security cooperation with FAO, which includes irrigation and drought topics.

In Club 9, it can be observed that The Gambia started the period well below the group average, but over time, with the increase in the share of irrigated area, it approached the average of the group. As mentioned in previous chapters, FAO aims to establish a seed industry in The Gambia, as in Afghanistan and Türkiye[173]. Creating an enabling environment within the framework of policies and programs for this purpose requires minimizing dependence on natural conditions. Measures taken include protecting forest areas against global warming and climate change, facilitating seed growers' access to the country's seed market, disaster risk reduction and management, and strengthening capacity for adaptation to climate change[174]. In this vein, the country appears to have received financial and technical assistance under hundreds of projects and programs.

[173] FAO, (2019), "The Gambia and FAO", (https://www.fao.org/3/az483e/AZ483E.pdf), p.1., (Date of access: 30.08.2023).
[174] FAO, (2023), "FAOin Gambia", (https://www.fao.org/gambia/programmes-and-projects/programmes/fr/), (Date of access: 30.08.2023.).

Figure 89. Relative Transition Paths of Countries in Club 9



Emissions

The OIC geography is one of the regions that are adversely affected and increasingly vulnerable to global warming and climate change as well as water concerns. While some OIC member countries are suffering from rising and intensifying floods, others are getting closer to drought and thirst every day. As of 1990, the levels of air warming gases that have been measured in the OIC region are roughly 18 per cent[175]. In addition, Sub-Saharan African countries with arid and semi-arid climates, MENA countries and Central Asian countries will suffer the most from this unfavourable process. This group of countries is expected to experience disasters such as heat waves, increasing drought, decreasing renewable water resources and floods. It is important to cut down the amount of greenhouse gas that may lead to food insecurity and social unrest.

Looking at the sectoral shares of greenhouse gas emissions in OIC member countries, it can be observed that agriculture contributes 13.7 percent while switching in land usage and forestry cause 19 percent. In terms of emission gases, methane (CH_4) has 21.3 per cent,

[175] SESRIC, (2021), "OIC Environment Report", Statistical Economic and Social Research and Training Centre for Islamic Countries, p.55.

N_2O has 7.3 per cent and F-gases have 2.2 per cent share[176]. The Paris Agreement, which is the framework agreement on the subject, has been accepted by all OIC member countries except Libya, Iran and Yemen, and 26 member countries with 56 per cent of intra-OIC GHG emissions have declared their intention to reduce their GHG emissions by 30 per cent for 2030. These countries are Afghanistan, Bangladesh, Benin, Burkina Faso, Cameroon, Chad, Comoros, Ivory Coast, Djibouti, Indonesia, Iraq, Jordan, Kyrgyzstan, Lebanon, Mauritania, Morocco, Niger, Nigeria, Oman, Pakistan, Senegal, Togo, Tunisia, Turkiye and Uganda.

Reducing the emission rates of countries depends on their investments in environmental technologies. In this context, the OIC region provides funds through UNFCCC agreements. Bangladesh, Indonesia, Turkiye, Uzbekistan and Morocco are the countries attracting the most funds respectively.

Forest area as a proportion of total land area indicator in SGD 15 group shows the change in world forest land. The negative change in forested land area shows that there are different purposes for utilisation and gives evidence of agricultural utilisation[177].

The purpose of utilising this data is to determine whether the change in forested areas is channelled towards arable agricultural production or not. If there is an increase in the areas where agricultural production is carried out despite the decline in forested areas, it is considered important in terms of sustainable agriculture. Soil, as the main agricultural production medium, contributes both to an increase in the amount of production and improvement in welfare, as well as making new mineral-rich soils more productive and nutritious without the use of additional inputs. Otherwise, it can be argued that forested areas are directed towards alternative uses such as construction and the carbon footprint will increase and contribute to global warming caused by agriculture.

Table 16 shows that when countries are categorized according to the ratio of forested areas under their political sovereignty to the total area of the country, 9 clubs are obtained.

[176] SESRIC, (2021),ibid., p.55.
[177] FAOsdg, (2023), "SDG Indicators: Metadata", (https://www.fao.org/faostat/en/#data/SDGB), (Date of access: 01.07.2023).

The first club includes the two countries with the highest forest areas according to their total area and the two countries with the most convergent course in terms of the changes in forest areas over time. The 12 countries in the not convergent club are countries that have not converged to any country in terms of the course of forest areas over time. The policies pursued by this group of countries are implemented relatively independently, rather than being directed towards a goal such as the Paris framework agreement. For instance, Kazakhstan, with its neighbours Turkmenistan and Uzbekistan, is home to the vast Kyzylkum and Karakum deserts and aims to prevent freezing winters and increase water retention through reforestation, as well as to increase biodiversity by opening arid and saline areas to agriculture[178].

Table 16. OIC Convergence Clubs for Forest Area

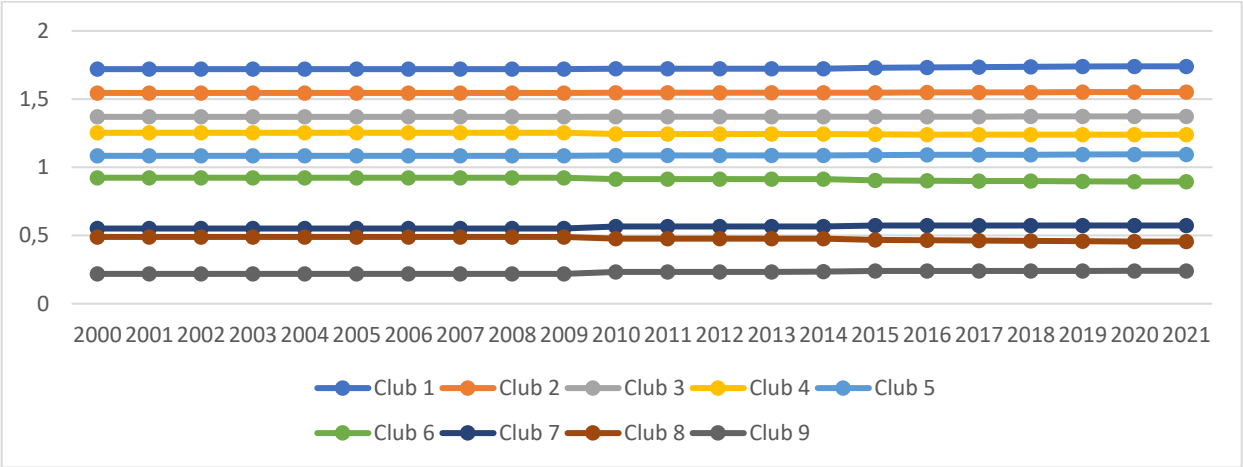
Clubs	**Countries**
Club 1 (2 Members)	| Brunei-Darrussalam | Guinea-Bissau |
Club 2 (2 Members)	| Cameroon | Mozambique |
Club 3 (5 Members)	| Albania | Benin | Guinea | Sierra Leone | Türkiye |
Club 4 (5 Members)	| Azerbaijan | Burkina Faso | Gambia | Nigeria | Togo |
Club 5 (4 Members)	| Bangladesh | Comoros | Lebanon | Morocco |

[178] FAO, (2019), "FAO and Kazakhstan: Partnering to Achieve Sustainable Livelihoods and Food Security", (https://www.fao.org/3/ax406e/AX406E.pdf), p.2

Club 6 (8 Members)	| Ivory Coast | Iran | Kyrgyzstan | Mali | Somalia | Sudan | Türkmenistan | Uganda |
Club 7 (4 Members)	| Pakistan | Syrian | Tunissia | United Arab Emirates |
Club 8 (4 Members)	| Chad | Maldives | Tajikistan |
Club 9 (4 Members)	| Afghanistan | Iraq | Palestine |
Not convergent Group	| Egypt | Gabon | Guyana | Indonesia | Jordan | Kazakhstan | Libya | | Malaysia | Oman | Senegal | Suriname | Yemen |

In general, it is observed that the first 6 clubs and the club number 9, although ranked in the lower ranks, follow a very consistent course. It can be said that Club 7 has slightly increased its forest area compared to the level at the beginning of the period, while Club 8 conversely reduced its forested area.

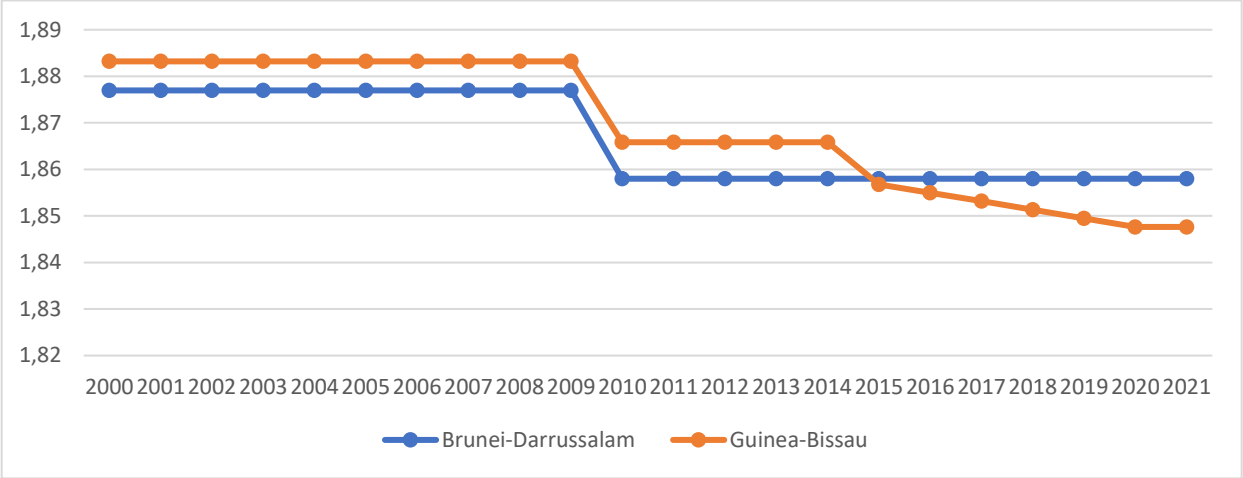
Figure 90. Relative Transition Paths of Clubs



Access to efficient and hygienic food depends on the nature in which agricultural production is carried out. In addition to soil, water and air pollution, noise pollution should also be taken into consideration since it affects livestock breeding. Agricultural production is subject to rent differences due to land and soil structure, climate and rainfall conditions, water quantity, land slope, forest and plant status and density and geographical location. When climate change and ecological degradation are coupled with housing construction, creation of industrial zones and industrial facilities and increased mining activities; negative externalities on agricultural areas and environmental pollution increase. With this knowledge in hand, a closer look at the club details reveals that the countries in the first club are in a very favorable group in terms of climate. In Guinea Bissau and Brunei Darussalam, 74 percent of the surface area is forested. In Brunei Darussalam, the share of forested areas decreased from 75.33 percent to 72.11 percent in 2009, while the share of agricultural areas increased by 18 percent. The absence of any change in other years gives the impression that the decrease in forested areas in Brunei is for agricultural land use. A similar assessment for Guinea Bissau shows a steady increase in the share of agricultural land. Agricultural land increased by 23 percent at the end of the period compared to the beginning of the period. The share of forested areas, on the other hand, decreased from 76.42 percent in 2009 to

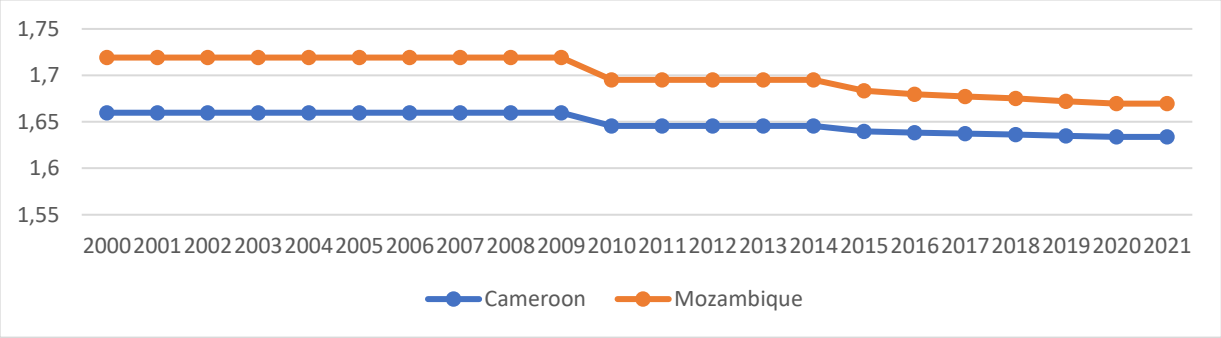
73.42 percent in 2010, to 71.91 percent in 2015 and then to 70.41 percent at the end of the period. Therefore, it can be said that for Guinea Bissau, the expansion of agricultural areas first spread to idle areas and then to forested lands.

Figure 91. Relative Transition Paths of Countries in Club 1



Cameroon and Mozambique in Club 2 are also rich in forest areas. The ratio of forest areas to the country's surface area is 45 percent in Cameroon and 50 percent in Mozambique. Similar to the first club, it is observed that countries increased their agricultural land use after the 2008 food crisis. In this context, in Cameroon, the share of agricultural areas increased by 4 percent in 2010 compared to the previous year, while the share of forest areas decreased from 45.19 percent to 44.21 percent. In Mozambique, the share of forested areas decreased from 52.38 percent to 49.56 percent in the year of the breakdown, while the share of agricultural areas increased continuously.

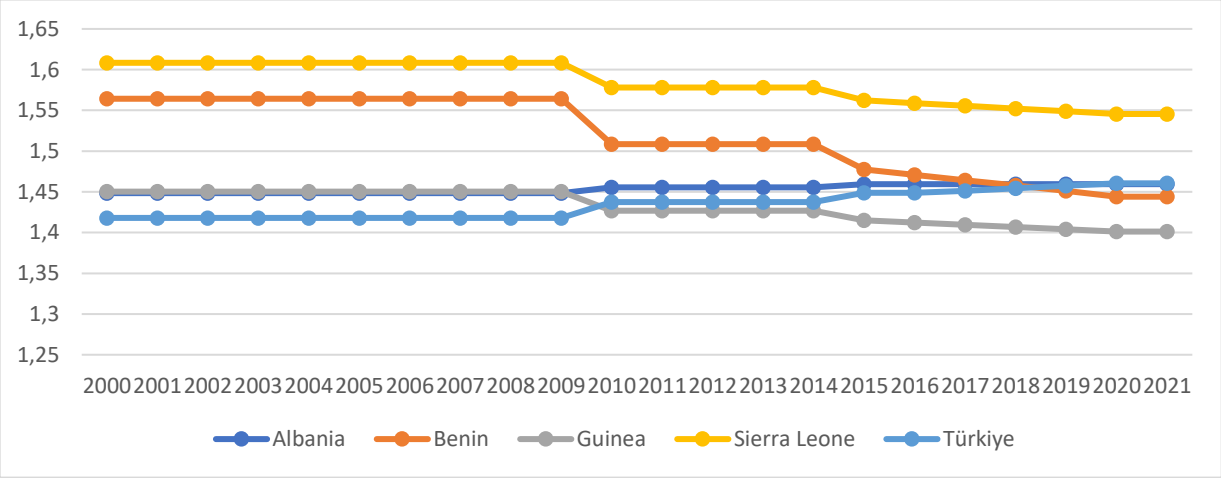
Figure 92. Relative Transition Paths of Countries in Club 2



In Club 3, where more countries are grouped than in the first two clubs, Sierra Leone, Benin and Guinea show decreasing trends in forested area shares, while Türkiye shows increasing trends and Albania shows relatively stable ones. In Sierra Leone, there was a decline in agricultural areas during the food crisis in 2007-2009, an increase in arable areas, and a steady increase in permanent cropland after 2010. Yet, the downward trend in forest areas has not ceased. Therefore, the decrease in forest areas, which is evaluated within the framework of global warming and carbon footprint, has not been directed towards the expected purpose of agricultural land use. Looking at the employment levels in Sierra Leone, it is observed that agricultural employment has continuously decreased since 2004, while employment in the service sector has continuously increased. The 68.4 percent share of agricultural employment in Sierra Leone in 2004 declined to 42.7 percent in 2021, while the share of employment in the service sector increased from 25 percent to 45.4 percent [179]. The share of agriculture in total value added increased from 48.55 percent to 60 percent for the same periods. In short, although there is no information on the increase in the share of agriculture in GDP and internal and external displacements, when the shift of labor force from agriculture to the service sector is assessed together, it can be inferred that there has been an increase in productivity in agriculture and that the agricultural rural population has preferred non-agricultural areas for income.

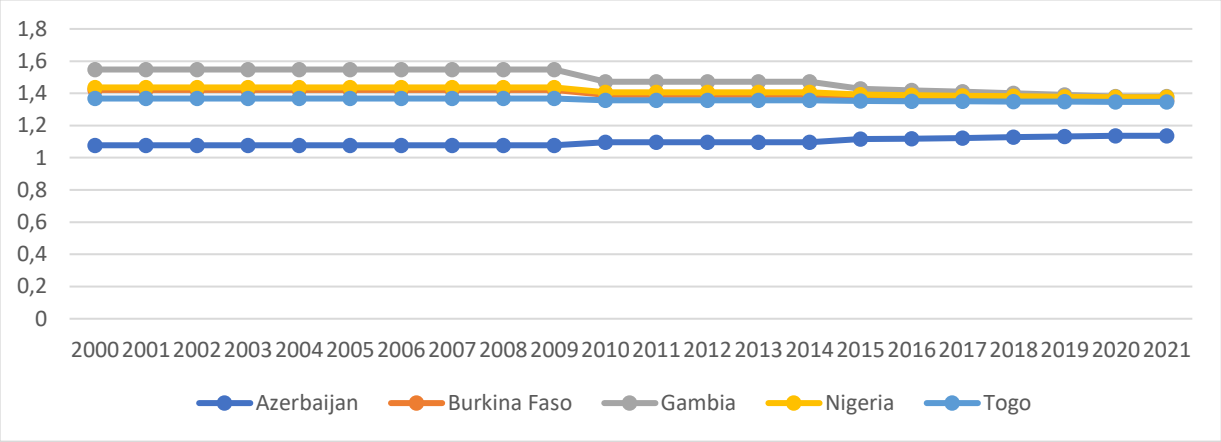
[179] OIC, (2023), "OIC Countries in Figures: Labor and Social Protection Accounts and National Accounts", (https://www.sesric.org/cif.php?c_code=46), (Date of access: 30.08.2023).

Figure 93. Relative Transition Paths of Countries in Club 3



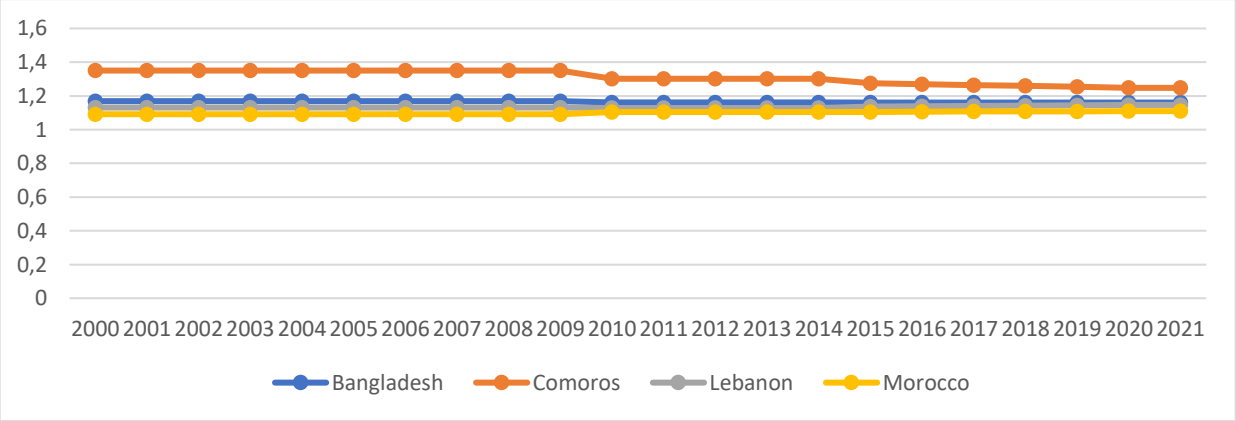
The countries in Cluster 4, Azerbaijan, Togo, Nigeria and Burkina Faso, have consistently maintained their shares of forested areas at the beginning of the period, while Gambia shows a downward trend as of 2009. In The Gambia, the share of agricultural areas increased by 12 percent and 9 percent in 2008 and 2009, respectively, compared to the previous years. The share of forested areas started to decline as of 2010. In terms of shares of employment, the share of employment in the agricultural sector in The Gambia decreased from 53 percent to 48.5 percent in the relevant periods, while the share of industrial employment increased from 6.3 percent to 7.4 percent and the share of the service sector increased from 39 percent to 44 percent, albeit with a fluctuating trend. In short, although agricultural production is increasing in The Gambia, this is not due to an increase in the agricultural labor force. In other words, there is hidden unemployment in the agricultural sector.

Figure 94. Relative Transition Paths of Countries in Club 4



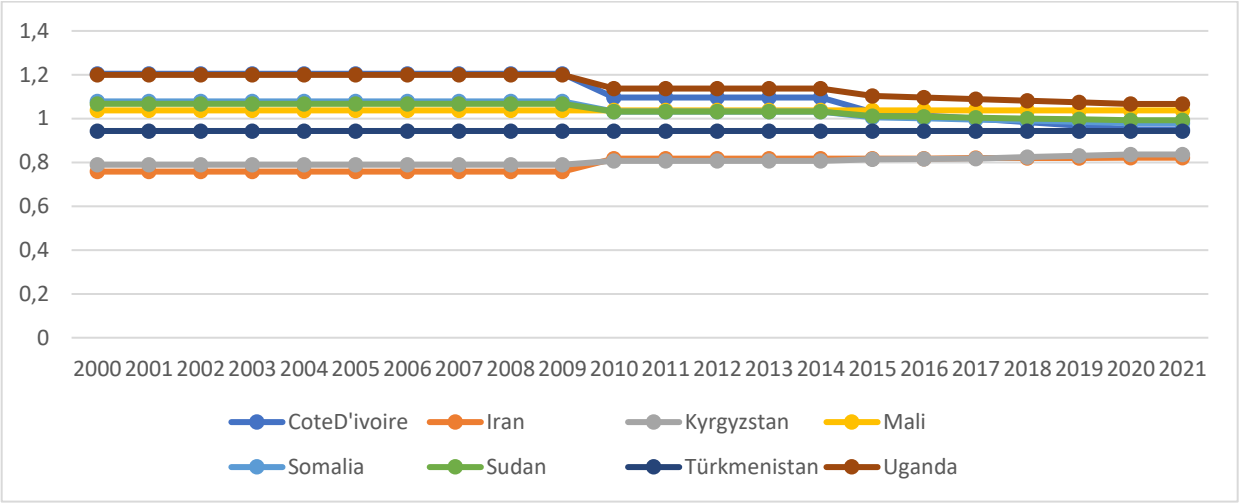
The countries in Club 5 are quite close to each other, similar to Club 4. In Comoros, the share of forest area decreased from 22.4 percent in 2009 to 20 percent. However, there has been no change in the share of agricultural areas.

Figure 95. Relative Transition Paths of Countries in Club 5



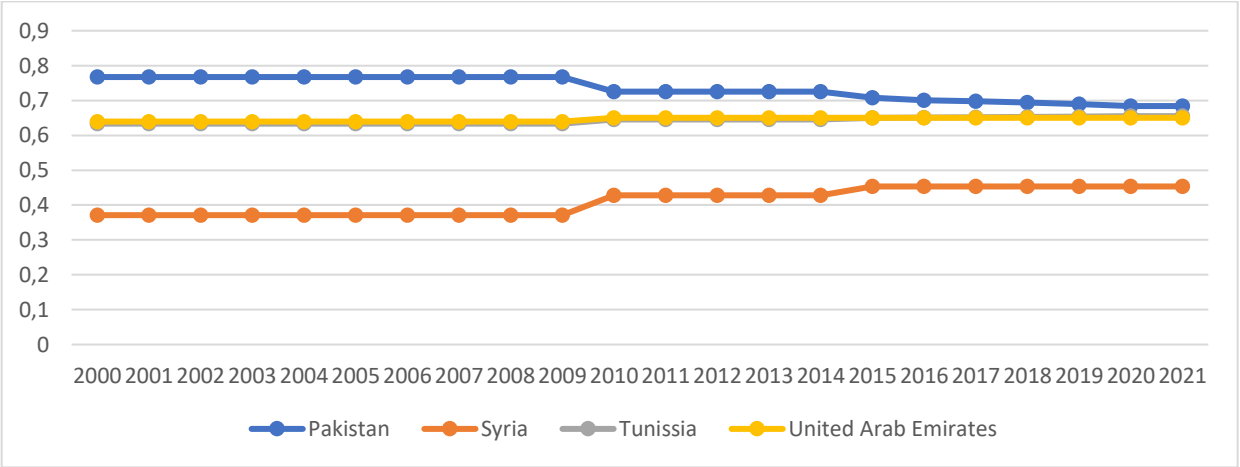
The countries in Club 6, with the exception of Turkmenistan, Kyrgyzstan and Mali, had a higher forest coverage at the beginning of the period. In 2009, there was a decrease in the share of forested areas in all countries. When the end-of-period values are analyzed, it is seen that all countries are converging to each other.

Figure 96. Relative Transition Paths of Countries in Club 6



Among the countries in Club 7, Pakistan has a tendency to decline in forest area. Syria, on the other hand, has increased its forested area compared to the beginning of the period.

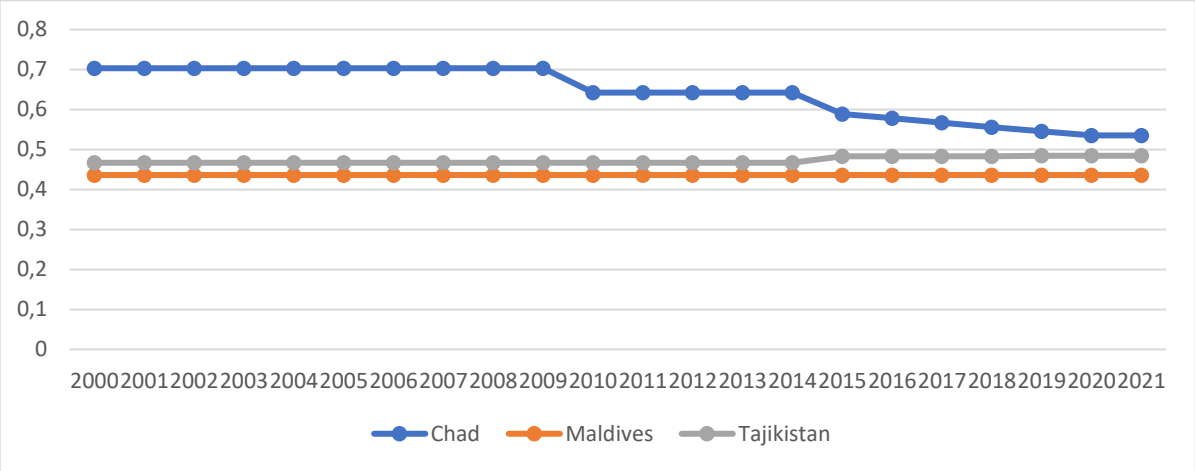
Figure 97. Relative Transition Paths of Countries in Club 7



In Club 8, the decrease in Chad is noticeable. In Chad, agricultural areas increased continuously in 2009-2016 compared to the previous year. The periodic increase was 2.6 percent. The decrease in forested areas decreased from 5 percent to 3.8 percent. The decline

in forested areas continues. Although the decline in forest areas is thought to be closely related to the opening of agricultural land, natural disasters, which have intensified in recent years, also have an impact. For instance, in Chad, approximately 0.05 percent of forested areas were lost due to fires in 2021. In the study period 2000-2021, 0.14 percent of the total forest cover was lost due to fires, which corresponds to 85 hectares.[180]. 60.4 hectares were lost due to other reasons such as illegal logging.

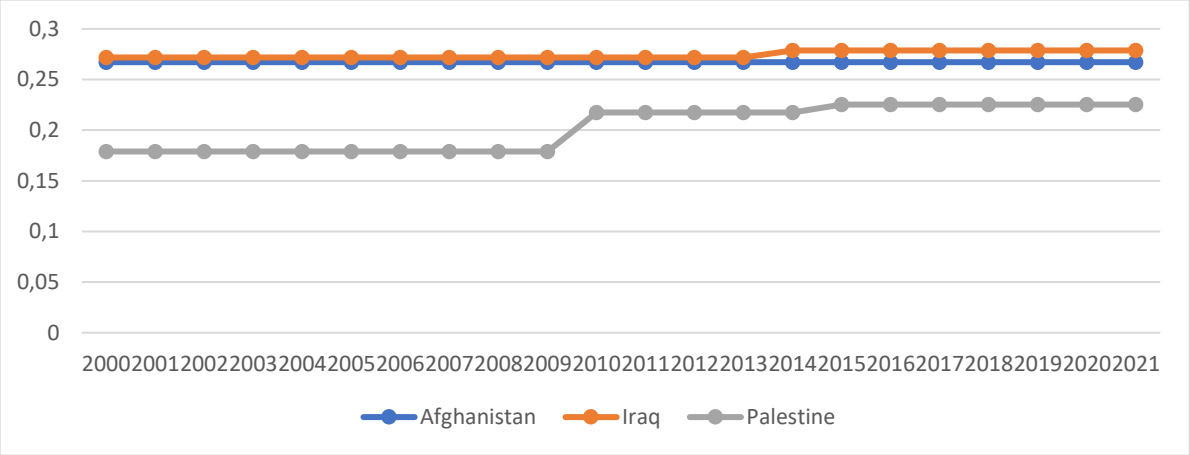
Figure 98. Relative Transition Paths of Countries in Club 8



Club 9 also reveals an increase in Palestine's forest area. Iraq and Afghanistan maintain their forest presence at the beginning of the period.

[180] GFW, (2023), "Chad", (https://www.globalforestwatch.org/dashboards/country/TCD/?category=fires), (Date of access: 30.08.2023).

Figure 99. Relative Transition Paths of Countries in Club 9



Agricultural Production

Agricultural production is a type of production that every country realises regardless of its level of development. Within the framework of food sovereignty and food security, every independent country should be able to supply basic nutrients. As an economic and value-adding sector, its share in GDP is higher in developing countries. This is not only because the agricultural sector produces a high volume of agricultural products. In cases where there is an industrial or manufacturing sector where high value-added production is not available, it can also be observed that there is a predominantly agricultural structure. Therefore, the number of people employed in agriculture can also be evaluated as a supporting indicator.

Looking at the OIC region, there are member countries with high levels of mechanisation and very low levels of agricultural employment, and high value-added production. However, the OIC average consists of economies that seek to develop and grow by generating surplus mainly through agricultural production. Although the share of agricultural employment is relatively high, the value of the products produced in GDP has been declining. The declining trend may be due to structural transformations, instability in agricultural markets, increasing environmental stress levels, and deterioration of water and

soil resources[181]. It should not be ignored that this trend, in the absence of production milestones, may also mean the impoverishment of agricultural producers in the sector of exporting countries in international trade, which is stated in the SESRIC (2020) report as a decrease in the ratio of agricultural value added to GDP[182]. The same report includes the sectors to which the decrease in agriculture is channelled. The decrease in agriculture is mainly compensated not by manufacturing but mainly by the service sector[183]. This can be evaluated as the migration of "uneducated/low-skilled" labor force, who cannot make a living from agricultural production or who somehow leave agricultural production, to areas where the service sector is concentrated. In terms of contribution to the economy, this phenomenon may require an in-depth analysis of the sectoral structure in terms of the growth of the service sector with a focus on tourism and construction and increase in national income of countries. On the other hand, the addition of the wage costs of the decreasing labor force to food security and food input prices, which have the potential to increase, and the decreasing amount of food production may be a sign that food price increases will further deepen.

Within the OIC, the value of agricultural production corresponded to 11.3 per cent of GDP, which decreased to 9.8 per cent as of 2018 in the analysis period[184]. In order to analyse the data and information in this section of the study, it is deemed to be meaningful to provide a table summarising the general overview in the introductory part. Table 17 below calculates the change in the 20-year period between 2000-2021 as the period of study[185].

[181] OIC, (2020), "Agriculture and Food Security in OIC Member Countries: 2020", Organization of Islamic Cooperation, Statistical Economic and Social Research and Training Centre for Islamic Countries, pviii
[182] Ibid., 14.
[183] Ibid.
[184] Ibid., viii
[185] Calculated with FAOSTAT and OIC Countries in Figures-National Accounts data

Table 17. Some Indicators Related to Agricultural Production

OIC Member Country	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Albania	-10.29	-16.1	34.6	123.76	-3.53	20.28	1.45	0.71
Algeria	43.55	-11.9	10.3	285.24	0.02	12.65	2.64	0.16
Afganistan	105.19	-18.6	46.9	31.92	-21.95	35.33	0.44	0.00
Azerbaycan	25.92	-6.8	34.2	108.56	-7.43	6.42	0.48	1.74
Bahrain	105.68	-0.7	1	-21.19	-0.29	0.30	-5.79	0.37
Bangladesh	31.09	-23.70	37.1	123.78	-6.69	12.09	-0.17	-0.28
Benin	85.72	-23.70	28.1	194.15	27.64	31.39	14.44	-8.87
Brunei-Darrussalam	33.38	-0.1	1.3	-39.36		1.29	23.29	-3.22
Burkina Faso	85.99	-12	73.3	294.02	-3.52	19.07	18.53	-3.66
Cameroon	80.22	-24	42.6	81.19	16.89	18.63	3.59	-2.66
Chad	108.01	-13.7	68.9	119.29	30.84	46.49	1.71	-1.62
Comoros	53.07	-22.6	35	76.88	35.69	38.73	-0.04	-4.71
Ivory Coast	63.56	-5.7	45		-4.00	21.86	5.00	-7.10
Djibouti	48.99	-1.2	1.2	26.98		1.37	5.92	0.01
Egypt	53.09	-9.8	19.8	81.70	0.25	12.03	10.42	-0.01
Gabon	83.92	-11.8	29	41.61	4.72	6.47	3.23	-0.66

Gambia	83.64	-5.4	48.5	-32.07	20.53	24.14	3.33	-11.33
Guinea	62.31	-12.1	59.2	101.99	-3.53	28.13	1.61	-3.01
Guinea-Bissau	67.42	-10.6	50.3	11.15	3.84	32.43	12.55	-6.01
Guyana	5.99	-12.1	13.1	456.03		14.25	5.30	-0.76
Indonesia	27.88	-16.3	29	123.81	-0.68	13.48	17.36	-4.87
Iran	34.14	-6.4	16.3	69.38	0.27	13.00	-19.22	0.90
Iraq	76.76	-7.5	19.8	22.89		4.03	6.45	0.03
Jordan	120.49	-1	3.2	142.63	1.32	5.78	-4.06	0.00
Kazakhstan	25.99	-21.2	15	275.97	-3.15	5.43	-0.43	0.11
Kuwait	119.66	-0.4	2	74.58	-0.05	0.38	1.91	0.08
Krygyzstan	32.27	-36.5	16.6	237.59	-13.78	15.34	-0.84	0.70
Lebanon	29.44	-1.5	3.8	13.00	-0.22	4.09	9.65	0.50
Libya	30.66	-5.3	16.3	27.61		3.59	-0.46	0.00
Malaysia	46.32	-8.8	9.6	71.49	0.95	9.72	10.62	-1.75
Maldives	84.58	-3.9	10.5	-11.97	-0.33	6.10	-14.07	0.00
Mali	98.90	0.7	67.7	273.26	1.40	38.24	5.49	0.00
Mauritania	71.24	-12.7	29.5	15.36	-4.80	20.22	-0.20	-0.11
Morocco	29.85	-9.4	34.6	160.05	-1.22	13.42	-1.23	0.53
Mozambique	80.53	-12.7	70.3	101.95	5.80	30.73	5.80	-5.65
Niger	117.24	-8	70.7	81.24	-1.73	38.66	17.15	-0.20

Nigeria	73.71	-14.1	35.2	256.35	-0.06	23.70	2.47	-3.58
Oman	92.83	-2.3	4.1	44.07	-0.47	2.05	20.22	0.00
Pakistan	49.90	-7.6	37.5	8.12	-2.52	24.23	-1.13	-1.02
Phalestine	63.49	-7.4	6.7	157.10	-0.04	8.34	-9.42	0.17
Qatar	316.18	-1.4	1.2	50.18	-0.03	0.28	4.11	0.00
Saudia Arabia	66.84	-4.4	2.7	67.08	2.36	2.54	-0.11	0.00
Senegal	73.91	-27.7	21.6	87.95	14.66	17.10	-1.45	-4.07
Sierra Leone	83.69	-26.5	42.7	203.73	56.64	60.03	33.43	-5.47
Somalia	95.67	-12.1	26.3	1.11	52.87	60.18	0.18	-2.45
Sudan	279.63	-11.1	40.6	33.30	18.53	19.73	0.87	-1.85
Suriname	27.97	0.7	7.9	24.21	-8.73	9.41	-8.78	-0.93
Syria	30.73	-20.4	12.5	141.05		20.60	1.22	0.49
Tajikistan	55.43	-17.8	42.6	236.85	-2.58	26.77	3.93	0.12
Togo	72.62	-25.9	30.9	222.90	-6.26	21.12	7.72	-1.09
Tunissia	23.95	-7	13.9	85.69	-0.41	10.86	2.56	0.22
Türkiye	32.33	-18.9	17.1	64.26	-1.08	6.20	-3.00	2.69
Turkmenistan	38.80	-14	22.3	42.56		11.13	-3.20	0.00
Uganda	90.90	-6.6	62.9	-16.19	-1.71	25.23	10.79	-4.17
UAE	185.93	-6.8	1.7	22.90	0.73	0.88	-16.68	-4.36
Uzbekistan	36.73	-13.8	23.9	170.49	-14.55	26.11	-4.83	0.00
Yemen	77.05	-21.5	28.1	-2.91	1.71	19.50	-0.65	0.00

The columns represent the variables as follows:

1: Total Population Change (%)

2: Agriculture Employment Change (%)

3: Share of Agriculture Employment in Total Employment (%), (2021)

4: Change of Agriculture Value Added Per Worker (%)

5: Change of Agriculture Value Added Share of GDP (%)

6: Agriculture Value Added Share of GDP (%), (2021)

7: Agricultural Land Change (%)

8: Forest Land Change (%)

As widely known, the main determinant of agricultural production, other than seeds, pesticides and fertilizers, is land and labor force to produce. When we look at the OIC countries, except Mali and Suriname, the decline in agricultural labor force is noteworthy. However, these decreases are not in parallel with the population decreases of the countries, except for Albania. In other words, the decline in the agricultural labor force indicates that the healthy labor force between the ages of 15-65 that can be employed is directed towards non-agricultural sectors. In addition to not reaching the expected income level, the need for less labor force due to mechanisation may affect this trend because agricultural value added per worker is increasing except for Bahrain, Brunei Darrussalam, Gambia, Maldives, Uganda and Yemen. In fact, this increase is very high in some countries such as Kazakhstan, Guyana, Nigeria, Burkina Faso, Tajikistan and Togo. Despite this productivity increase in agricultural labor force, the share of agricultural output in gross domestic product (GDP) has generally decreased, while the opposite trend has been observed in some countries. For instance, in Sierra Leone, agricultural employment decreased by 26.5 per cent, while agricultural output per capita increased by 203.73 per cent and the share of agricultural value added in GDP increased by 56.64 per cent. In Mozambique, despite a 12.7 per cent decrease in the share of

agricultural employment, agricultural output per capita increases by 101.95 per cent and its share in GDP by 5.8 per cent. Similarly, in Benin, a 23.70 per cent decline in employment is followed by a 194.15 per cent increase in output per capita and a 27.64 per cent increase in agricultural value added in GDP.

The reasons for this situation are considered to be as follows. First of all, the crops grown in some countries are relatively scarce and valuable products specific to certain climates in the world. For example, Cassava is grown in Cameroon, Comoros, Gabon, Indonesia, Sierre Leone, Togo, Turkmenistan, Nigeria, Mozambique[186] whereas Sorghum is mainly grown in Chad, Togo, Sudan, Niger; Coconuts Comoros, Guyana; Palm oil in Indonesia, Malaysia; Natural Rubber and yams in Ivory Coast, Gabon, Indonesia, Malaysia, Togo, Nigeria; Mango Senegal, Egypt, Senegal, Yemen; cocoa in Ivory Coast; sugarcana in Guyana; pistachios in Iran, Türiye; Green coffee in Sierra Leone and fennel in Suriname [187]. Although these crops have different shares in the volume of agricultural production, their market prices and the market prices of wheat follow similar cycles and levels of increase.

On the other hand, tons of paddy rice, cotton lit or wheat production may not provide an accurate comparison with production tons of these crops. In wheat production, where intensive agriculture is practiced, 10 hectares of wheat production may be equivalent to 0.5 hectares of bananas, mangoes or other fruits. This prevents a healthy comparison of countries in terms of production amount. In addition, in countries, especially in West Africa, large food companies engaged in industrial agriculture and small subsistence-level producers engaged in labor-intensive agriculture produce together. It is clear that the positive results on production increases are not in favor of subsistence peasants, who constitute the majority and are unable to break out of the trap of poverty and hunger. Moreover, the staple food of OIC member countries is wheat for arid regions and paddy rice for countries in the rainy belt, and most countries are unable to achieve food sovereignty in

[186] OIC, (2023), "Countries in Figures: Economy and Sector", (https://www.sesric.org/cif-home.php), (Date of access: 01.09.2023)
[187] Ibid., OIC, (2023).

the production of these crops and resort to imports. Therefore, it does not seem plausible to conclude that increased agricultural production reduces food insecurity or alleviates nutritional stress. Moreover, in all countries, productivity growth is not reflected in GDP as a price increase; in a sense, agricultural production becomes cheaper with the value of land. For these reasons, it is considered that grouping and interpreting countries based on agricultural production data would not yield healthy results.

In the study, the effect of mechanisation on productivity increase and the status of agricultural land in terms of sustainability of agricultural production were also calculated and it was observed that there were significant decreases in agricultural land in some countries such as UAE, Maldives, Iran in 20 years. On the other hand, significant increases in agricultural land are observed in Benin, Brunei-Darrussalam, Burkina Faso, Egypt, Guinea-Bissau, Indonesia, Malaysia, Niger, Oman, Sierra Leone, Uganda. In Benin, Brunei-Darrussalam, Burkina Faso, Guinea-Bissau, Guinea-Bissau, Indonesia, Sierra Leone and Uganda, there is a decrease in forest areas and it is assumed that forest areas are at least partially converted to agricultural land. In other countries where agricultural land has increased, it is thought that idle or uncultivated areas are utilised as agricultural land. The increase in agricultural land is an important indicator for the sustainability of agricultural production.

After these brief remarks, to look at the groupings of the mentioned data among the OIC member countries and to determine the direction for possible policy recommendations, the country groups that converge to each other are presented as follows.

Production Value

This indicator expresses agricultural output per worker employed in agricultural production. The indicator used as a measure of agricultural productivity is obtained by dividing agricultural value added (agriculture, forestry, fisheries) by the number of people

employed in agriculture[188]. However, the share of mechanization in this data cannot be measured accurately due to the lack of up-to-date figures. The extent to which productivity growth among OIC countries, where agri-food companies also produce to a significant extent, is driven by small producers engaged in labor-intensive production cannot be measured. Therefore, the grouping of countries may yield quite misleading results. For this purpose, only country clubs are included in order to provide a rough orientation. Accordingly, countries are divided into 4 basic clubs. The first club includes countries with the highest value added per agricultural worker. Somalia does not converge with any other country. Based on Table 18, it is obvserved that the country has experienced a productivity increase of 1 per cent in the 20-year agricultural production process. In the country where the Food Price Index data also fluctuates considerably, it is thought that the food aid provided under the UN World Food Programme[189], especially during severe drought periods, influences the price changes.

Table 18. OIC Convergence Clubs for Agricultural Value Added Per Worker

Clubs	**Countries**
Club 1 (23 Members)	| Algeria | Bahrain | Brunei-Darrussalam | Egypt | Guyana | Iran | Jordan | Kazakhstan | Kuwait | Malaysia | Maldives | Nigeria | Oman | Palestine | Qatar | Saudi Arabia | Suriname | Syrian | Tunissia | Türkiye | Türkmenistan | United Arab Emirates | Uzbekistan |
Club 2 (17 Members)	| Albania | Benin | Burkina Faso | Comoros | Gabon | Indonesia | Iraq | Kyrgyzstan | Lebanon | Libya | Mali | Mauritania | Morocco | Senegal | Sierra Leone | Tajikistan | Togo |

[188] FAOSTAT, (2023), "Employment Indicators: Agriculture", (https://www.fao.org/faostat/en/#data/OEA), (Date of access: 01.07.2023).
[189] UNWFP, (2023),"Somalia Emergency", (https://www.wfp.org/emergencies/somalia-emergency), (Date of access: 01.07.2023).

Club 3 (10 Members)	| Afghanistan | Azerbaijan | Bangladesh | Cameroon | Chad | Gambia | Guinea | Guinea-Bissau | Pakistan | Yemen |
Club 4 (4 Members)	| Djibouti | Mozambique | Niger | Uganda |
Not convergent Group	| Somalia |

Sustainable profitability is important for the continuity of agricultural production. The reason for both the discontinuation of production and migration is the unprofitable prices of production, which do not even cover the costs today. In order to sustain agricultural production, governments take measures such as subsidies and various protection measures. The amount and intensity of these measures are aligned with the sustainability of agricultural production.

In order to meet the cost deficits arising from globalisation and sustainability to a certain extent, ecotourism, agro-tourism, gastro-tourism branches have been established and tourism revenues have begun to be obtained through agriculture. Today, like the industrialisation of agriculture, the touristicisation of agriculture has started.

Another important dimension of sustainability is transaction costs. Implementation of sustainable agricultural systems incurs additional costs due to additional measures for good agricultural practices, time-dependent waiting period for organic agriculture and the inability to establish fair trade relations. On one hand, these reasons hinder competition conditions by preventing small producers from taking part in the production process, and on the other hand, in a process that evolves into oligopolisation, they turn the price advantage in favour of large producers in production and inefficiency is caused.

The gross value of agricultural production refers to the monetary value obtained by multiplying physical outputs by farmgate prices. Since agricultural outputs used as intermediate goods are also included in this value, it is defined as gross value. This value, which can be measured in fixed currency or current US dollars, gives the international market value of food and agricultural products for the production period. The course of this value over time also helps to explain economic trends. Fixed prices can be used to see the change in the volume and quantity of production. The value in US dollars is calculated by expressing the gross value of production in local currency in terms of the official real dollar exchange rate in the relevant period. It is important to express the data in common currency in order not to reflect the valuation differences in the local currencies of the countries[190].

Table 19. OIC Convergence Clubs for Value of Agricultural Production

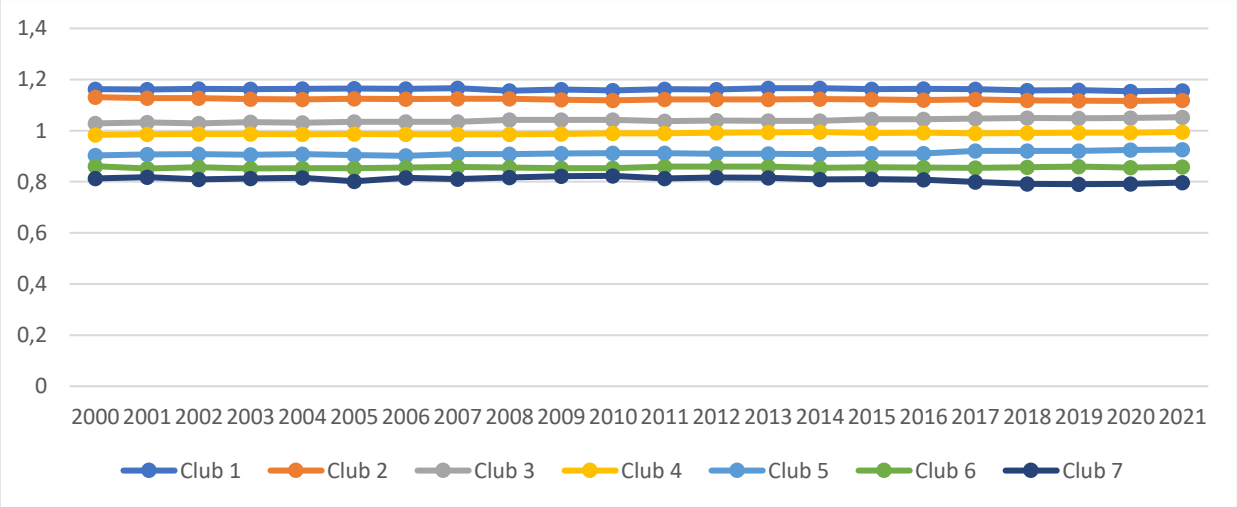
Clubs	**Countries**
Club 1 (3 Members	| Algeria | Iran | Pakistan |
Club 2 (4 Members)	| Bangladesh | Ivory Coast | Egypt | Malaysia |
Club 3 (6 Members)	| Cameroon | Mali | Morocco | Niger | Saudi Arabia | Senegal |
Club 4 (15 Members)	| Albania | Azerbaijan | Benin | Burkina Faso | Chad | Guinea | Guyana | Iraq | Jordan | Lebanon | Mozambique | Sierra Leone | Tajikistan |Tunissia | Yemen |
Club 5 (3 Members)	| Oman | Togo | Türkmenistan |
Club 6 (5 Members)	| Guinea-Bissau | Kuwait | Palestine | Qatar | Suriname |

[190] FAO, (2023), "Value of Agricultural Production", (https://fenixservices.fao.org/faostat/static/documents/QV/QV_e.pdf), (Date of access: 01.07.2023).

Club 7 (2 Members)	| Brunei-Darrussalam | Gambia |
Not convergent Group	| Indonesia | Kazakhstan | Kyrgyzstan | Maldives | Nigeria | Türkiye |

Looking at the value of agricultural product data with 7 different clubs, it is observed that countries maintained their production levels at the beginning of the period except for the 2008 food crisis and the 2020 COVID-19 pandemic.

Figure 100. Relative Transition Paths of Clubs



Agricultural production is crucial for OIC countries. As can be observed from Table 15, more than 20 per cent of the GDP of 24 countries for 2021 is based on revenues from agricultural production. For some countries, this ratio is as high as 60 per cent. In terms of agricultural employment, 33 countries are above 20 per cent, with some countries reaching 70 per cent. However, some of the agricultural production of the countries is not sufficient for their domestic consumption and is supplied through foreign trade. FAOSTAT data have been utilised in this subject which is discussed in detail.

Major Agricultural Products

Production data are reported as harvested area, production amount and yield. The 278 product data are grouped under the headings of primary agricultural products, processed agricultural products, livestock, primary animal products, processed animal products. Basic/primary agricultural products include cereals, pulses, root and tuber crops, fibre crops, oil crops, sugar crops, fruits, citrus fruits and crustaceans. Processed agricultural products include cotton seed and lint, molasses, all kinds of vegetable seed oils, sugar, wine and barley beer.

Livestock includes all kinds of cattle and sheep, poultry including pigeons, bees, rodents including rabbits, pigs, donkeys and camels. Basic animal products include all types of eggs, leather and wool, honey, meat, milk, silkworm cocoons and snails. Processed animal products include animal fat, cheese, cream, buttermilk, yoghurt and raw silk.[191].

Agricultural production within the OIC is grouped as cereals, fruits and vegetables. According to 2021 data, OIC region accounts for 13.19 per cent of world production and 73.71 per cent of EU production in cereals. Among OIC countries, Indonesia (18.37), Bangladesh (15.34), Pakistan (12.94), Türkiye (7.86), Nigeria (7.38), Egypt (5.50) are the major cereal producing countries with their shares. Bahrain has no cereal production[192]. Regarding the 20-year average increase in cereal production, the world average increase in cereal production was 49.10 per cent, the EU average was 43.03 per cent and the OIC average was 46.84 per cent.

According to a similar comparison to be carried out in fruit production; OIC production covers 20.73 per cent of world production and 230.31 per cent of EU production for 2021. While the average production increase is 59.02 per cent in the world and 76.15 per cent in the OIC, there is a decrease of 2.21 per cent in the EU. Türkiye (13.28), Indonesia

[191] FAO, (2023), "Production Indices", (https://www.fao.org/faostat/en/#data/QI), (Date of access: 01.07.2023).
[192] Calculated from FAOSTAT - "Crops and Livestock Products" data

(12.52), Iran (8.83), Egypt (7.49), Nigeria (6.29), Pakistan (5.90), Uganda (4.91) are the major fruit producing countries[193].

In vegetable production; the OIC corresponds to 14.41 per cent of the world production and 186.38 per cent of the EU average. The average production increase is 68.10 per cent in the world, 6.07 per cent in the EU and 83.80 per cent in OIC. Türkiye (16.02 per cent), Nigeria (9.49), Egypt (9.36), Indonesia (7.82), Uzbekistan (6.22), Iran (5.61) are the largest vegetable producing countries in OIC[194].

The high average values of the OIC countries in agricultural production become more evident on a per product basis. For example, 87 per cent of world palm oil production, 64 per cent of cocoa, 44 per cent of millet production, 37 per cent of cassava and sorghum production are supplied from OIC countries.[195]

Based on this information, OIC countries have a relatively smaller average land size and have an agricultural structure dominated by small-scale production type with labor-intensive production. The advantage of this structure is that labor, which is relatively abundant and cheap, is directed towards vegetable and fruit cultivation such as greenhouse cultivation, vineyard-gardening with high added value. On the other hand, the intensive agriculture method, where production is carried out with intensive use of chemical inputs on large-scale lands with mechanisation, is concentrated in relatively industrialised economies in the developed group. Although the average production amount of OIC has increased in all product groups, the fact that it has achieved higher levels of increase in vegetable and fruit production can be explained with this reasoning. Especially the production increases in fruits and vegetables, which are much higher than the EU average, can be considered as a superiority in fruit and vegetable production within the agricultural

[193] Ibid.
[194] Ibid.
[195] OIC, (2020), "Agriculture and Food Security in OIC Member Countries: 2020", Organization of Islamic Cooperation, Statistical Economic and Social Research and Training Centre for Islamic Countries, p.viii

strategy of the OIC region. In order to make more reliable projections about the trend, it is necessary to analyse the foreign trade data of agricultural products.

Livestock and Fisheries

OIC countries have started to meet the demand for animal products by transitioning to large-scale industrial animal husbandry in livestock production in parallel with changing food consumption patterns. In this vein, they increased their animal production by 13 per cent as of 2000 and meet 8 per cent of the world production. In the period examined, meat production increased by 85 per cent, milk production by 69 per cent and egg production by 98 per cent on average.[196]. Pakistan, Türiye, Iran, Kazakhstan, Egypt and Morocco are respectively the largest countries in meat production in OIC countries[197].

Fisheries are also growing at an average annual rate of 2.2 per cent, accounting for 19.4 per cent of world inland fisheries production and 19.6 per cent of marine fisheries. [198]. Due to the increasing demand for seafood products on a global scale, FAO is shifting the agricultural production structures of countries with arid climates that have a coast to freshwater and seafood products.

For example, FAO, in its research covering the Gulf Cooperation Council States (GCC) and Yemen, Bahrain, Omman, UAE and Yemen are orientated towards aquaculture production in the agri-food system[199]. Within the framework of cooperation with the UAE, the programmes and projects developed to strengthen the sustainability of agriculture and fisheries production in its sub-regions aim to develop agriculture and fisheries to create fishery-based livelihoods and reduce the exacerbated poverty in the region[200]. In the Gulf region and in Yemen, the transformation of the agri-food system to aquaculture is supported

[196]Ibid., viii, ix.
[197] Ibid., 20.
[198] Ibid., ix.
[199] FAO, (2022), "FAO in the United Arab Emirates Bulletin", (https://www.fao.org/3/cc3957en/cc3957en.pdf), p.3.
[200] FAO, (2019), "United Arab emirates and FAO: Partnering for Sustainable Agricultural Development and Food Security", (https://www.fao.org/3/az580e/AZ580E.pdf), p.1.

in terms of low carbon footprint and greenhouse gas emissions, as well as wide product diversity and nutritional value. In the programme called "Blue Transformation", it is aimed to increase aquaculture production by 35 percent by 2030 in order to meet the increasing global demand, to register all marine and inland fisheries to ensure healthy stocks, and to reduce food loss and waste by 50 percent by improving aquaculture value chains.[201].

Agricultural Trade

WTO member countries conclude bilateral and multilateral agreements on many issues related to agriculture and food trade, from farm production subsidies to export restrictions and direct market access for agricultural producers. Under the Trade Agreement;

- Domestic subsidies that distort the world trade order and the balance of fair competition in markets should be reduced and eliminated. Domestic support prohibitions do not restrict direct payments made by governments for research, infrastructure, farmer advisory services, domestic food aid and environmental aid. Developing countries may also contravene the general provisions to a certain extent in the provision of input and investment subsidies (WTO, 2023).

- Market access is an agreement introduced on the grounds that the disruption of agricultural producers' access to markets may increase the food costs of consumers. In this context, the countries that are parties to the Agreement on Agriculture will gradually reduce tariffs and eliminate non-tariff customs measures.

- Ensure at least transparency of subsidies for export competitiveness and similar practices that have a similar effect,

- Export quantity restrictions have been a topic on the agenda as a result of sudden food price increases in 2008, 2011 and 2022. It is stated that the aim is to ensure easy accessibility of food on the grounds that countries dependent on food imports and in the

[201] FAO, (2022), "FAO in the United Arab Emirates Bulletin", (https://www.fao.org/3/cc3957en/cc3957en.pdf), p.4.

low-income group are adversely affected by the process. In this context, it was decided to exempt food purchased by the UN World Food Programme (WFP) for humanitarian purposes from restrictions until countries take action.

Certain standards and rules are established especially for products that are subject to foreign trade. Agricultural products must be certified to meet the standards, inspected according to the accepted standards, laboratory results must be obtained indicating that they are produced with appropriate inputs, and production must be carried out in accordance with organic farming regulations and good agricultural practices[202].

The trade order emerging according to the rules accepted by the countries in the WTO also covers the OIC group. In this framework, foreign trade data of OIC member countries were analyzed and a trend was sought to be obtained. In this direction, data on exports and imports of countries, including quantities and values, have been analyzed. Import and export unit value index (2014-2016=100) data show the changes in the unit value of agricultural products traded between countries. Weights are obtained by Laspeyres method according to the averages of quantities in 1989-1991. The total quantity index of agricultural products gives the changes in the price-weighted sums of product quantities. Like the value index, weights are calculated by Laspeyres method according to the averages of unit values in 1989-1991. The index includes edible and nutritious products excluding coffee, tea, animal feed and alcoholic beverages. The "food and agricultural trade data set", which includes the relevant data, is obtained from the relevant official institutions of the country and is aggregated and calculated according to the International Merchandise Trade Statistics (IMTS) method. The trade dataset covers agricultural and food imports and exports of all countries annually[203].

[202] Organic farming and good agricultural practices are two methods with specific standards in Türkiye. Organic agriculture is the combination of traditional production methods with advanced technology, which prohibits the use of inputs that harm soil, ecosystem and living health, and prioritizes biodiversity and native breeds. Organic agriculture alone is not sufficient for sustainability. For this reason, it is carried out together with good agricultural practices to ensure sustainability. (IFOAM, 2008).

[203]FAOSTAT, (2023), "TradeIndices", (https://www.fao.org/faostat/en/#data/TI), (Date of access: 01.07.2023)

In the analysis conducted with foreign trade data, countries have not converged to each other. This shows that each country has different policies and is not similar to each other. Therefore, in order to see the foreign trade patterns of OIC member countries in detail, Table 20 was developed and countries were monitored through this table. In Table 20, foreign trade comparisons in terms of the ratio of exports to imports, value and quantity are presented. Relevant data are foreign trade data obtained from FAOSTAT[204]. Data are calculated as value and quantity change in values (%).

The objective of the ratio of exports to imports is to observe how much of the foreign exchange that countries need for imports is obtained through exports. Because OIC countries have different characteristics in terms of natural resources and soil fertility. For example; Azerbaijan, Bahrain, Brunei[205], Chad, Gabon, Iran, Iran, Iraq, Kazakhstan, Kuwait, Libya, Qatar, Saudi Arabia, United Arab Emirates, Turkmenistan are countries with natural energy resources. These countries are unable to meet the ratio of agricultural exports to imports and meet their foreign exchange needs from energy export revenues, which is reflected in the ratio of total exports to imports.[206]. On the other hand, Guyana, Guinea-Bissau, Guinea-Bissau, Ivory Coast, Malaysia[207], and Indonesia, which are located in the tropical belt, grow tropical products with their very fertile soils and climate and have a trade surplus in agricultural products. Other OIC member countries generally face foreign trade deficits and cover these deficits with different external sources.

Foreign trade comparisons are made in terms of value and quantity in order to reveal the real changes in foreign trade and the gains/losses of countries. Foreign trade in general and foreign trade in agricultural products in particular are evaluated in this analysis. Thus, the

[204]FAOSTAT, (2023), "Crops and Livestock Products", (https://www.fao.org/faostat/en/#data/TCL), (Date of access:01.08.2023).
[205] MFA, (2023), "Brunei Darusselam!ın Ekonomisi", T.C.Dışişleri Bakanlığı, (https://www.mfa.gov.tr/brunei-ekonomisi.tr.mfa), (Date of access: 01.09.2023).
[206] SESRIC, (2023), "OIC Countries in Figures-Agriculture", (sesric.org/cif.php?c_code=1) , (Date of access: 01.07.2023).
[207] MFA, (2023), "Ülke Künyesi: Malezya", T.C.Dışişleri Bakanlığı, (https://www.mfa.gov.tr/malezya-kunyesi.tr.mfa), (Date of access: 01.09.2023).

unit change value of agricultural production exports relative to the previous period is derived. This calculation gives us information on how relative changes in the external prices of agricultural production affect agricultural producers and the sustainability of agricultural production. In order to make comparisons more apparent, changes in the value and quantity of foreign trade in agricultural products are given as indices. In addition, the average value per unit of exports and imports of agricultural products and the import coverage ratios of agricultural products and total exports in 2021 are given.

Table 20 shows that the average OIC country is a net importer in foreign trade of agricultural products. The ratio of exports to imports of agricultural products is 60.73 percent for the OIC average. For 2021, it was realized at 34 percent. Trade deficits are larger and persistent, especially for SSA and MENA regions[208]. However, the results are quite different when analyzed regionally and country-wise. Import unit value index is higher than export unit value index in Afghanistan, Bangladesh, Gambia, Gambia, Jordan, Sierra Leone, Somalia, Sudan, which do not have a foreign trade based on natural resources and precious metals and where the share of agricultural products in total trade volume is 20 percent or more. Again, Comoros, Benin, Djibouti, Djibouti, Guinea-Bissau, Niger, which have high shares in foreign trade of agricultural products, seem to have higher unit value of exported products. In other words, countries in this group produce goods with high value added in global agricultural products. These countries are not in the group with the highest levels of undernourishment, nor are they in the group with the lowest levels. In Food Price Index data, these countries are in the same group. Therefore, it can be interpreted that the agricultural production of these countries consists of field crops and fruits that are similar to each other. The crop pattern obtained from the SESRIC page confirms this, with cassava, bananas,

[208]OIC, (2020), "Agriculture and Food Security in OIC Member Countries: 2020", Organization of Islamic Cooperation, Statistical Economic and Social Research and Training Centre for Islamic Countries, p.25.

coconuts, paddy rice weight crops and meat. Libya and Tajikistan, which have a similar composition, also concentrate mainly on domestic meat production [209].

Table 20. Selected Foreign Trade Indicators

Country	Agricultural Foreign Trade									
	(X/M)$_{AP}$	**MU**	**MQI**	**MVI**	**EU**	**EQI**	**EVI**	**X$_{AGR}$** [210]	**(X/M)$_{AP}$, (2021)**	**(X/M), (2021)** [211]
Afghanistan	18.62	78.18	77.36	60.73	63.91	109.36	72.36	42.82	39.22	31
Albania	12.68	94.14	106.05	99.73	151.18	56.55	71.00	13.88	17.92	70
Algeria	2.85	89.87	75.95	71.00	143.86	58.32	64.18	24.42	4.94	101
Azerbaijan	45.18	76.36	86.55	71.73	72.64	126.73	95.18	13.22	47.72	156
Bahrain	19.49	86.23	70.18	63.91	107.5	57.77	72.68	6.68	26.68	128
Bangladesh	6.55	83.73	78.82	71.68	70.59	90.68	68.82	23.05	6.00	63

[209] SESRIC, (2023), "OIC Countries in Figures-Economy and Sector", (sesric.org/cif.php?c_code=1) , (Date of access: 01.07.2023).
[210] SESRIC, (2023), "OIC Countries in Figures-Agriculture", (sesric.org/cif.php?c_code=1) , (Date of access: 01.07.2023).
[211] Ibid.

Benin	74.76	86.96	69.00	61.14	97.68	113.41	112.32	22.71	73.51	77
Brunei	1.19	91.18			73.77	62.77	38.73	6.00	2.18	120
Burkina Faso	137.34	114	69.18	76.82	104.46	60.50	64.64	9.00	151.39	93
Cameroon	118.88	97.77	83.45	83.32	80.82	87.00	71	13.87	84.43	85
Chad	97.82	96.09	81.32	79.45	104.68	115.00	103.23	6.13	83.81	128
Comoros	33.20	70.68	66.09	52.82	135.41	91.77	95.05	32.54	15.65	24
Ivory Coast	436.54	96.09	84.59	84.36	84.18	87.41	75.05	12.55	437.05	103
Djibouti	12.09	92.09	65.73	61.82	367.59	93.91	90.14	29.56	20.22	86
Egypt	31.33	90.64	77.77	75.27	87.23	79.68	74.41	17.98	42.35	55
Gabon	8.74	88.32	76.64	70.45	132.23	94.32	122.09	15.11	9.58	270
Gambia	14.70	96.41	91.86	87.73	65.23	143.45	81.36	22.28	5.73	19
Guinea	19.93	101.55	63.73	66.27	81.91	108.18	92.64	15.17	16.59	123

Guinea-Bissau	122.77	77.77	98.73	77.32	78.32	66.64	54.36	30.92	83.72	55
Guyana	162.83	88.00	82.36	75.18	94.82	84.36	78.73	7.39	81.09	108
Indonesia	195.65	89.96	77.55	75.64	96.41	74.27	76.59	10.55	223.19	114
Iran	44.54	88.68	82.41	76.23	97.91	64.05	61.59	3.99	18.99	100
Iraq	1.56	78.59	91.18	77.36	80.09	72.95	59.27	19.88	1.43	153
Jordan	36.03	83.86	76.86	68.64	72.36	84.41	64.23	19.24	29.31	60
Kazakhstan	85.95	84.77	85.05	76.64	87.05	96.00	87.73	11.87	57.74	140
Kuwait	6.22	84.96	72.95	66.36	108.46	45.09	47.23	10.45	6.38	140
Kyrgyz Republic	59.92	74.77	87.36	69.77	93.46	112.77	108.32	13.38	41.98	56
Lebanon	20.68	87.73	77.68	69.95	82.91	83.32	70.18	2.29	34.96	48
Libya	0.75	88.09	78.64	72.18	151.46	63.23	91.36	41.27	0.18	138
Malaysia	161.16	83.64	87.14	76.59	90.59	87.91	82.45	9.47	146.22	111

Maldives	0.07	92.93	74.45	69.32	66.78			15.43	0.04	112
Mali	116.75	100.55	74.45	75.45	79.91	96.68	71.77	11.72	83.72	74
Mauritania	5.59	102.68	79.23	78.95	291.59	79.77	84.55	15.94	2.10	65
Morocco	52.22	96.96	81.50	82.64	91.27	84.95	81.23	12.59	65.21	78
Mozambique	49.97	94.77	92.41	91.55	100.36	67.73	64.59	15.74	43.61	46
Niger	41.96	97.09	84.18	85.82	134.32	70.41	89.36	21.14	23.31	38
Nigeria	22.23	83.05	85.23	74.36	84.55	89.32	78.18	16.55	19.10	91
Oman	35.69	90.55	79.14	72.23	101.41	71.86	73.91	14.01	35.77	127
Pakistan	62.57	82.86	93.05	80.18	81.46	83.23	71.86	18.48	40.77	50
Palestine	11.13	80.73	92.23	73.91	74.86	135.36	79.77	11.08	9.64	31
Qatar	2.26	82.68	70.09	63.36	128.77	48.00	57.91	4.90	1.37	173
Saudi Arabia	15.20	85.14	75.41	67.59	89.00	70.68	66.55	11.19	18.02	143

Senegal	32.49	100.41	85.82	88.32	84.64	83.45	71.45	17.21	48.82	52
Sierra Leone	12.28	94.14	78.09	73.68	92.73	75.91	68.77	27.17	14.82	41
Somalia	36.07	67.41	71.77	60.32		36.95	47.55	40.88	9.81	23
Sudan	6.75	90.80	101.30	89.70	82.20	136.10	99.10	77.39	8.85	44
Suriname	40.70	92.68	81.68	76.32	106.82	72.27	75.27	12.82	54.63	104
Syria	58.23	77.36	118.00	87.18	81.91	349.64	235.77	35.73	30.59	99
Tajikistan	56.50	77.86	84.09	70.41	129.82	97.23	125.91	22.60	26.18	51
Togo	125.61	97.68	92.23	90.27	99.64	118.18	118.05	12.18	85.13	75
Tunusia	64.38	95.50	85.59	83.77	95.59	86.68	83.55	10.87	59.46	81
Türkiye	121.45	95.27	81.95	78.45	84.00	84.00	73.00	6.97	117.45	99
Turkmenistan	90.48	66.05	75.36	50.00	81.59	65.59	55.32	1.74	45.27	168
Uganda	153.35	94.91	83.59	81.41	100.05	67.50	69.45	9.72	130.85	54

UAE	42.87	81.09	7482	65.23	75.46	76.00	66.64	5.18	81.61	122
Uzbekistan	187.41	95.05	73.45	73.73	113.23	116.27	126.09	11.26	54.55	59
Yemen	7.49	84.96	82.64	73.41	91.00	96.2	89.68	123.95	5.41	29

The variables are as follows;

*XM_{Ap}: Ratio of exports to imports for Agriculture Foreign trade, (X/M*100), (%), mean value*

MQI : Import quantity index

MVI : Import value index

EQI : Export quantity index

EVI : Export value index

X_{AGR} : Agriculture products exports in total exports, (%)

MU: Import unit value index of agriculture products. Unit value indices express changes in the quantity-weighted unit values of products traded between countries.. [212]

EU:Export unit value index of agriculture products. Unit value indices for bulk agricultural and food products express changes in the quantity-weighted unit values of products traded between countries.[213].

Export to Import Ratio (%), for 2021.

[212] FAOSTAT, (2023), "Trade Indices", (https://www.fao.org/faostat/en/#data/TI), (Date of access: 01.09.2023).
[213] Ibid.

While the ratio of agricultural exports to imports is 98 percent on average in the European Union, the world average is 96 percent. While the ratio exceeded 100 percent in Europe as of 2014, meaning that the export revenues of agricultural products covered the import expenditures of agricultural products and started to generate an external surplus, this development could not be realized in the world average. Although there has been an increase in value in the world average, it has not exceeded 98 percent. In OIC countries with very different production and resource patterns, this ratio is around 60 percent. That is, OIC member countries turn to sources other than agricultural exports to meet their agricultural product imports. In order to have an idea about what these sources might be, one can look at the ratio of total exports to imports of OIC member countries. The ratio of exports to imports is 87 percent in the OIC average (for 2021) and the foreign trade structures of countries differ. In this framework, countries should be analyzed in detail.

In general, countries experienced significant setbacks and rebounds during the 2008 and 2011 food crises. In general, the upward trend in this category continued as of 2015. If we accept the reflection of the 2019 pandemic on 2020 as accurate, there is a decrease in the ratio of exports to imports in 2020, but the trend within the period is in the direction of an increase in the ratio of exports to imports. Although the general consensus is in this direction, it differs specific to countries. In some countries where trade volumes differ by 2 times over the years, the opposite occurs in others. In the evaluations made on this ratio where the value is expressed, it is not the amount of products subject to foreign trade, but the products themselves. For example; Ivory Coast's cocoa-yams and paddy rice, Cameroon's cassava or Burkina Faso's tropical fruits make a difference in value.

A brief look at the key changes indicates that the ratio of exports to imports in agricultural production for Afghanistan has generally started to improve as of 2014. The value, which was 16.69 percent in 2000, changed to 13.48 percent in 2008 and 30.92 percent in 2009. It was 14.24 percent in 2014, 18.84 percent in 2015 and 39.22 percent in 2021.

Benin's position differs. The country, which had a surplus in foreign trade of agricultural products in 2000-2005 and 2009-2010, started to run a deficit of 60 percent as

of 2011. In Brunei Darussalam, where the level of agricultural production is very low, the ratio increased from 0.30 percent to 2.18 percent in 2021. Burkina Faso has always been in surplus except in 2000 and 2008. In Chad, the ratio of exports to imports, which was 305 percent in 2000, dropped to 60 percent in 2008 and continued to decline in the following years. In Comoros, the ratio of exports of agricultural products to imports, which was 42.56 percent in 2000, declined to 5.66 percent in 2015, and then started to increase in the following period, reaching 15.65 percent by 2021. In The Gambia, the ratio, which was 17.85 percent on average between 2000 and 2016, declined to 1 percent in 2018 and then recovered in the following years, reaching 5.73 percent as of 2011. However, a rate of 18.39 percent was attained, well below the 2000 baseline. Until 2008, Kazakhstan was able to cover its food imports with export revenues, but by 2009 it had fallen to 70 percent. While the ratio of Libya's agricultural product exports to imports was 4.62 percent in 2000, it started to decline in the following years and reached the lowest level of 0.19 percent in 2012. In Maldives, which stands out with luxury tourism, almost all agricultural production is imported. The country, whose main agricultural products are palm oil, natural rubbers, palm kernels and paddy rice, did not export any agricultural products between 2005-2019. Mali, which has an agricultural production surplus, could not meet its agricultural product imports with its export revenues in 2008, 2011 and 2019. Niger, which could not cover its imports with its agricultural export revenues, reversed the trend in 2017 and reached 105 percent. As of 2019, this rate has dropped to around 20 percent. Saudi Arabia's exports-to-imports ratio for agricultural products, which was 8.83 percent in 2000, showed a steady upward trend and reached 18.02 percent by 2021. Sierra Leone's ratio, which was 4.24 percent in 2000, increased steadily except for 2013 and reached 20 percent in 2016-2017. Somalia exhibits the opposite outlook. The country's ratio of agricultural exports to imports, which was 80 percent in 2000, halved in 2004 and 2006 and fell below 10 percent over a 20-year period. As of 2012, Sudan is a food import dependent country in general. Suriname, whose exports of agricultural products cover half of its imports in the usual course, exported more than its average between 2003 and 2009, leading to a decline in its 20-year average rate. Syria is among the countries whose agricultural product imports are covered by exports. In

fact, the country has periodically recorded foreign trade surpluses in agricultural products. The ratio of exports to imports, which was 95 percent on average until 2011, dropped to 20 percent in 2011. Tajikistan follows a very similar trend to Syria. The country, which had a foreign trade surplus of 126 percent in agricultural products until 2004, declined to 70 percent by 2005 and to 20 percent by 2011. Togo, which is one of the important agricultural countries and had a surplus in foreign trade in agricultural products with an average rate of 151 percent until 2013, has a tendency to increase its foreign trade deficit in agricultural products after 2013.In Turkmenistan, where the ratio of exports of agricultural products to imports was 169 percent on average until 2007, the ratio decreased to 38 percent as of 2008 and the ratio of exports of agricultural products to imports shows a fluctuating trend over the years. Saudi Arabia increased its exports of agricultural products during the lean periods and raised the ratio from 30 percent in 2000 to 80 percent. Uzbekistan, like other neighboring countries in Asia, has experienced sharp declines in the ratio of exports to imports, which averaged 380 percent until 2007. The ratio of exports to imports, which was 482 percent in 2004, dropped to 67 percent in 2014 and 55 percent in 2021.

Agricultural Imports and Exports Indexes

Explanations on this dataset are covered in the Agricultural Trade section. Therefore, only the tables showing the clubs are included in this subsection. When the data including import and export quantity indices and value indices are analyzed, it is seen that countries do not exhibit similar performances. There are various reasons for this situation. OIC member countries may be members of different economic and political organizations. The product variety and quantity of each country may differ depending on the population and welfare level. Periods of social and political change, dietary habits, trade barriers and productivity gains may vary[214].

[214]OIC, (2020), "Agriculture and Food Security in OIC Member Countries: 2020", Organization of Islamic Cooperation, Statistical Economic and Social Research and Training Centre for Islamic Countries, p.25.

Table 21. Import Quantity Index

Clubs	**Countries**
Club 1 (55 Members)	| Afghanistan | Albania | Algeria | Azerbaijan | Bahrain | Bangladesh | Benin | Burkina Faso | Cameroon | Chad | Comoros | Ivory Coast | Djibouti | Egypt | Gabon | Gambia | Guinea | Guinea-Bissau | Guyana | Indonesia | Iran | Iraq | Jordan | Kazakhstan | Kuwait | Kyrgyzstan | Lebanon | Libya | Malaysia | Maldives | Mali | Mauritania | Morocco | Mozambique | Niger | Nigeria | Oman | Pakistan | Palestine | Qatar | Saudi Arabia | Senegal | Sierra Leone | Somalia | Suriname | Syria | Tajikistan | Togo | Tunissia | Türkiye | Türkmenistan | Uganda | United Arab Emirates | Uzbekistan | Yemen |

Table 22. Import Value Index

Clubs	**Countries**
Club 1 (55 Members)	| Afghanistan | Albania | Algeria | Azerbaijan | Bahrain | Bangladesh | Benin | Burkina Faso | Cameroon | Chad | Comoros | Ivory Coast | Djibouti | Egypt | Gabon | Gambia | Guinea | Guinea-Bissau | Guyana | Indonesia | Iran | Iraq | Jordan | Kazakhstan | Kuwait | Kyrgyzstan | Lebanon | Libya | Malaysia | Maldives | Mali | Mauritania | Morocco | Mozambique | Niger | Nigeria | Oman | Pakistan | Palestine | Qatar | Saudi Arabia | Senegal | Sierra Leone | Somalia | Suriname | Syria | Tajikistan | Togo | Tunissia | Türkiye | Türkmenistan | Uganda | United Arab Emirates | Uzbekistan | Yemen |

Table 23. Export Quantity Index

Clubs	**Countries**
Club 1 (55 Members)	| Afghanistan | Albania | Algeria | Azerbaijan | Bahrain | Bangladesh | Benin | Burkina Faso | Cameroon | Chad | Comoros | Ivory Coast | Djibouti | Egypt | Gabon | Gambia | Guinea | Guinea-Bissau | Guyana | Indonesia | Iran | Iraq | Jordan | Kazakhstan | Kuwait | Kyrgyzstan | Lebanon | Libya | Malaysia | Maldives | Mali | Mauritania | Morocco | Mozambique | Niger | Nigeria | Oman | Pakistan | Palestine | Qatar | Saudi Arabia | Senegal | Sierra Leone | Somalia | Suriname | Syria | Tajikistan | Togo | Tunissia | Türkiye | Türkmenistan | Uganda | United Arab Emirates | Uzbekistan | Yemen |

Table 24. Export Value Index

Clubs	**Countries**
Club 1 (55 Members)	| Afghanistan | Albania | Algeria | Azerbaijan | Bahrain | Bangladesh | Benin | Burkina Faso | Cameroon | Chad | Comoros | Ivory Coast | Djibouti | Egypt | Gabon | Gambia | Guinea | Guinea-Bissau | Guyana | Indonesia | Iran | Iraq | Jordan | Kazakhstan | Kuwait | Kyrgyzstan | Lebanon | Libya | Malaysia | Maldives | Mali | Mauritania | Morocco | Mozambique | Niger | Nigeria | Oman | Pakistan | Palestine | Qatar | Saudi Arabia | Senegal | Sierra Leone | Somalia | Suriname | Syria | Tajikistan | Togo | Tunissia | Türkiye | Türkmenistan | Uganda | United Arab Emirates | Uzbekistan | Yemen |

Intra-Trade in OIC Members

Intra-OIC trade is essential for food security, poverty and hunger alleviation, growth and employment not only for the member countries but also for the regions in which they are located. For example, preferential matching of agricultural products based on the aggregate supply and demand of OIC member countries can create great opportunities for trade volume, cooperation and development of regional potential.[215] Countries that are connected to each other but located on different continents are constrained by high transportation costs, inability to realize the potential production amount due to insufficient mechanization, and high tariff barriers and countries' preferences[216].

Table 25 provides the trade volumes of OIC member countries among each other. Although import and export values differ, a holistic analysis shows that Afghanistan, Benin, Comoros, Gambia, Jordan, Lebanon, Mali, Niger, Oman, Somalia, Sudan, Suriname, Syria, Tajikistan, Togo and Yemen have intra-OIC trade shares above 40 percent. Guyana, which has the lowest share in intra-OIC trade, is located in a geographically disadvantaged region. In terms of exports, Albania, Bangladesh, Comoros, Gabon, Guinea and Libya are the countries with the lowest shares in imports, while Nigeria, Kazakhstan and Suriname have the lowest shares in imports.

Geographical distance is also an important constraint for the OIC group. The Asian countries of Türkiye, Azerbaijan, Kazakhstan, Kyrgyzstan, Turkmenistan and Tajikistan trade mainly between themselves, while Suriname and Guyana trade with each other and the Mediterranean littoral countries trade mainly within themselves.

[215]OIC, (2020), "Agriculture and Food Security in OIC Member Countries: 2020", Organization of Islamic Cooperation, Statistical Economic and Social Research and Training Centre for Islamic Countries, p.25.
[216] Ibid.,OIC, (2020), p.viii.

Table 25. Intra-OIC Trade Shares in Foreign Trade

Country (2021)	Export (%)	Import (%)	Country (2021)	Export (%)	Import (%)
	X_{OIC}	M_{OIC}		X_{OIC}	M_{OIC}
Afghanistan	46.13	58.72	Malaysia	10.60	13.35
Albania	1.84	20.46	Maldives	3.19	39.54
Algeria	12.81	15.05	Mali	30.82	54.36
Azerbaijan	13.41	28.94	Mauritania	5.61	29.08
Bahrain	42.61	21.50	Morocco	8.23	19.06
Bangladesh	4.71	25.72	Mozambique	6.09	15.85
Benin	21.34	63.29	Niger	53.81	17.01
Brunei	10.76	30.27	Nigeria	12.17	4.33
Burkina Faso	16.71	23.82	Oman	51.90	52.12
Cameroon	15.13	20.49	Pakistan	20.65	45.49
Chad	33.29	29.95	Palestine	9.56	21.04
Comoros	7.43	56.08	Qatar	14.33	14.57
Ivory Coast	26.16	27.97	Saudi Arabia	23.24	19.85
Djibouti	36.82	40.99	Senegal	40.25	15.56
Egypt	34.85	26.15	Sierra Leone	10.99	23.44
Gabon	7.53	12.20	Somalia	88.31	31.79
Gambia	69.95	52.04	Sudan	65.06	37.16
Guinea	7.89	17.65	Suriname	43.60	3.19
Guinea-Bissau	16.30	39.45	Syria	85.91	20.17
Guyana	3.72	3.61	Tajikistan	51.00	36.63
Indonesia	13.59	13.71	Togo	67.82	22.37
Iran	41.30	31.29	Tunusia	13.28	18.13

Iraq	5.76	40.31	Türkiye	25.30	11.08
Jordan	41.19	36.54	Turkmenistan	16.78	40.51
Kazakhstan	14.74	6.63	Uganda	8.79	22.74
Kuwait	4.94	23.05	UAE	19.11	20.48
Kyrgyz Republic	45.17	18.51	Uzbekistan	28.44	24.18
Lebanon	61.72	26.82	Yemen	79.53	46.61
Libya	5.98	34.40			

X_{OIC} : Share of intra-OIC trade in total exports, (%)

M_{OIC} : Share of intra-OIC trade in total imports, (%)

Considering that Table 25 covers all trade products, the intra-OIC demand of countries' trade products should also be taken into account. For example, the intra-OIC trade shares and partners of countries that export oil predominantly are higher. Considering that foreign trade is an important income item for countries, trade with regional organizations such as the European Union, ASEAN, APEC, ECOWAS, CEEAC-ECCAS (Economic Community of Central African States), SCO (Shanghai Cooperation Organization), UNASUR (International Cooperation in South America) [217] etc. may provide more revenue or strategic advantage than intra-OIC trade. Trade outside the OIC geography may also be advantageous if the aim is to expand production and trade volumes by tapping new markets or if certain countries produce specific raw materials..

In addition to all of these, it is expected that ensuring the mechanization of agricultural production through investment and finance mechanisms and providing food

[217]MFA, (2023), "Uluslararası Kuruluşlar ve İlişkilerimiz" , (https://www.mfa.gov.tr/sub.tr.mfa?23a3fc26-4f3b-47dd-943e-d8934cdad97e), (Date of access: 20.08.2023).

aid by establishing an organization such as UNWFP will increase the intra-OIC trade volume and cooperation between countries.

Food Security

Among the SDG targets, poverty eradication and zero hunger are closely related to this pillar. In fact, other targets such as ensuring health and welfare, quality education, equality of opportunity, sustainable cities and society, reduction of working hours and economic growth can only be possible by ensuring adequate agricultural production and offering it at price levels that the society can afford to consume. On the one hand, the employment opportunities and income level to be provided by agricultural production, on the other hand, the added value to be created with affordable agricultural inputs and products with high nutritional value will lead the society to get the amount of calories it needs and to be healthy.

In this framework, the UN has determined US$ 1.90 per day as the international poverty threshold according to purchasing power parity in 2011. According to this figure, the poverty rate in the OIC region is around 13 per cent[218].Poverty rates in Uganda, Yemen, Iraq, Guinea Bissau and Nigeria remain above the OIC average and have been increasing over time[219].

In respect to food price index, the world average is 3.90, the EU average is 2.40 and the OIC average is 8.36[220]. This rise has become more severe after the Covid-19 pandemic. The change in these values in the last 3 years is presented in Table 26. In 2019, the OIC average for the food price index was 6.07 per cent, while it was 21.68 per cent for 2020 and 22.29 per cent for 2021. For the same periods, the EU average was 1.03 and 4.46 per cent,

[218] SESRIC, (2020), "Towards the Achievement of Prioritised Sustainable development Goals in OIC Countries", Organisation of Islamic Cooperation, p.16.
[219] A.g.g., 17.
[220](EUROSTAT, 2023).

while the world average was 5.75 and 11.02 per cent, respectively. Moreover, these increases are not distributed evenly among OIC member countries. For example, while Qatar, Phalestine, Comoros, Jordon, Morocco and Oman recorded decreases in the food price index, Lebanon, Sudan, Syria and Türkiye experienced increases above the OIC average[221].

Table 26. Food Price Index Indicator for Selected Countries and Regions

Food Price Index (%)	**2019**	**2020**	**2021**
Lebanon	9,77	402,25	438,65
Sudan	63,28	206,47	191,60
Syria	39,13	172	44,3
Türkiye	10,89	20,61	43,80
OIC average	6,07	21,68	22,29
EU average	1,91	1,03	4,46
World average	5,35	5,75	11,02

In this perspective, it is necessary to put forward concrete targets and a road map. Poverty alleviation in all aspects is important for OIC member countries. As it is known, poverty intensively affects small agricultural producers. Improving the welfare level by increasing agricultural production requires possession of means of production as well as the size of arable land. While the average land size is 24.98 per cent in the Netherlands, which corresponds to 5.34 per cent of OIC member Türkiye in terms of area and where the share of agricultural employment is 2.77 per cent and where industrial agriculture is practised, the OIC average is 4.75 per cent. [222]. Furthermore, the distribution of average land size among

[221](EUROSTAT, 2023).
[222](EUROSTAT, 2023).

OIC members is relatively diverse. For instance, while the average land size in Bangladesh, Comoros, Gunea, Mozambique where agricultural employment is high is less than 2 acres, Kazakhstan and Saudi Arabia are the OIC member countries with the highest average land size with 26.97 per cent and 13.29 per cent shares, respectively.

Similar observations apply to the use of fertilizers and pesticides, which are the other main inputs. The table below provides the averages of the related inputs in order to facilitate comparison. The OIC region, which follows a close course with the world average in terms of agricultural employment, is relatively disadvantaged at least in terms of inputs other than soil and water. Under these conditions, it does not seem very easy to break the cycle of poverty and malnutrition, at least under self-functioning market conditions. Public interventions and planned co-operation within the OIC can accelerate and facilitate the process.

Table 27. Selected Input Indicators and Food Price Increases

(Average Value)	Food Price Index	Agricultural Employment (%)	Pesticide	Fertilizer	Manure applied to soil
Netherlands[223]	1,58	2,77	11.042	318.681	292.432.328
OIC	8,36	33,25	4.085	425.449	59.970.803
European Union	2,46	7,26	467.613	22.130.093	7.348.312.160
World	3,90	32,65	2.476.649	169.972.502	26.111.807.232

As can be observed from Table 27, the share of agricultural employment in total employment is quite low in the Netherlands, where the food price increase is the lowest. On the other hand, capital stock is increasing rapidly. For instance, despite a 145.73 per cent

[223] The agricultural sector in the Netherlands is the most productive and productive per unit of land in the European Union (EU). However, ammonia emissions, nitrogen and phosphorus excesses, and pesticide use per hectare of agricultural land are also among the highest in the EU. While agriculture, which is a productive sector in the Netherlands, has an important share in national income, it is under the pressure of important environmental problems in terms of input use. Despite successful policies and farm measures to reduce this pollution, agriculture still poses the greatest environmental pressure on biodiversity.
Systems aiming at the sustainable and efficient management of natural resources are essential to meet the food needs of the next generation. Sustainable agri-food system not only reduces loss of biodiversity, waste of fresh water, greenhouse gas emissions, but also creates a sustainable ecosystem with less nitrogen and phosphorus consumption. There are three main ways of intervention to reduce the negative environmental and health impacts of the agri-food system. These are to increase the efficiency of agricultural production, reduce food waste and create healthy diets that consume fewer resources.
The Netherlands ranks second in the world after the US and before Brazil, China and much larger EU countries like Germany, France, and Spain. Ranking countries by gross export gives a distorted picture of the economic relevance of national agro-food sector as, particularly for the Netherlands, a large share of imported commodities is almost directly re-exported e.g., via Rotterdam harbor and Schiphol airport.
This rank is a remarkable achievement considering that the Netherlands only holds 0.04% of global agricultural land and 1% of that in the EU and inspired the claim that “A tiny country feeds the world". This position is made possible by a combination of a favorable climate, fertile soils, high levels of agricultural science and technology, high cost-efficiencies, a very profitable horticultural sector, but also a high intensity primary production system with high imports of agricultural products like livestock feed.

increase in mechanisation in the Netherlands in the period between 2000 and 2021, an increase of 353.18 per cent is recorded in the OIC average, 106.09 per cent in the EU average and 193.87 per cent in the world average. However, in terms of quantity, in 2000, the capital stock of the Netherlands alone in agriculture increased from USD 62.782 million to USD 72.512 million, while the OIC average increased from USD 11.692 million to USD 21.993 million[224]. In addition to high mechanisation, high levels of pesticides, fertilizers and manure also affect productivity and price level.

However, this form of production differs among OIC member countries and may lead to disadvantageous circumstances. For example, Bahrain, Brunei-Darrussalam, Comoros, Djibouti, Guinea-Bissau, Guyana, Maldives, Sierra Leone and Togo have very low levels of net capital stock. It is decreasing further in Syria, Somalia and Oman[225]. In this perspective, SESRIC focuses especially on low-income OIC member countries and emphasises public support for the mechanisation of small-scale agricultural producers, R&D, infrastructure and irrigation improvement works and increasing plant and animal gene banks[226].

Prevalence of undernourishment data is the percentage of individuals in the SDG 2 group who do not have access to a diet that includes the amount of energy necessary to lead an active and healthy life. Data are based on UN Population Division, FAO Food Balance Sheets and household surveys, including food consumption where possible[227].

Club 1 lists the countries with the highest levels of hunger. Yemen is experiencing losses in social resilience and capacity as a result of the crisis caused by the civil war combined with poverty and environmental degradation. In this context, the European Union

[224] FAOSTAT, (2023), "Capital Stock", (https://www.fao.org/faostat/en/#data/CS), (Date of access: 05.09.2023).
[225] FAOSTAT, (2023), "Capital Stock", (https://www.fao.org/faostat/en/#data/CS), (Date of access: 05.09.2023).
[226] SESRIC, (2020), "Towards the Achievement of Prioritised Sustainable development Goals in OIC Countries", Organisation of Islamic Cooperation, p.21.
[227] FAOSTAT, (2023), "SDG Indicators: Metadata", (https://www.fao.org/faostat/en/#data/SDGB), (Date of access: 01.07.2023).

and the Swedish government are implementing the "Supporting resilient livelihoods, food security and climate adaptation programme Project"[228].

Table 28. OIC Convergence Clubs for Undernourishment

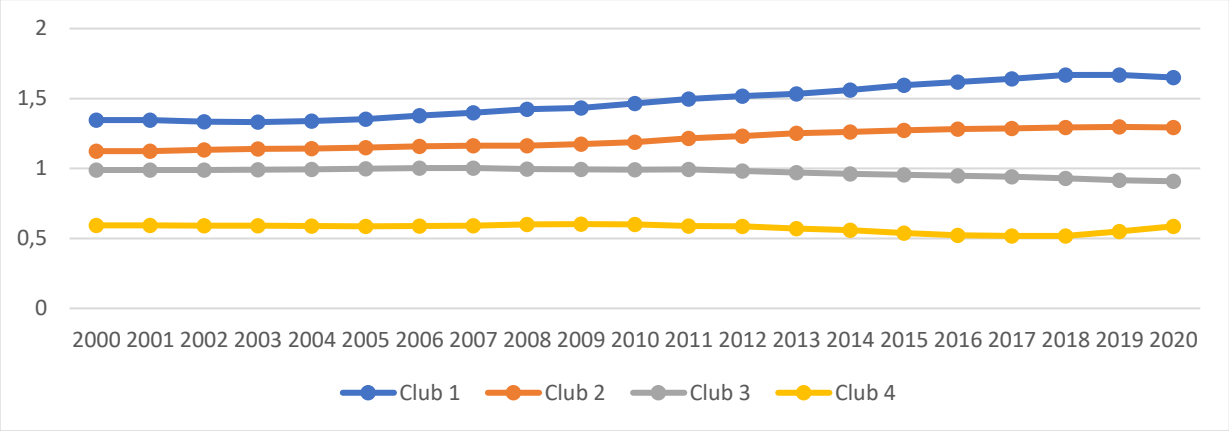
Clubs	**Countries**
Club 1 (5 Members	| Chad | Jordan | Mozambique | Somalia | Yemen |
Club 2 (12 Members)	| Afghanistan | Albania | Bangladesh | Burkina Faso | Gabon | Gambia | Iraq | Mauritania | Nigeria | Pakistan | Sierra Leone | Togo |
Club 3 (17 Members)	| Benin | Brunei-Darrussalam | Cameroon | Ivory Coast | Djibouti| Egypt | Guyana | Indonesia| Iran | Kyrgyzstan | Lebanon| Morocco | Oman | Senegal | Sudan | Suriname| United ArabEmirates |
Club 4 (7 Members)	| Kuwait | Malaysia | Mali | SaudiArabia | Tunissia | Türkiye | Türkmenistan |
Not convergent Group	| Algeria | Azerbaijan | Kazakhstan | Uzbekistan |

In general, although countries are grouped into clubs, undernourishment has been increasing, especially after the 2008 food price hikes. However, this is not consistent with the food price index. That is, Chad, Jordan, Mozambique, Somalia and Yemen, which have

[228] FAO, (2022), "FAO in the United Arab Emirates Bulltein", (https://www.fao.org/3/cc3957en/cc3957en.pdf), p.6.

the highest levels of undernourishment in the OIC, are not in the group with the highest food price increases. On the contrary, these countries are in the last two clubs with the lowest food price increases. Therefore, policy implementation to address the problem of malnutrition should take into account not only price increases but also access to adequate quantities of nutritious and healthy food and its balanced distribution.

Figure 101. Relative Transition Paths of Clubs

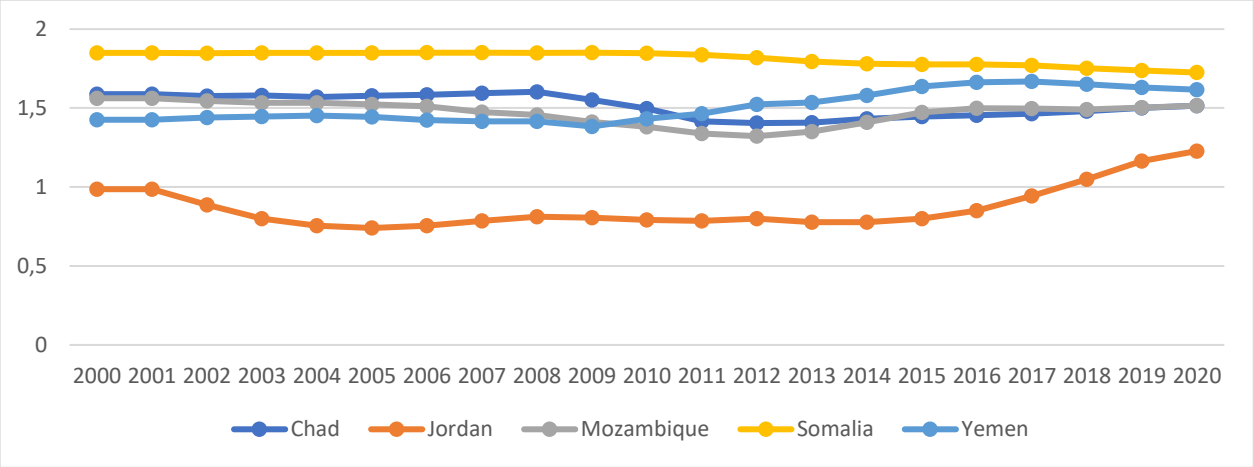


A detailed look at the clubs shows that Somalia, one of the countries in the first club, has the highest level of undernourishment and has only begun to show a downward trend since 2011. Geographically located in one of the driest regions of the OIC group, but also dominating the Gulf of Aden along with Yemen and Djibouti, the Eastern Mediterranean country's crop production is severely limited by water shortages. The country, rich in gold, uranium, natural gas and oil, is trying to concentrate on livestock farming like other oil-rich countries with water shortages[229]. Besides, due to internal instability in the country, aquaculture production is very limited like other countries in the region. The country, which historically dominated the region's trade, was dragged into a conflict environment for decades, first along the coastline and inland regions, then north and south. Until 2012, an

[229] OIC, (2023), "OIC Countries in Figures: Somalia", (https://www.sesric.org/cif.php?c_code=47), (Date of access: 01.09.2023).

effective central authority could not be established in the country and the legislative executive was based on 4.5 clan representation[230]. During this period, mass killings and famines occurred in Somalia and the country became in need of food aid not due to the lack of agricultural inputs but due to the political turmoil. In addition to armed conflicts, droughts and floods continue to cause humanitarian needs. Regional conflicts, which intensify from time to time, deepen food insecurity by preventing the Somali people suffering from chronic malnutrition from accessing humanitarian aid.[231].

Figure 102. Relative Transition Paths of Countries in Club 1

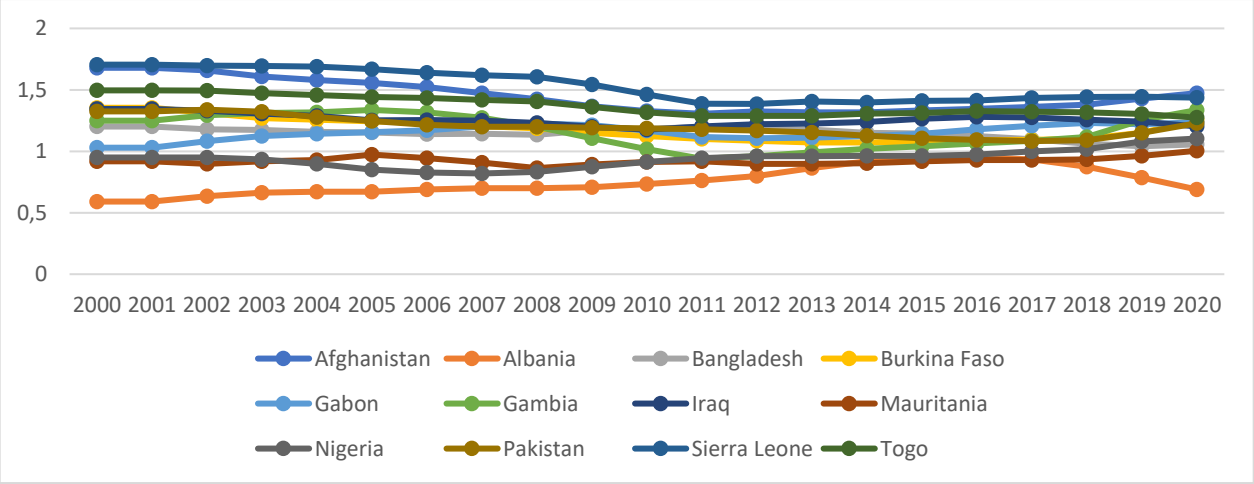


In Jordan, which is in Club 1, the group where malnutrition is prevalent is the refugees in the country. As explained in previous chapters, food aid has made significant improvements to the severely food insecure group in the country, which is predominantly made up of displaced people from Syria and Palestine[232].

[230] MFA, (2023), "Somali'nin Siyasi Görünümü", (https://www.mfa.gov.tr/somali-siyasi-gorunumu.tr.mfa), (Date of access: 01.09.2023).
[231] WFP, (2023), "WFP Somali Country Brief", (https://docs.wfp.org/api/documents/WFP-0000152341/download/?_ga=2.248705474.473552008.1696116906-243752179.1695125611&_gac=1.220642922.1696116935.Cj0KCQjwjt-oBhDKARIsABVRB0xH25XyYy2JDCM7bLr5-Q3iZlhKmwZ98evHiP7RfNA7JHv-ZcAi_w4aAtlREALw_wcB), p.1, (Date of access: 01.09.2023)
[232] WFP, (2023), "Food Security in Numbers: Refugwws in Jordan", (https://docs.wfp.org/api/documents/WFP-0000151223/download/?_ga=2.258095695.473552008.1696116906-

In the countries in Club 2, the level of undernourishment appears to have been higher at the beginning of the period and generally decreased after 2009. Albania is the country with the lowest level of undernutrition in the club, but it differs slightly from the group in terms of the pattern of undernourishment. In the European country, the undernourishment rate showed an increasing trend until 2017 and started to decline after that date. In 2018, the impact of the program to prevent poverty by increasing rural income can be observed[233]. The program also provides support for the country's alignment with European Union agricultural standards.

Figure 103. Relative Transition Paths of Countries in Club 2



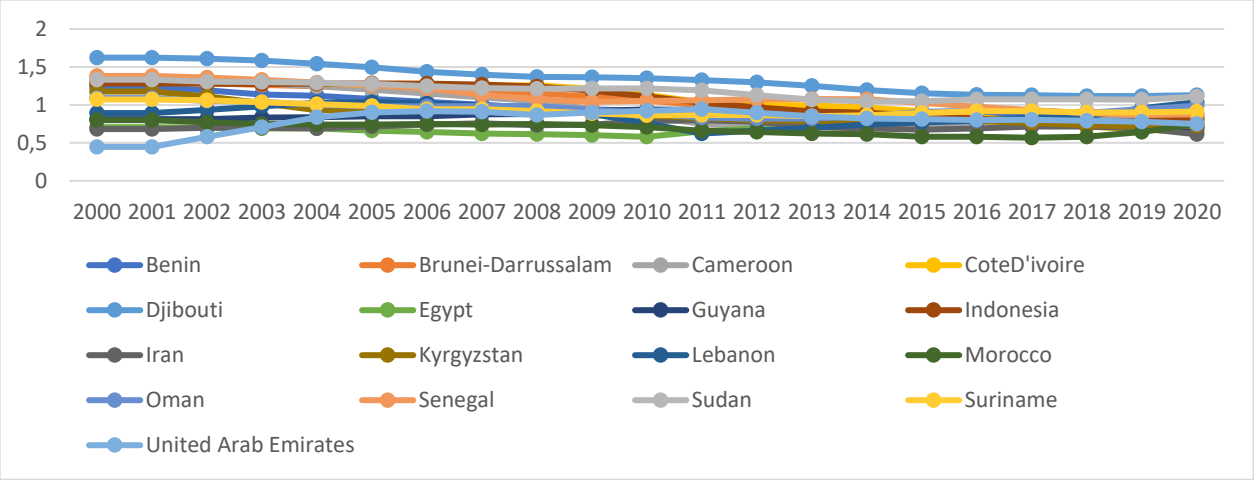
Overall, the end-of-period undernutrition levels of the countries in club 3 have decreased considerably compared to the beginning of the period. Small increases are observed in the UAE and Egypt. In Egypt, where the average undernourishment level is 5.1 percent, the average undernourishment level was 5 percent at the beginning of the period,

243752179.1695125611&_gac=1.190258649.1696116935.Cj0KCQjwjt-oBhDKARIsABVRB0xH25XyYy2JDCM7bLr5-Q3iZlhKmwZ98evHiP7RfNA7JHv-ZcAi_w4aAtlREALw_wcB), p.18, (Date of access: 01.09.2023)

[233] FAO, (2022), "support the Development of Smallholders: Albania", (https://www.fao.org/3/cb8867en/cb8867en.pdf), p.2, (Date of access: 28.07.2023)

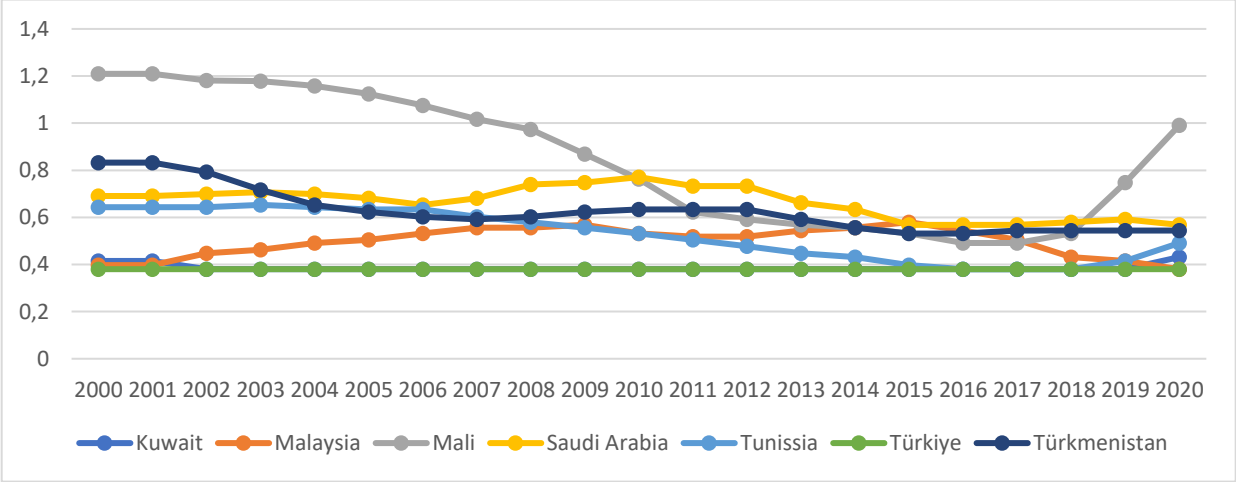
decreased to 3.8 percent by 2010, started to increase in 2011 and decreased again to 5.2 percent by 209. In the UAE, the level of undernourishment, which was 2.8 percent at the beginning of the period, increased to 8.8 percent by 2011 and then started to decline to 5.6 percent.

Figure 104. Relative Transition Paths of Countries in Club 3



Other countries in Club 3 have improved upon their relatively high levels of undernourishment at the beginning of the period, which were better than those of OIC member countries at the end of the analysis period. Although countries show very similar improvement trends, Indonesia, for example, plans to achieve food sovereignty by increasing farmer welfare within the framework of the promotion of sustainable agro-industry launched in 2013. To strengthen food sovereignty and achieve self-sufficiency, the country has been preparing National Action Plans on Food and Nutrition since 2005, taking measures to address malnutrition-related problems, including stunting, and implementing policies to promote food diversity and local food consumption.

Figure 105. Relative Transition Paths of Countries in Club 4



Although there are periodic deteriorations in the undernourishment levels of the countries in Club 4, as in the food crises of 2008 and 2011, an improvement trend is observed when considered overall. Mali in the group draws attention with its volatile structure. The country started with a high level of undernourishment compared to the group average, but decreased to the group average until 2017, after which there was an increase again. As of 2012, the World Bank launched a food security and nutrition program in the country where political instability began. Following the 2006 agricultural land management program, cash transfer payments were introduced in 2013. The program, which also provided special health services to severely malnourished children between the ages of 2-6 and pregnant women, ended in 2017[234]. In addition, the goal of replenishing the country's grain stocks, which was initiated in 2004, was revived as a government plan to address the 2016 food shortages, but malnutrition has increased again in the country with the withdrawal of foreign aid.[235]

As mentioned at the beginning of the section, undernourishment is not an issue that can be addressed or evaluated in isolation. It is a multidimensional phenomenon that

[234] FAO, (2017), "Country Fact Sheet on Food and Agriculture Policy Trends: Mali", (https://www.fao.org/3/i7617e/i7617e.pdf), p.5, (Date of access: 15.09.2023).
[235] Ibid., FAO, (2017).

encompasses political and economic stability and fair distribution mechanisms. Yet, studies associate undernourishment or food insecurity with food price increases. However, as is well known, the main factors affecting food price increases are input costs and value chains that disrupt value transfer after farm prices. The main reason for food price increases is the change in the foreign currency-indexed prices of imported agricultural inputs and the determining role of companies in certain countries in the market structure, as in the case of seeds and chemical fertilizers. Therefore, it seems possible for countries to remove nutritional stresses within the framework of food security and sustainability of agricultural production by ensuring self-sufficiency in agricultural inputs.

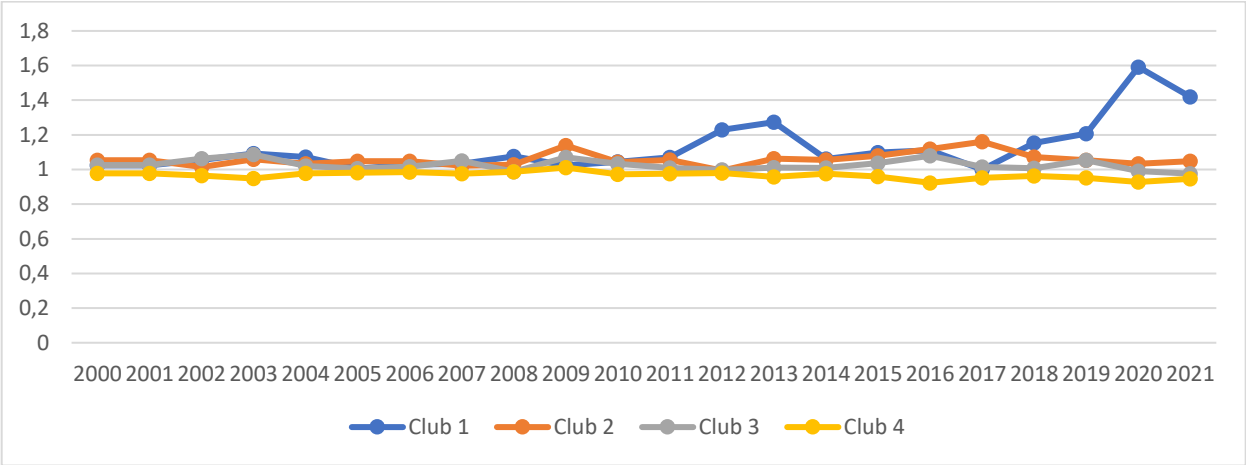
The table below shows the categorization of countries according to the food price index. Food price index measures the average annual change in field prices of agricultural products over time. Data collected in local currency are indexed by FAO using the Laspeyres method. As mentioned, the index includes primary plant and animal products, but excludes fisheries and aquaculture. Therefore, production price changes of countries that concentrate their production on aquaculture products cannot be monitored here. Another issue related to the index is product diversity. The index of a country with a relatively low diversity of agricultural production may be seen at marginal thresholds depending on the conjuncture. Moreover, the value of the index is not the cause or solution of undernourishment, as seen in the case of Yemen. Lack of access to food and food insecurity is a public policy issue that requires multidimensional solutions.

Table 29. OIC Convergence Clubs for Food Price Index

Clubs	**Countries**
Club 1 (3 Members)	| Iran | Lebanon | Syria |
Club 2 (8 Members)	| Afghanistan | Egypt | Guinea | Libya | Nigeria | Sierra Leone | Türkiye | Uzbekistan |
Club 3 (9 Members)	| Albania | Azerbaijan | Gambia | Kazakhstan | Mozambique | Pakistan | Tajikistan | Tunissia | Yemen |
Club 4 (32 Members)	| Algeria | Bahrain | Benin | Brunei-Darrussalam | Burkina Faso | Cameroon | Chad | Comoros | Ivory Coast | Djibouti | Gabon | Guinea-Bissau | Indonesia | Iraq | Jordan | Kuwait | Kyrgyzstan| Malaysia | Maldives | Mali | Mauritania | Morocco | Niger | Oman | Palestine | Qatar | SaudiArabia | Senegal | Somalia | Togo | Uganda | United ArabEmirates |
Not convergent Group	| Suriname |

In order to provide a perspective, 4 groups of countries and Suriname, which does not converge to any club, were obtained in the grouping of countries according to food price indexes. Accordingly, there is a significant increase in Club 1 after 2011-2014 and 2017.

Figure 106. Relative Transition Paths of Clubs



The countries in Club 1 are Syria, Lebanon and Iran. The production structures, production patterns and the level of external dependence on agricultural inputs of these countries should be considered together. However, considering that these countries are located in similar geographical areas and have similar mineral wealth, it can also be inferred that domestic stability and access to food also have an impact on price increases.

Producer prices of agricultural outputs are determined by agricultural input prices in the absence of public interventions such as input support payments, in-kind input supports, support purchases, tax exemptions and exemptions, base price determination; that is, under market conditions. Basic agricultural inputs are land, labor, seed, water, fertilizer, pesticides and machinery. In the current production process; as a result of the framework "Agreement on Agriculture", especially seeds-fertilizers-pesticides are used as industrial outputs with chemical or gene codes modified. These inputs, which are mainly imported, can have a negative impact on both the amount and price of agricultural production and negatively affect consumer and producer welfare, especially during periods of foreign exchange price increases and import restrictions. For example, a brief look at the fertilizer market shows that the world chemical fertilizer sector has grown by 12.75 percent in the last 10 years. Chemical fertilizer production increased by 50.11 percent and consumption by 47.38

percent. [236]. Russia, China, USA and OIC member country Morocco are respectively the world's largest exporters of chemical fertilizers. Chemical fertilizer prices, which began to increase with the pandemic, peaked with the Russia-Ukraine war and started to decline as of July 2022.

[236] Yeniay, Emre, (2023), "Turkey & Global Fertilizer Sector: Fertilizer Trade Volume of the Organization of Islamic Cooperation With Turkey", T.C. Tarım ve Orman Bakanlığı, (https://www.comcec.org/wp-content/uploads/2023/05/3-GUBRE-SUNUM-ENG-2023.pdf), (Date of access: 09.09.2023).

In Depth Assesment of the Agricultural Sustainability and Food Security Practices in Selected Countries

Field Visits

Egypt

Background

The Egyptian civilization, which is the oldest civilization of the world, was fundamentally established on the fruitful banks of Nile. Egypt which was once the food basket for the Romanian empire, started to be a net importer of agricultural commodities since 1974. Hence, agriculture represents a vital sector for the Egyptian state with a population passed 110 Million people. Egypt`s population growth has increased pressure on natural resources, including land and water. This part of the study reviews the challenges face the Egyptian state in the field of agriculture and the programs and the plans made by the Egyptians governments to enhance the agriculture productivity in Egypt.

Facts about the Agriculture Sector

- The total agricultural area of Egypt is about 9.7 million acres, while the total cropped area of Egypt is about 17.5 million acres according to the number published by State İnformation Service (SIS).
- Although its contribution to the GDP is gradually diminishing, the agricultural sector in Egypt contributes about 17% to merchandise exports abroad, and the agricultural sector's contribution to the gross domestic product is about 15%. The percentage of workers in the agricultural sector is about 25% of the total workforce in Egypt[237].

[237] Information Office , (2022), Agriculture figures.. Learn about the most important figures for the agricultural sector in Egypt أرقام لزراعة..تعرف على أهم الأرقام الخاصة بالقطاع الزراعي في مصر. Cairo: State Infirmation Service (SIS) الهيئة العامة للاستعلامات.

- Egypt is IFAD's largest recipient of financial assistance in the Near East and North Africa region.
- Egypt has moderate food security, with its strengths in affordability and sustainability. However, access to high-quality and safe food needs improvement[238].

Challenges Faced in Agriculture

The problems of agriculture in Egypt briefly as food shortage, water insufficiency for agricultural purposes, the extreme poverty among small-scale farmers, lack of coordination and integration between various stakeholders, complicated local administration system and centralization, and declined governmental investments in the agriculture sector[239].

Additionally, the report of the Egyptian Journal of Agriculture Research for the year 2019 summarize the problems of agriculture in Egypt as following:

- The fragmentation of agricultural holdings, and the dominance of dwarf holdings, where about 92.1% of the total number of owners in the Republic owns an area of agricultural land about 47.2% of the total area of agricultural owned, thus leaving about 8% of the total number of owners in the Republic owns the area of the agricultural land, amounting to about 52.8% of the total agricultural land owned.
- Increasing the encroachment on agricultural land for urban expansion and by excavation, especially in the period from 25/1/2011 to 18/3/2014.
- Neglecting the maintenance of agricultural economic resources by land clearing, poor service operations, wasteful irrigation and poor drainage.

[238] IFAD, (2023, September 9), International Fund for Agricultural Development Official Page https://www.ifad.org/en/, Retrieved from Egypt Profile

[239] Elmenofi, G. A. (2013). Governance of agriculture and rural development in Egypt. 4th International Symposium "Agrosym 2013" (pp. 1124-1129). Jahorina (East Sarajevo): Food and Agriculture Organization of The United Nations.

- The risks of climate change on land, leading to high salinity of soil, land development, rising groundwater level, coastal erosion and displacement of the northern coastal population.
- Social and economic problems, namely, the complete liberalization of the agricultural sector in 1990, and the release of agricultural land rents in full in 1997, which led to the increase in the value of production inputs in addition to the increase in wages of agricultural workers and fuel prices.
- An abolition of subsidies on agricultural loans and hence the increase in interest rates on it agricultural loans.
- A decline of role cooperative marketing and cooperative societies, which led to high production costs in addition to the cancellation of the agricultural cropping system, which led to increase the size of the food gap in the main crops in the average period (2011-2015) to 45% for wheat, 50% for 94% for lentils, 88% for vegetable oils, 70% for municipal beans, 30% for sugar, 23% for dairy products and 25% for red meat. This gap is covered by imports from the dollar markets. Exchange of the dollar in Egyptian pounds[240].

In conclusion, Egypt's agricultural problems can be summed up as the limited arable land, especially in light of the encroachments that took place on the land in past periods, which led to the decline of arable land and the erosion of large areas. Water scarcity, especially as the agricultural sector is considered to be the largest consumer of Egypt's share of water. Population growth at rates that do not correspond to the rates of increase in the area of agricultural land, when the per capita share of the area of agricultural land decreases to less than 2 karats, after it was more than one acre in some past periods, which requires the search for mechanisms and solutions to control population growth so that the positive results of the growth achieved can be observed. Another issue is the fragmentation of agricultural

[240] Kabeel, M. E., Mobarack, M. A., Azzam, A. A., and Ghonuim, S. A. (2019). The Most Important Agricultural Problems and Obstacles Leading to The Widening of Food Gap of Agricultural Crops in Egypt, Egyptian Journal of Agriculture Research, 97(4), 835-856.

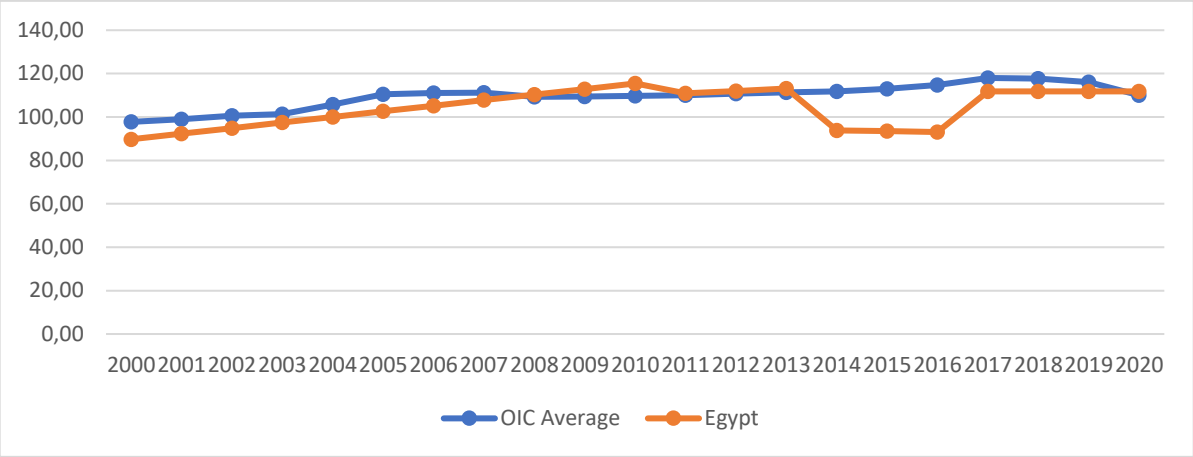
ownership when the number of owners of areas of less than one hectare largely reaches 3.4 million owners which represents about 70% of the total number of owners, which leads to low efficiency of agricultural land use and low possibility of using agricultural mechanization causing difficulties in implementing the agricultural cycle and increased production costs. The recent climatic changes that have affected many countries also affects Egypt including the agricultural sector especially with the increase in evaporation rates and water needs of plants and its impact on flowering, knotting, diseases, insects and others. Finally, the findings from the field observations show that small producers face difficulties in using chemical fertilizers, that the use of chemical fertilizers can significantly increase agricultural productivity, and that there is an awareness that pesticides harm the environment.[241].

Sustainability of Agricultural Inputs

Compared to the average of OIC countries, it can be observed that Egypt is at a critical stress level with water stress above 100 percent in the 2000-2020 period, while water stress in Egypt has been increasing since 2004 and exceeded the OIC average with 115 percent in 2010. In the 2014-2016 period, the water stress decreased and remained below 100 percent, but returned to the critical level as of 2017.

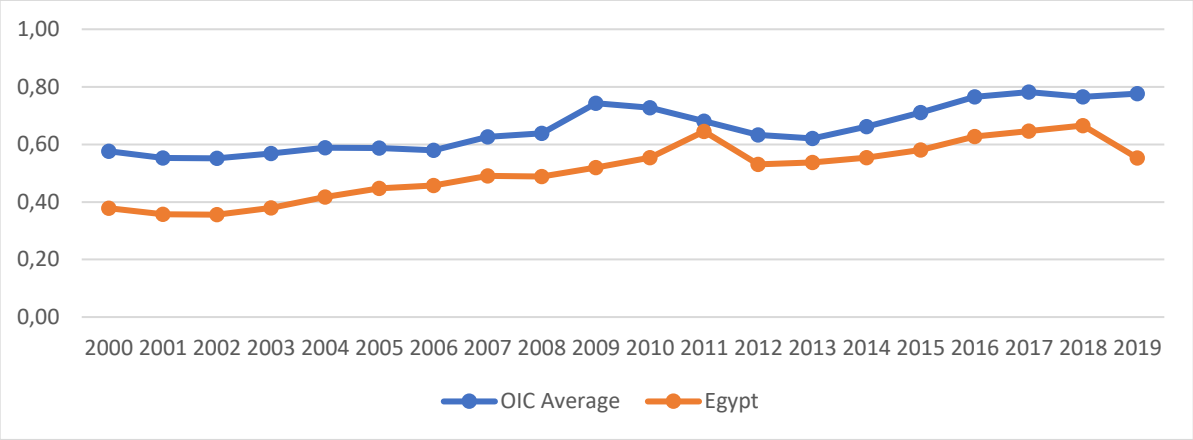
[241] Field visit observations, 2023, Egypt

Figure 107. Level of Water Stress



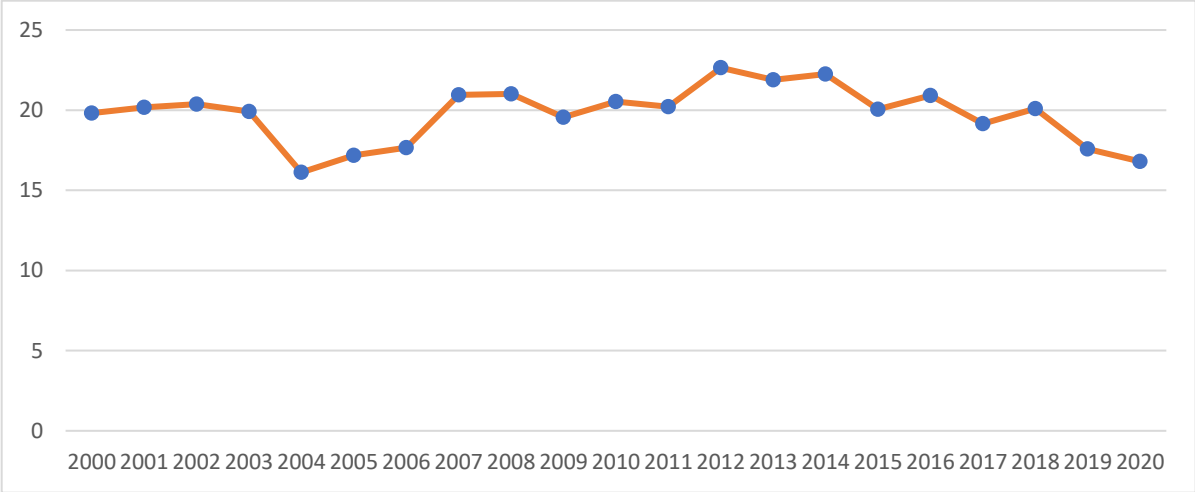
Looking at the change in the ratio of agricultural value added to water use volume, which is defined as water use efficiency, it is observed that Egypt has been consistently below the average of OIC countries throughout the 2000-2020 period.

Figure 108. Water Use Efficiency



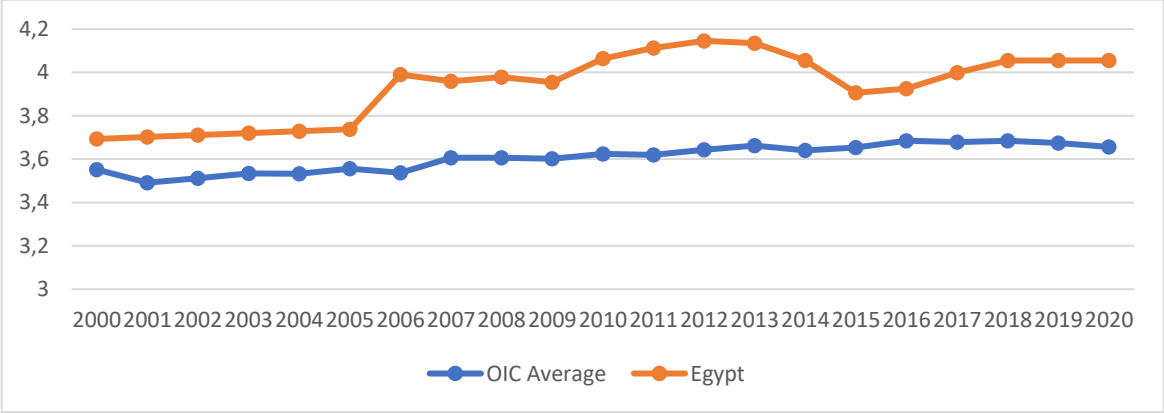
Although the use of chemical fertilizers is quite high in Egypt, the share of animal fertilizer use in total fertilizer use increased in the period 2012-2015, whereas it has decreased significantly since 2018.

Figure 109. Shares of Manure to Soil in Total Fertilizer



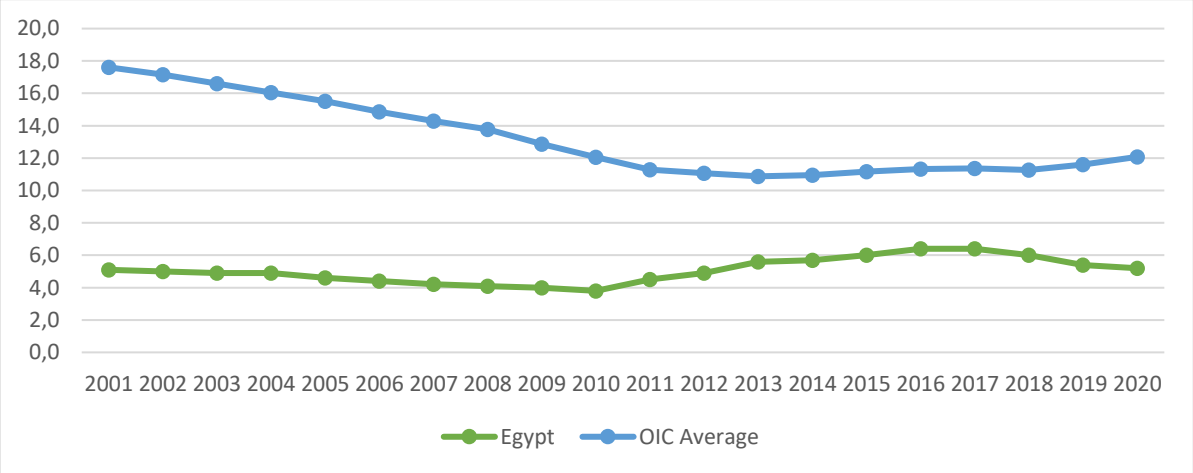
For the period 2000-2020, Egypt's pesticide use has consistently exceeded the OIC average. There has been a sharp increase especially since 2005, while the rate of increase in pesticide use has continuously accelerated despite the decline in the 2013-2015 period.

Figure 110. Changes in Pesticide Use



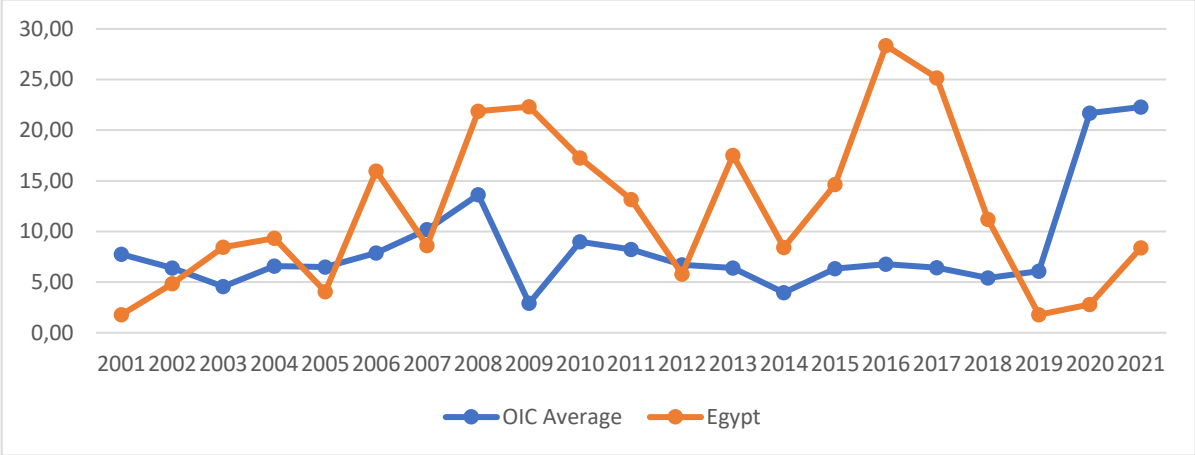
Regarding the prevalence level of undernutrition, the OIC average has been at a lower and more stable level since 2011, while Egypt has been at a very low level compared to the OIC average. When the 2001-2020 period is evaluated for Egypt, it is seen that the prevalence of undernutrition has increased significantly since 2010 and reached the highest level of the relevant period in 2016 and 2017.

Figure 111. Prevelance of the Undernourishment



Finally, the food price index shows a rather unstable situation in Egypt. Since 2002, food prices have been consistently above the OIC average, while they have fallen below the OIC average since 2018. The most dramatic increases in food prices were observed in the 2007-2009 and 2014-2016 periods.

Figure 112. Food Price Index



Kyrgyzstan

Background

Kyrgyzstan, whose capital is Bishkek, is a Central Asian country with a population of 6,803,000 according to 2022 data. Located on an area of approximately 200 thousand km^2, the country ranks 23rd in Asia and 87th in the world in terms of area. Located in a mountainous region, the country is landlocked and has land borders with China, Kazakhstan, Tajikistan and Uzbekistan.

Facts about the Agriculture Sector

Looking at the GDP shares in the country as of 2020, it is seen that the share of agriculture is 12%According to the data of the National Statistics Committee of Kyrgyzstan, 1,232 thousand hectares of land has been used for agriculture so far for 2023. Most of the agricultural products grown are cereals (47.5%), followed by legumes. Among cereals, wheat and barley are the main crops. Chui, Osh and Issyk-Kul regions are important in terms of grain production, while Talasoblast stands out in legume production[242].

[242] Kyrgyz Statistical Office, http://stat.kg/en/statistics/selskoe-hozyajstvo/ (Date of access: 01.09.2023).

As of January 1, 2023, the area available for agriculture is 1,286 thousand hectares, most of which is used by small farmers. In 2023, there were 42.6 thousand hectares of arable land, a decrease compared to last year. These are due to salinization and waterlogging inefficiencies in the irrigation network, lack of moisture in the soil, remote and stony areas, settlement expansion, lack of productive seeds, exposure to natural disasters and other causes[243].

Small-scale farms contribute to almost all agricultural production, while livestock is the main source of household income[244] and has the potential to be much more productive. Increasing access to credit and markets for those in the agricultural sector and encouraging the use of technology will play an important role in increasing agricultural production.

Livestock breeding is dominated by cattle, ovine and poultry, but breeding of horses, camels, donkeys, rabbits and beekeeping are also practiced[245]. Livestock food sources, animal diseases and inefficient breeds are seen as some of the major constraints[246]. From this perspective, adequate disease control, steps to improve the quality of inputs, incentives to increase access to markets and improvements to reduce logistics costs will support positive developments to help the country reach its potential in livestock.

[243] Ibid.
[244] IFAD (2023), https://www.ifad.org/en/web/operations/w/country/kyrgyzstan International Fund for Agricultural Development Official Page (Date of access: 01.09.2023).
[245] Kyrgyz Statistical Office, https://stat.kg/media/publicationarchive/1181fdb1-15ed-4aa8-b105-0d7298edda44.pdf (Date of access: 01.09.2023).
[246] IFAD (2023), https://www.ifad.org/en/web/operations/w/country/kyrgyzstan (Date of access: 01.09.2023).

In a broader sense, policies implemented or planned by the state include investments in irrigation and water management, provision of technical assistance to farmers, promotion of the use of improved seeds and fertilizers, development of agricultural markets, and adaptation to climate change.

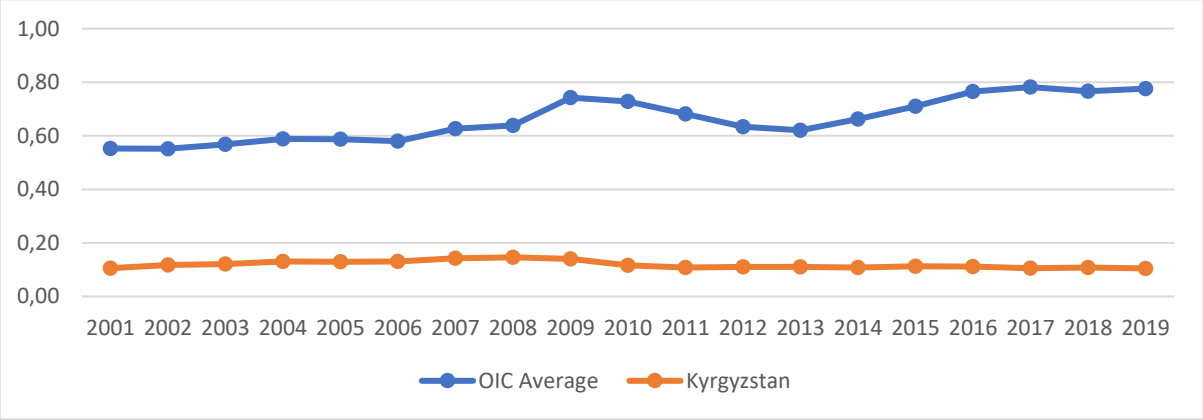
Challenges Faced in Agriculture

Logistics in agriculture play a critical role in getting products from the field to the consumer. The processes of collecting, storing, packaging and distributing agricultural products are not only crucial for efficiency and food security. Improving logistics also plays an important role in maintaining price stability and supporting the sustainability of the agricultural sector. While logistics helps agriculture to be competitive in domestic and international markets, it also plays a critical role in food safety and supply chain management. Effective logistics management in the agricultural sector is therefore a key element that serves the interests of both producers and consumers.

Sustainability of Agricultural Inputs

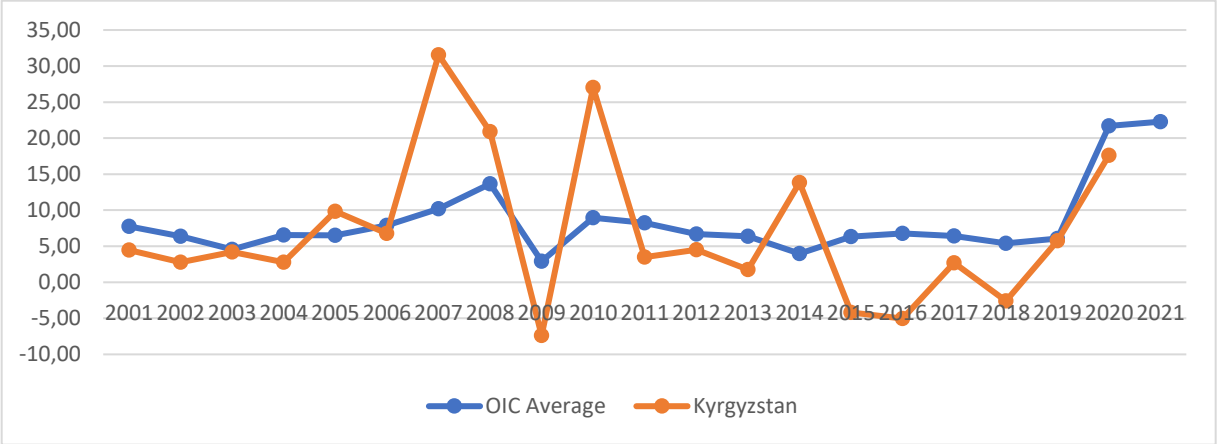
With global warming, Kyrgyzstan has also faced various challenges. Despite having rich water resources, water use efficiency remains limited compared to member countries.

Figure 113. Water Use Efficiency



To add more, food price index inhibits a highly volatile trend which not only impacts the ones in the agriculture sector but society as a whole.

Figure 114. Food Price Index



In terms of the country's approach to sustainability and agriculture, the following highligts were observed during the field visits.

- Currently, trade is focused on specific partners (Russia and Kazakhstan). It exports meat, milk, processed dairy products and fish, and it is planned to improve relations with China. Economic cooperation with Russia has an impact on the trade. In addition, it is planned to improve trade relationships with Iran and the Gulf countries through halal meat production.
- In Kyrgyzstan, many small farmers are involved in agricultural production, and legal measures are being taken to encourage cooperatives to become more involved. The transfer of knowledge and experience between different businesses is important and steps in this direction are regarded as beneficial.
- It can be said that Kyrgyzstan has implemented a program to promote green economy and awareness in this field has started to increase. Along with the state incentive,

expert support for organic agriculture and regional networks can be characterized as positive steps. In addition, the agricultural equipment used needs to be long-lasting and economically sustainable.

- Steps are also being taken towards green transformation in the use of pesticides and fertilizers in agriculture.
- Given the large number of small farms in Kyrgyzstan, it is important to promote cooperatives, and TIKA and similar organizations support training activities in this field.
- Biofuels are energy sources derived from biological resources. Biofuels are produced using organic matter known as biomass. This organic matter can be derived from biological sources such as plants, microorganisms or animal waste. Biofuels are a more environmentally friendly energy source that can be used to replace fossil fuels, and biofuels such as biodiesel, bioethanol, and biomethane are gaining attention as climate risks increase in severity. Although they can be more environmentally friendly compared to fossil fuels, their production and usage can may have some environmental impacts and sustainability issues which requires consideration.
- Currently, energy needs in Kyrgyzstan are largely met through fossil fuels and the use of biofuels remains limited. It was observed that the public sector is taking steps towards promiting renewable energy.

Desk Analysis

Türkiye

Background

In Türkiye, food prices, which have been highly volatile and rising since the second half of the 2000s, have negatively affected low-income groups together with the price increases of agricultural products. In this context, population growth, rapid urbanization and climate change are seen as sources of instability. The increasing demand for water resources and the protection of agricultural areas have become critical for food security. There is an anticipation that lowering food prices, which hover above world prices, will be possible by increasing productivity, and water and land maintain their importance[247].

Facts about Agriculture Sector

- Regarding the agricultural structure in Türkiye, roughly 4% permanent employment and 13% seasonal workers are employed in agricultural enterprises.
  In terms of land use, 25% of the land in non-agricultural use is residential land, 15% is tourism area, and 21% is agricultural land that is suitable for agriculture but not yet in use. 80% of the housing areas are agricultural lands, 29% of the agricultural lands are woodland and forest lands, and 26% of the agricultural lands are suitable for agriculture but not utilized.[248].
- Agriculture and food became a relatively profitable sector in Türkiye as the price index for agricultural products rose faster than the total producer price index, attracting investment and employment, with an average annual growth rate of 3.9% and a share of total employment of 24.6%.

[247] X. Beş Yıllık Kalkınma Planı (2014-2018), (http://kkp.tarim.gov.tr/sp/Onuncu%20Kalk%C4%B1nma%20Plan%C4%B1(2014-2018).pdf)
[248] TÜİK, (2015), Gelir ve Yaşam Koşulları Anketi, www.tuik.gov.tr

- The share of diesel and fertilizer, which are directly affected by oil prices, in production costs and thus in food price increases increased from 25% to 30-40% for cereals and from 30% to 45-55% for oilseeds. Milk prices, on the other hand, depend on the increase in feed prices, which account for 80% of the cost of feeding livestock.[249]
- In addition, while fertilizer use decreased by 13.2% between 2006-2011, it increased by 33.2% between 2006-2016. While the use of pesticides decreased by 12.9% between 2006-2011, it increased by 10% between 2006-2016.
- In Türkiye, 27.8% of cultivated land is irrigated, 69.7% is cultivated land, 0.4% is pasture land and 2.5% is permanent meadow land. 59.7% of those with a land size between 1-4 have 21.6% of cattle and 18.6% have 1% of small ruminants. 0.7% of those with 50 decares and above own 7% of cattle and 28.2% of ovine and 75.8% of ovine.
- 95% of those with up to 10 decares of land manage only their own land, while 2% manage both their own land and the land of others. This rate is 37% on average for those with 200 decares of land and above. 2.2% of the group with 5 decares of land or less operate 162 land only by renting and 0.6% by sharecropping. These rates are 1.6% and 0.4% in the collective average. 45% of the enterprises with 10 decares of land and 65% of the other landowners are engaged in both animal husbandry and crop production.

Challenges Faced Regarding Agriculture

- The fragmentation of agricultural lands through inheritance leads to a reduction in the size of holdings and thus to a decrease in agricultural productivity. The shrinkage of agricultural holdings causes significant problems of economies of scale and production tends towards decreasing yields. As a result, small enterprises are forced

[249] Kıymaz T. ve Saçlı Y. (2008), Tarım ve Gıda Ürünleri Fiyatlarında Yaşanan Sorunlar ve Öneriler, DPT Yayın No: 2767.

to abandon agricultural activities as they cannot meet the increasing production costs with their insufficient income

- Considering that approximately 70% of agricultural holdings combine animal and crop production, specialization is not widespread in agricultural enterprises.
- Excessive price hikes in basic production inputs such as fertilizers, pesticides, seeds, agricultural machinery and diesel fuel have significantly reduced the profits of agricultural enterprises. This has led to losses for some agricultural businesses.
- The desired level of farmer training and the use of modern agricultural technologies has not been achieved. For these reasons, farmers' knowledge and capital accumulation have been insufficient and current developments in agriculture have not been closely followed. Another reason for this is that small-scale agricultural enterprises do not have the financial resources required for modern agricultural tools and equipment and modern agricultural production techniques.
- One of the most important problems of Türkiye's agricultural sector is the smaller average size of agricultural land compared to developed countries and the existence of unemployment in rural areas[250].
- The sudden increases in natural gas prices due to the effects of COVID - 19 and Ukraine - Russia tensions were also reflected in fertilizer prices. Due to the higher fertilizer use per area in Türkiye, farmers are on average more affected by the increase in fertilizer prices.
- - When calculated with the agricultural land size excluding fallow areas, it is observed that 0.27 kg of pesticide is used per decare in Türkiye in 2022, which is above the world average of 0.18 kg/ha.
- Although the use of agricultural machinery in Türkiye has shown significant improvements over the years, the contribution to agricultural production and productivity remains low compared to the volume growth when evaluated together

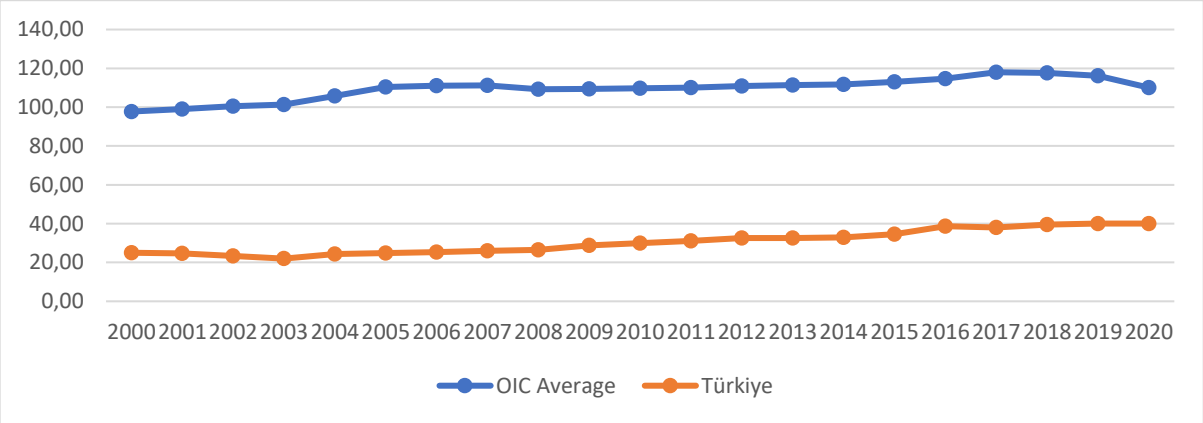
[250] Doğan Z., Arslan P, Berkman A.N., (2015), Development and Problems of Agricultural Sector in Turkey: A Historical Outlook, Niğde Üniversitesi İ.İ.B.F. Dergisi, 8(1): 29-41.

with the average age, technological level and the size of the area suitable for machinery use[251].

Sustainability of Agricultural Inputs

It is recognized that 15 OIC member countries have problems with water stress. Türkiye, on the other hand, although experiencing lower stress compared to the OIC average, has faced an ever-increasing water stress problem especially since 2008. At this point, Türkiye appears to be a low-stress country with a water stress level exceeding 40 percent. The fact that the water stress level, which was about 20 percent at the beginning of the period, has doubled in 20 years is seen as an important difference.

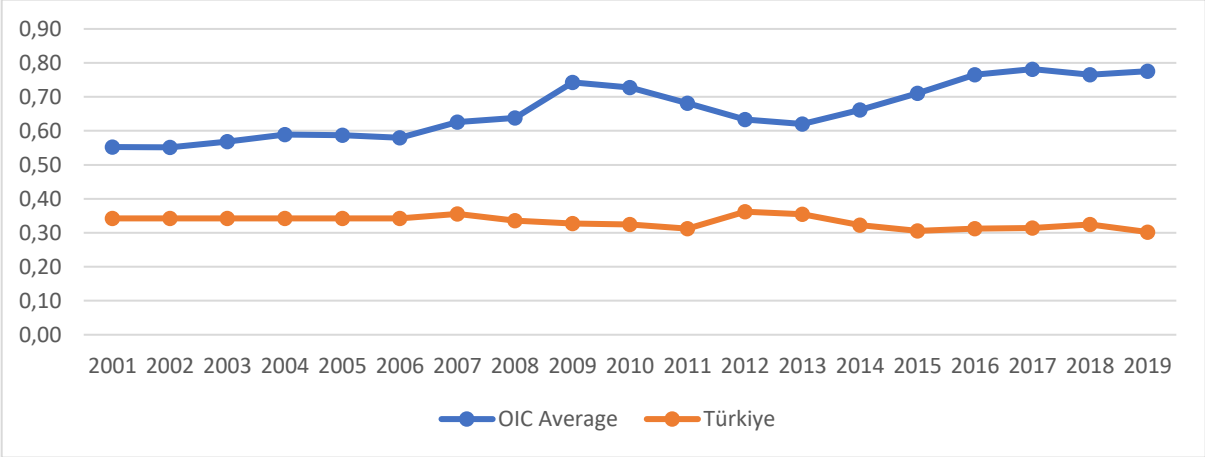
Figure 115. Level of Water Stress



When Türkiye is evaluated in terms of water use efficiency, it is seen that it has a very low level of efficiency compared to the OIC average. Especially in the 2015-2019 period, Türkiye's water use efficiency level reached the lowest level of the last 20 years.

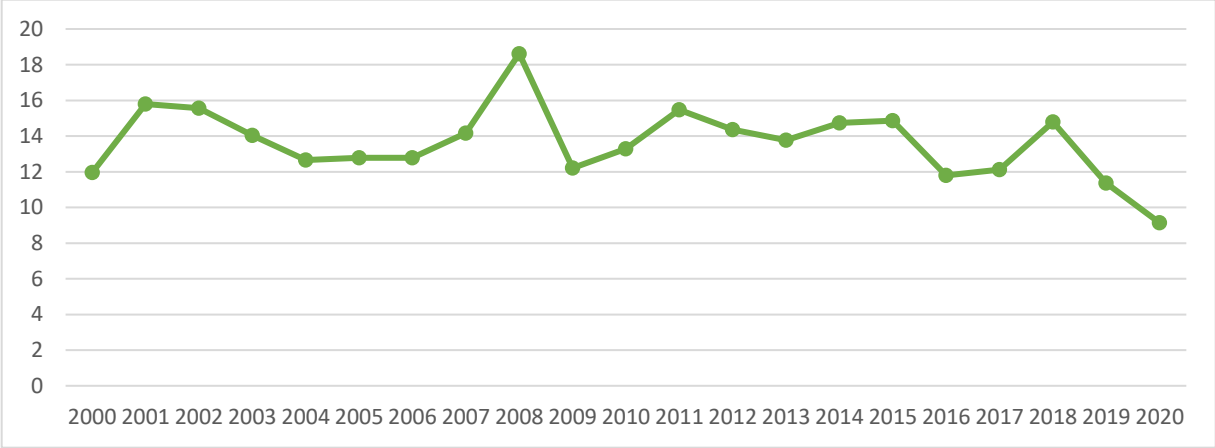
[251] TSKB, (2023) Tarım Sektörü Raporu, https://www.tbb.org.tr/Content/Upload/Dokuman/8960/Tarim_Sektor_Raporu_130723.pdf

Figure 116. Water Use Efficiency



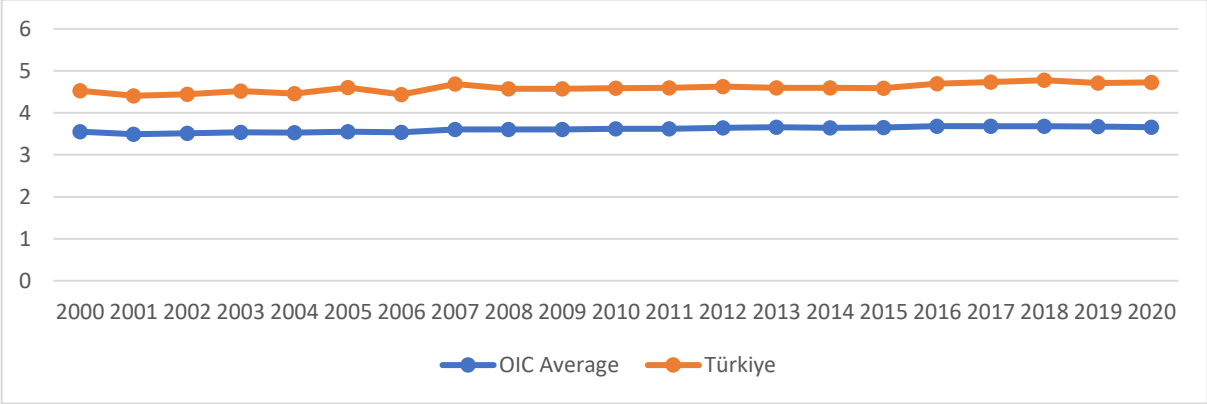
Although the use of chemical fertilizers is quite high in Türkiye, the share of animal fertilizer use in total fertilizer consumption has changed from time to time, but it is observed to have followed a stable course in the 2000-2020 period. However, it should be noted that there has been a significant decrease since 2018.

Figure 117. Shares of Manure to Soil in Total Fertilizer



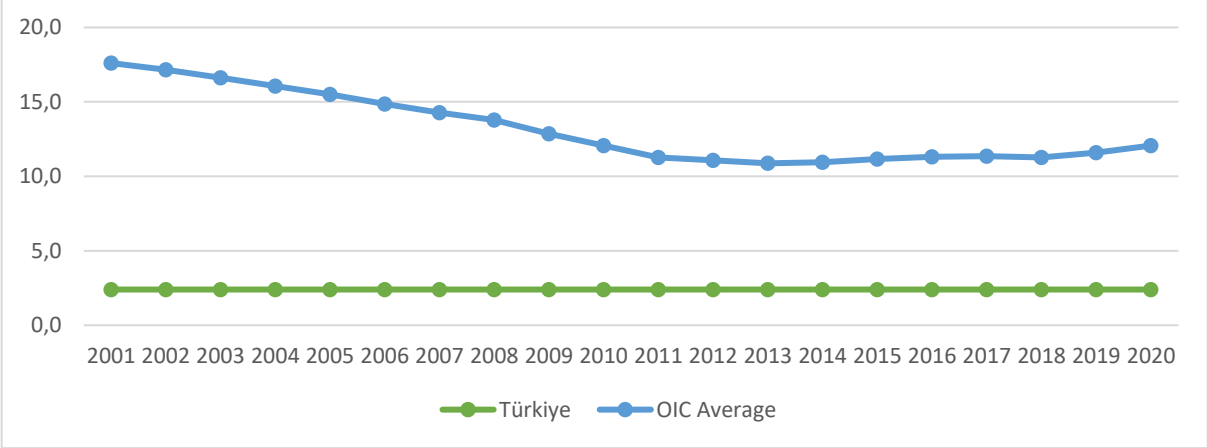
For the period 2000-2020, Türkiye's use of pesticides has been consistently above the OIC average.

Figure 118. Changes in the Pesticide Use



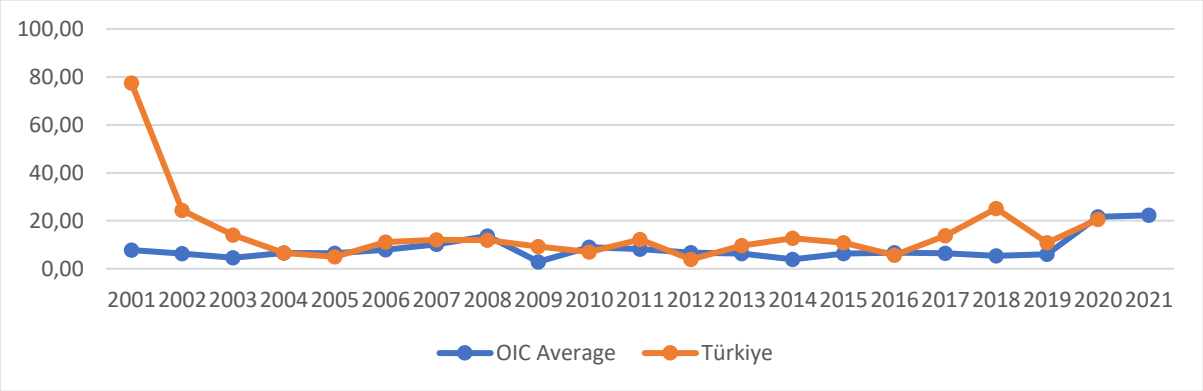
Regarding the prevalence of undernutrition, although the OIC average has been at a lower and stable level since 2011, Türkiye has a stable course at a level of 2.4, which is quite lower compared to the OIC average.

Figure 119. Prevelance of Undernourishment



Finally, the food price index shows that food prices in Türkiye, which declined rapidly between 2001 and 2003, have followed a course close to the OIC average except for 2014 and 2018.

Figure 120. Food Price Index



According to 2018 data, Türkiye is among the top five countries with the highest performance in agricultural trade of the OIC group. The group consisting of Türkiye, UAE, Saudi Arabia, Indonesia, Malaysia covers 44.9% of intra-OIC agricultural trade.

The level of drought in Turkiye, which ensures food security, is 44%. It is in the group that experiences water scarcity but does not suffer from critical drought. The country is also in the group of six countries with the lowest prevalence of undernourishment (2.5% or below). Among the OIC countries' agricultural production, Turkiye ranks first in fruit and vegetables, fourth in cereals and second in meat production. The share of agriculture in total exports is 9.8%, which is higher than the OIC average of 7.4%. Türkiye is below the OIC average in importing, where it ranks last among the OIC countries with a rate of 5.4% [252].

The Netherlands

Background

The agricultural sector in the Netherlands is the most productive and productive per unit of land in the European Union (EU). However, ammonia emissions, nitrogen and phosphorus excesses, and pesticide use per hectare of agricultural land are also among the highest in the EU. While agriculture, which is a productive sector in the Netherlands, has an

[252] OIC (2020) Agriculture and Food Security in OIC Member Countries (https://sesricdiag.blob.core.windows.net/sesric-site-blob/files/article/748.pdf) Date of access: 03.04.2023

important share in national income, it is under the pressure of important environmental problems in terms of input use. Despite successful policies and farm measures to reduce this pollution, agriculture still poses the greatest environmental pressure on biodiversity.

Systems aiming at the sustainable and efficient management of natural resources are essential to meet the food needs of the next generation. Sustainable agri-food system not only reduces loss of biodiversity, waste of fresh water, greenhouse gas emissions, but also creates a sustainable ecosystem with less nitrogen and phosphorus consumption. There are three main ways of intervention to reduce the negative environmental and health impacts of the agri-food system. These are to increase the efficiency of agricultural production, reduce food waste and create healthy diets that consume fewer resources.

The Netherlands ranks second in the world after the US and before Brazil, China and much larger EU countries like Germany, France, and Spain. Ranking countries by gross export gives a distorted picture of the economic relevance of national agro-food sector as, particularly for the Netherlands, a large share of imported commodities is almost directly re-exported e.g., via Rotterdam harbor and Schiphol airport.

This rank is a remarkable achievement considering that the Netherlands only holds 0.04% of global agricultural land and 1% of that in the EU and inspired the claim that “A tiny country feeds the world". This position is made possible by a combination of a favorable climate, fertile soils, high levels of agricultural science and technology, high cost-efficiencies, a very profitable horticultural sector, but also a high intensity primary production system with high imports of agricultural products like livestock feed.

Facts about Agriculture Sector

The Netherlands is a leading country in fisheries, horticulture and farming. It is constantly innovating and setting an example to countries around the world. The stakeholders of the agricultural sector - primary agricultural producers, suppliers, banks,

food manufacturing companies, exporters, catering companies and restaurants - are in close cooperation with each other[253].

The total agricultural area of Netherland is about 1.9 million acres, while the total cropped area of Netherland is about 1.1 million acres according to the number published by FAOSTAT[254]. The size of agricultural land utilized increased from 18,929,955,990 hectares in 2010 to 24,873,826,630 hectares in 2020[255].

According to EUROSTAT data, the farm area of the Netherlands is 55,680 hectares, all of which is used for agriculture. The area used for organic farming is 1,370 hectares, corresponding to 2.5 percent of the farm area. Arable land (42,150) is 76 percent of the farm gate and permanent grassland is 67 percent[256]. Industrial crops are cultivated on 3.82 percent of arable land. Cereals for the production of the grain are cultivated on 28 percent of arable land and root crops on 30 percent. 8 percent of arable land is fallow land[257].

The contribution of agricultural production to GDP is 1.79 percent on average. In terms of quantity, exports cover imports in the foreign trade of the Netherlands as of 2004. In terms of value, exports have given an export surplus throughout the analysis period[258].

---

[253] MANFQN, (2018), "Agriculture, Nature and Food: Valuable and Connected", (www.agroberichtenbuitenland.nl/binaries/agroberichtenbuitenland/documenten/beleidsnotas/2018/11/15/lnv-visie/271.003+LNV_Visie_Engels_interactief-v04_def.pdf), p.10., (Date of access: 01.09.2023).

[254] FAO, (2023), "Land Use", (https://www.fao.org/faostat/en/#data/RL), (Date of access: 01.09.2023)

[255] EUROSTAT, (2023), "Main Farm Indicators: Netherlans", (https://ec.europa.eu/eurostat/databrowser/view/EF_M_FARMANG/default/table?lang=en), (Date of access: 01.09.2023)

[256] EUROSTAT, (2023), "Main Farm Land Use:Netherland", (https://ec.europa.eu/eurostat/databrowser/view/EF_LUS_MAIN/default/table?lang=en), (Date of access: 01.09.2023).

[257] EUROSTAT, (2023), "Main Crops:Netherland", (https://ec.europa.eu/eurostat/databrowser/view/EF_LAC_MAIN/default/table?lang=en), (Date of access: 01.09.2023)

[258] FAOSTAT, (2023), "Trade Indices", (https://www.fao.org/faostat/en/#data/TI), (Date of access: 01.09.2023).

Urbanization and the decline in the population working in agriculture make agricultural production vulnerable. In the Netherlands, agricultural employment accounts for 2.78 percent of total employment and agricultural employment is on a downward trend[259]. However, the amount of output per agricultural employment increased by 75 percent from US$ 41,887 in 2000 to US$ 53,391 in 2020. Large-scale processing gains an advantage in modern agriculture, which today is characterized by reducing costs and increasing productivity. Yet the dominance of small-scale producers as the dominant production unit leads to negative profit margins, increasing economic vulnerability and income fluctuations[260]. Competitive pressure and efforts to reduce costs put pressure on biodiversity and the environment.

As things stand, the Netherlands is moving to a new model of circular farming practices, focusing on farm, horticulture and fisheries production[261]. In this model, the effort to reduce production costs requires pressure to reduce the use of raw materials. Combining input cost reduction with ecological concerns, agriculture, livestock and horticulture act as mutually reinforcing supply chains, utilizing waste streams. Animal production needs to be in the loop as it avoids waste and consumes crop waste, and soil health improved by processed animal manure is the beginning of the process. Improved technology in livestock production contributes to food security and reduced environmental pressures. In crop production, crops

[259] FAOSTAT, (2023), "Employment Indicators: Agriculture", (https://www.fao.org/faostat/en/#data/OEA), (Date of access: 01.09.2023).
[260] MANFQN, (2018), "Agriculture, Nature and Food: Valuable and Connected", (www.agroberichtenbuitenland.nl/binaries/agroberichtenbuitenland/documenten/beleidsnotas/2018/11/15/lnv-visie/271.003+LNV_Visie_Engels_interactief-v04_def.pdf), p.10., (Date of access: 01.09.2023).
[261] MANFQN, (2019), "Plan of Action: The Dutch Governmenet's Plan to Support the Transition to Circular Agriculture", (www.agroberichtenbuitenland.nl/binaries/agroberichtenbuitenland/documenten/beleidsnotas/2018/11/15/lnv-visie/271.003+LNV_Visie_Engels_interactief-v04_def.pdf) , p.2, (Date of access: 01.09.2023).

have been developed to respond to a changing climate and sustainable production. In fisheries, pulse fisheries have been developed to reduce costs and protect biodiversity[262].

Challenges Faced Regarding Agriculture

The Netherlands adheres to the Common Agricultural Policy (CAP) of the European Union. CAP makes general regulations. Shaping the agricultural sector according to the CAP, the Netherlands has designed the agricultural system as a supply chain. In order to obtain maximum benefit, raw materials obtained at minimum cost are processed with maximum efficiency. This structure has made the Netherlands dependent on imports of raw materials and basic commodities for its agri-food sector. Nevertheless, this cannot always be maintained on a consistent basis. Dependence on weather conditions, animal and plant diseases are still a major risk and this has a direct impact on producers' incomes. Individual small-scale producers are powerless in the face of large purchasers. Small producers are adversely affected by negative external shocks and need to be guaranteed fair prices and minimum incomes.[263].

Meanwhile, the government has concrete targets to reduce greenhouse gas emissions by 3.5 megatons by 2030 according to the CAP and the Paris Framework Agreement[264]. On the other hand, industrial livestock farming is increasing in the Netherlands. The development of environmentally friendly technologies that prioritize biodiversity in their production and transportation is at the forefront[265], and it is trying to reduce its carbon footprint by increasing its forest cover from 10.65 to 10.97 percent[266]. Regarding the change

---

[262] MANFQN, (2018), "Agriculture, Nature and Food: Valuable and Connected", (www.agroberichtenbuitenland.nl/binaries/agroberichtenbuitenland/documenten/beleidsnotas/2018/11/15/lnv-visie/271.003+LNV_Visie_Engels_interactief-v04_def.pdf p.10., (Date of access: 01.09.2023).

[263] Ibid. MANFQN, (2018), p.16.

[264] Ibid. MANFQN, (2018), p.15.

[265] Ibid., MANFQN, (2018), p.10.

[266] FAOSTAT, (2023), "Forestland", (https://www.fao.org/faostat/en/#data/RL), (Date of access: 01.09.2023).

in emission gases, the share of total greenhouse gases from farm gate was 65.10 percent at the beginning of the period and 81.79 percent at the end of the period; according to pre and post production, it was 31.23 percent at the beginning of the period and 32.93 percent at the end of the period; and according to emissions on agricultural land, it was 65.12 percent at the beginning of the period and 81.84 percent at the end of the period[267].

Another topic of interest is fishing. Fishing is part of the cultural history of the Netherlands and the main source of income for some villages. However, the fishing grounds are being devoted to sustainable energy and nature conservation measures and their size is gradually decreasing[268].

Sustainability of Agricultural Inputs

The Netherlands is a member of the EU and is considered one of the leading countries in terms of agricultural production and income level. Information on the country is partially included in the text, but in order to avoid repetition, a brief table on agricultural inputs has been presented here and a country-specific assessment has been provided. Since it is an EU member country, the laws and restrictions it is subject to are different. Therefore, instead of making OIC or world comparisons, country-specific policies and problems have been addressed. Data is obtained from FAOSTAT to maintain the integrity of the study.

[267] FAOSTAT, (2023), "Emissions Shares", (https://www.fao.org/faostat/en/#data/EM), (Date of access: 01.09.2023).
[268] Ibid. MANFQN, (2018), p.10.

Table 30. Selected Indicators on Agricultural Inputs

	L.W.S.	**W.U.E.**	**Manure**	**Fertilizer**	**Pesticide**	**FPI**
2000	0.17		299	0.41	0.011	6.57
2005	0.14	23.27	250	0.34	0.010	0.46
2010	0.23	22.51	293	0.29	0.009	1.03
2015	0.20	25.11	304	0.27	0.011	1.02
2020	0.51	27.86	281	0.27	0.011	0.60
Average	0.22	27.86	281	0.31	0.011	1.53

The variables are as follows:

L.W.S. : Level of Water Stress (%)

W.U.E. : Water use efficiency (%)

Manure : The amount of fertilizer applied per hectare of manure applied to soil (ha/kg).

Fertilizer : Total amount of chemical fertilizer applied to soil per hectare (ha/kg).

Pesticide: Total amount of pesticide applied to soil per hectare (ha/kg).

FPI : Food Price Index is the average of the annual change in the cost of production per farm.

The Netherlands is not a water-scarce country. Nevertheless, water quality in the country, where intensive livestock farming is practiced, is of concern due to nitrate pollution. It is estimated that 78 per cent of Dutch surface waters and 52 per cent of underground waters are under pollution stress[269]. Efforts have been made to prevent pollution through various legislative measures in the country. Although there has been a reduction in

[269] OECD, (2019), "Agriculture and Water Policies: MAin Characteristics and Evolution From 2009 to 2019", (https://www.oecd.org/agriculture/topics/water-and-agriculture/documents/oecd-water-policies-country-note-netherlands.pdf), p.1., (Date of access: 01.09.2023).

phosphate-based pollution from dairy cows, there has not been a reduction in the overall level of pollution, as can be seen from the emission levels in the following sections. In addition to pollution, agricultural water use in the Netherlands accounts for less than 1 percent of total water use, but illegal water use is becoming a problem. Another water-related problem is flooding caused by the sea and rivers[270].

The area of land with irrigation infrastructure increased throughout the analysis period. There was a 5% increase over the period analysed. One reason for this is the recognition of the rights of agricultural producers to take precautions against flooding on their own land. While public spending on agriculture is not as high as in most developed countries, averaging 0.42 per cent, voluntary compliance by farmers with water-saving measures has been boosted by the development of a national action plan to combat drought[271].

As discussed in the chapter on manure and fertilizer, the Netherlands, one of the leading countries in the world in agricultural production, is increasing the use of manure. As mentioned in a few OIC member countries, the Netherlands cultivates with improved seeds that are fertile and productive. Fertilization, pesticides and proper irrigation are very important for increasing the yield of these seeds. Nevertheless, the Netherlands is increasing the use of manure, not chemical fertilizers. Livestock stock in the Netherlands continued to increase until 2016, but as of 2016, it began to decline.[272]. This is reflected in the use of fertilizers. Nitrogen in the manure of these animals, however, evaporates and leaks into the air and soil, polluting groundwater. For this reason, storage and accumulation locations of fertilizers are important.

With these innovations, the Netherlands processes animal manure, which reduces environmental stress, and puts it to use in circular farming practices. In this new production

---

[270] Ibid., OECD, (2019).
[271] Ibid., OECD, (2019), p.4.
[272] FAOSTAT, (2023), "Crops and Livestock Products", (https://www.fao.org/faostat/en/#data/QCL), (Date of access: 01.09.2023)

process, the Dutch emphasize that animal manure is essential for soil health. A certain level of reduction in pesticide use has also been attempted, although it has returned to the level at the beginning of the period.

Food Price Index is an indicator of food price increases. Table N, which was created for inputs, shows food price changes by years. However, the food price index in the Netherlands was 4.68 percent in 2008, 3.63 percent in 2012 and 3.71 percent in 2019. In 2004 and 2009, food prices decreased due to abundant production. Looking at the producer and consumer price indices in the country, the average value of the producer price index is 97.67; the average value of the consumer price index is 95.66. Except for the years 2009, 2015, 2016 and 2020, producer price indices were above consumer price indices. In other words, the reflection of agricultural product price increases on producers was prevented through intervention. It can be argued that there is no malnutrition problem in the country, where the undernourishment level is < 2.5 in FAOSTAT data.

Survey

Methodology

In order to measure attitudes towards sustainable agriculture, which plays a crucial role in the fight against food insecurity, a survey was designed and disseminated via online channels to people working in various fields in sectors closely related to agricultural production.

A total of 398 responses were statistically valid for further analysis. The descriptive statistics are presented in the table below. The length of employment metrics show the extent to which individuals with different levels of experience in the agricultural sector and their current employers are engaged in sustainability practices, while the age distribution can provide information on generational perspectives on sustainable agriculture.

Table 31. Descriptive Statistics of Survey Respondents

Gender	**f**	**%**
Male	292	73,4
Female	106	26,6
Total	**398**	**100**
Marital Status	**F**	**%**
Married	370	93,0
Single	28	7,0
Total	**398**	**100**
Education	**f**	**%**
Primary education	86	21,6
Secondary Education	152	38,2
Associate degree	44	11,1
Undergraduate	93	23,4
Graduate	23	5,8
Total	**398**	**100**
Total Duration of Employment in the Sector	**f**	**%**
1-10 years	63	15,8
11-20 years	89	22,4
21-30 years	112	28,1
31-40 years	75	18,8
41 years or above	59	14,8
Total	**398**	**100**
Total Duration of Employment in Current Employer	**f**	**%**
1-10 years	131	32,9
11-20 years	135	33,9
21-30 years	81	20,4
31-40 years	44	11,1
41 years or above	7	1,8
Total	**398**	**100**
Age	**F**	**%**

18-25	21	5,3
26-35	42	10,6
36-45	112	28,1
46-55	103	25,9
56 or older	120	30,2
Total	**398**	**100**

Reliability Statistics

Cronbach's Alpha	*N of Items*
,828	23

Cronbach's Alpha coefficient of the scale was calculated as 0.828. The evaluation of Cronbach's Alpha coefficient indicates the scale is reliable.

The data obtained from the questionnaires were first transferred to the statistical package application (SPSS 25.0). The data obtained from 398 questionnaire forms were tabulated and interpreted by calculating the frequency and percentage distribution, arithmetic mean and standard deviation values of the responses to the statements in the survey as follows.

Results

The survey results are provided in Table 32 below.

Table 32. Percentage, Frequency, Arithmetic Mean and Standard Deviation Values on Evaluations of the Participants Regarding Sentiment Towards Sustainable Agriculture

		Strongly disagree (1)	Disagree (2)	Neither agree nor disagree (3)	Agree (4)	Strongly agree (5)	**Total**	**m**	**s.d.**
Soil and water are the source of all life and should therefore be strictly protected.	**f**	13	1	2	13	369	398	4,82	0,753
	%	3,3	0,3	0,5	3,3	92,7	100		
Indiscriminate use of agricultural chemicals is harmful to humans.	**f**	11	2	3	46	336	398	4,74	0,754
	%	2,8	0,5	0,8	11,6	84,4	100		
Clover and its cultivation increase soil fertility.	**f**	14	37	116	159	72	398	3,60	1,001
	%	3,5	9,3	29,1	39,9	18,1	100		
The application of animal manure can increase soil fertility.	**f**	13	3	12	132	238	398	4,45	0,864
	%	3,3	0,8	3,0	33,2	59,8	100		
The key to the future success of agriculture lies in learning to mimic natural ecosystems and farm in harmony with nature.	**f**	12	2	12	83	289	398	4,60	0,834
	%	3,0	0,5	3,0	20,9	72,6	100		
Farmers should only till as much land as they can take care of.	**f**	15	8	21	145	209	398	4,32	0,948
	%	3,8	2,0	5,3	36,4	52,5	100		
Farmers' primary goal should be to maximize the productivity, efficiency and profitability of their farms.	**f**	16	13	33	101	235	398	4,32	1,032
	%	4,0	3,3	8,3	25,4	59,0	100		
Most farms should integrate agriculture and animal husbandry.	**f**	12	25	40	105	216	398	4,23	1,057
	%	3,0	6,3	10,1	26,4	54,3	100		
Crop rotation and diversity can reduce farm pests.	**f**	12	17	120	165	84	398	3,73	0,941
	%	3,0	4,3	30,2	41,5	21,1	100		
Minimum tillage can reduce erosion and soil degradation.	**f**	29	39	127	145	58	398	**3,41**	1,082
	%	7,3	9,8	31,9	36,4	14,6	100		
If I don't use chemical fertilizers and pesticides on my farm, my farm productivity decreases.	**f**	46	44	84	184	40	398	3,32	1,156
	%	11,6	11,1	21,1	46,2	10,1	100		
One of the principles of agriculture is to reduce environmental damage.	**f**	11	5	24	157	201	398	4,34	0,868
	%	2,8	1,3	6,0	39,4	50,5	100		
Pest attack will increase due to the successive planting of a single type of plant on the farm.	**f**	22	32	129	176	39	398	**3,45**	0,969
	%	5,5	8,0	32,4	44,2	9,8	100		
Agricultural chemicals pollute the environment.	**f**	10	2	32	150	204	398	4,35	0,849
	%	2,5	0,5	8,0	37,7	51,3	100		
Machinery and new technologies should be used to increase agricultural production.	**f**	9	5	14	80	290	398	4,60	0,812
	%	2,3	1,3	3,5	20,1	72,9	100		

Weed cultivation is the best way to reduce pest and weed damage.	**f**	21	70	174	109	24	398	3,11	0,932
	%	5,3	17,6	43,7	27,4	6,0	100		
The best way to control pests and weeds and reduce their damage is through biological control.	**f**	9	11	51	138	189	398	4,22	0,932
	%	2,3	2,8	12,8	34,7	47,5	100		
Green manure application is not necessary due to existing chemical fertilizers.	**f**	113	170	78	25	12	398	2,13	0,994
	%	28,4	42,7	19,6	6,3	3,0	100		
Farmers' income will decrease due to crop rotation.	**f**	43	152	172	20	11	398	2,15	0,857
	%	10,8	38,2	43,2	5,0	2,8	100		
The appropriate method for controlling pests and weeds is the use of pesticides and poisons.	**f**	105	97	135	52	9	398	2,40	1,081
	%	26,4	24,4	33,9	13,1	2,3	100		
Farm productivity only increases due to increased fertilizer consumption.	**f**	70	187	85	43	13	398	2,35	0,997
	%	17,6	47,0	21,4	10,8	3,3	100		
Remnants of previous cultivation reduce fertile soil.	**f**	60	161	107	50	20	398	2,52	1,052
	%	15,1	40,5	26,9	12,6	5,0	100		
Crop rotation can cause soil erosion.	**f**	33	127	147	69	22	398	2,80	1,004
	%	8,3	31,9	36,9	17,3	5,5	100		

In the first statement, 92.7% of the respondents strongly agreed that soil and water should be protected, while 84.4% of the respondents believed that the uncontrolled use of chemicals harms nature. In addition, those who agree that agriculture should be done in harmony with nature and that new technology and machinery should be adopted are the statements with the highest percentage of agreement.

Overall, there is a strong support for the idea of strict protection of these vital resources as soil and water. The mean score of 4.74 in the second statement reflects a clear concern about the negative effects of agricultural chemicals.

The respondents also showed positive attitudes toward natural methods of improving soil fertility as approach towards animal manure and clover usage had higher than average mean scores. From this perspective, despite the availability of chemical

fertilizers, 47.5% of respondents agreed that green manure application is necessary, suggesting a positive attitude toward organic soil enrichment.

Responses to the statement “The key to the future success of agriculture lies in learning to mimic natural ecosystems and farm in harmony with nature” indicates a preference for sustainable and nature-friendly farming practices which can be boosted further with policies and incentivizing nature-friendly farming practices.

Pest control can be considered as a debatable topic as a little over 50 percent (54,8%) agreed with the use of pesticides but a much higher agreement level was observed regarding biological control as 79.9% supported biological control with a mean score of 4.22.

Overall, the survey highlights a strong interest in sustainable agricultural practices, including soil and water conservation, responsible chemical use, and the importance of mimicking natural ecosystems. It also reflects varying perspectives on certain practices, indicating the complexity of sustainable agriculture as pesticide control and optimizing income level with varying costs can be considered as topics which need much and precise attention.

Majority of respondents (78.8%) agreed that "Pest attack will increase due to the successive planting of a single type of plant on the farm." This suggests an understanding of the risks associated with monoculture and the importance of crop diversity. As combating food insecurity requires diversification, adjusting farming practices can help to achieve success.

A diversity of opinions and attitudes among respondents regarding various aspects of sustainable agriculture can also be observed including chemical use, environmental principles, and the role of technology in farming. It's clear that there is a range of

perspectives on how best to achieve sustainable and environmentally responsible agricultural practices which should be considered when designing related policies.

Limitations of the Survey

- This research is limited to the opinions of employees engaged in agricultural activities in OIC member countries and their responses to the questions in the questionnaire form and their evaluations.
- The data of the research was collected in summer months of 2023. Therefore, the research is limited to the opinions and evaluations of the employees who participated in the survey within these time periods.

Policy Recommendations

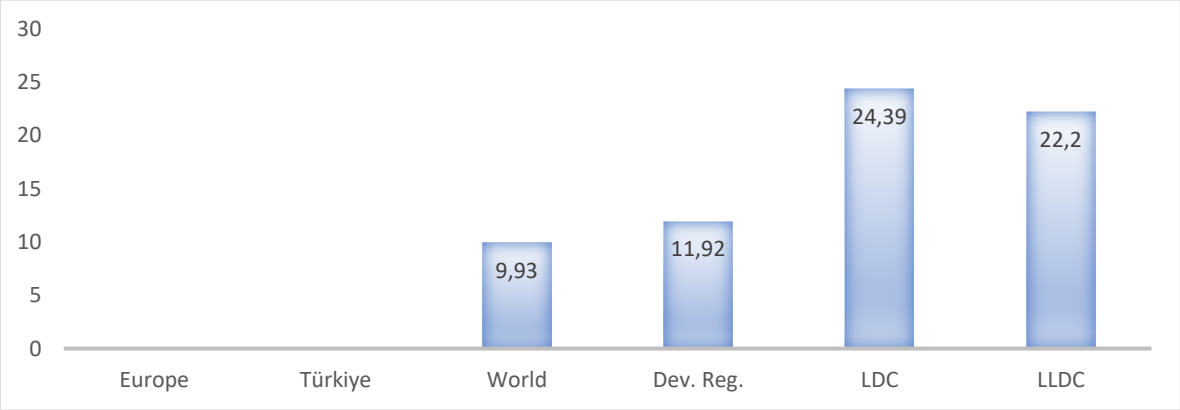
Insufficient consumption of dietary energy, which refers to the amount of calories required, is referred to as undernourishment. Although calorie levels and needs, categories and criteria are debated by those concerned with the subject, it can be considered as a disordered diet that leads to a state of not being active and healthy on a regular basis. FAO estimates the prevalence of undernourishment based on data regarding food availability, food consumption and energy need. Thus, there were 700-828 million undernourished people in the world in 2021. In terms of the regional distribution of those people, Africa and Asia led with 20.2% and 9.1%, respectively. While the majority of the world's food insecurity falls into the moderately insecure group (experiencing food insecurity, experiencing hesitancy in obtaining food and/or being concerned about the quantity and quality of food consumed), 23.4% of food insecure people in Africa are severely malnourished (i.e. run out of food and/or day(s) without eating)[273].

According to 2030 projections, the number of people suffering from hunger will increase from 278 million to 311 million in Africa, while decreasing from 425 million to 295 million in Asia and from 768 million to 670 million globally. To meet the needs of the projected population growth, current agricultural production needs to increase by 70%. Increased production is possible in the short term by increasing the available agricultural land and manpower. However, with the adoption of industrial agricultural policies, high yields are obtained by planting the same crops every year. Repeating this process and maintaining the yield level, ceteris paribus, depends on the use of high levels of chemicals. The process exhausts and de-mineralizes the soil, requiring intensive water consumption and intensive use of fossil fuels through agricultural machinery. As a result of this mode of production, where soil quality cannot be improved, new land is sought to increase production. New lands mean forest loss, mainly through burning and illegal felling, and even this process is estimated to increase production by 5%[274].

[273] (https://www.fao.org/interactive/state-of-food-security-nutrition/en/) Date of Access: 04.05.2023
[274] (https://www.fao.org/interactive/state-of-food-security-nutrition/en/) Date of Access: 04.05.2023

Access to food and food sovereignty, which can be measured by the agricultural areas and productivity of countries, go hand in hand with the climate crisis, as well as with debates on poverty and fair distribution. In this regard, FAO, the Organization of Islamic Cooperation (OIC), the Committee on World Food Security (CFS) supported by the World Food Programme (WFP), the International Fund for Agricultural Development (IFAD), the Standing Committee for Economic and Commercial Cooperation of the Organization of Islamic Cooperation (COMCEC) and the European Union (EU) have shifted their priority areas of work to food security and sustainability[275]. Turkiye falls into the low prevalence of undernourishment group, which corresponds to a value between 0-2.5. With this measure, Turkey has a level of food insecurity in line with the European Union which is considerably higher than the world average. Globally, food insecurity is 9.93%.

Figure 121. Undernourishment



Source: FAO database[276]

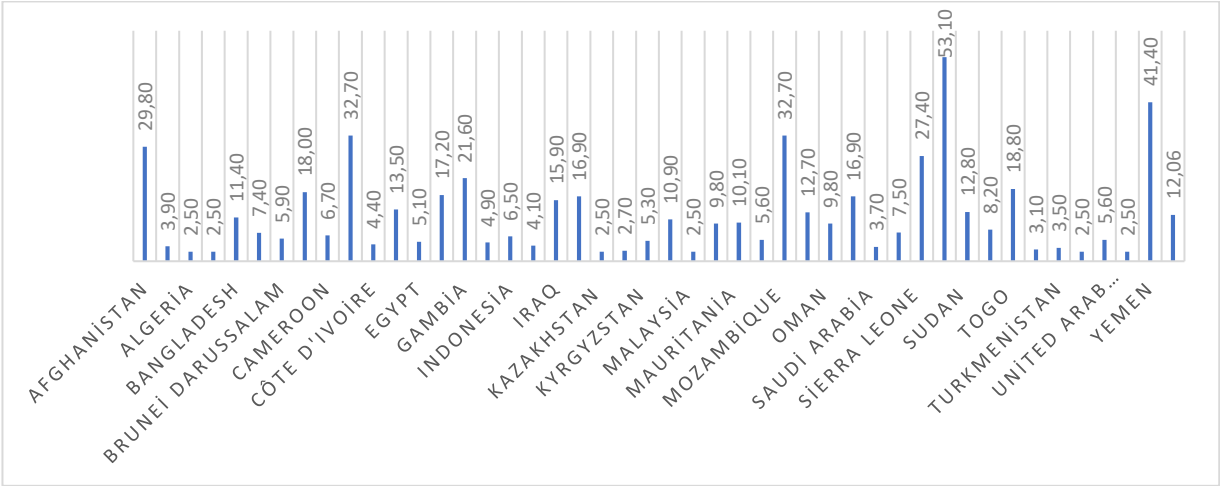
When a similar comparison is made for OIC countries, the average prevalence of undernourishment is 12.06. Ten of the 12 worst food insecure countries in the world are in Africa and are among OIC member countries. Within the group of countries, Somalia

[275](https://cdniys.tarimorman.gov.tr/api/File/GetFile/330/Sayfa/1416/1778/DosyaGaleri/6._gida_guvenligi_ve_guvencesi.pdf), 11:1-122, Date of Access: 03.05.2023

[276] FAO (2022), (https://www.fao.org/faostat/en/#data/SDGB), Date of Access: 04.05.2023

(53.10%), Yemen (41.40%), Chad and Mozambique (32.7%) are at very high levels of undernourishment.

Figure 122. Undernourishment in OIC Countries



Source: FAO database[277]

There is no data on OIC member countries Bahrain, Comoros, Guinea, Guinea-Bissau, Libya, Maldives, Niger, Palestine, Qatar, Syrian Arab Republic, Tajikistan and Uganda. Food insecurity is below2.5% in Algeria, Azerbaijan, Kazakhstan, Malaysia, Türkiye and Uzbekistan. If the food insecurity levels of those countries are assumed to be 2.5%, the OIC average of food insecurity is 12.06% and the OIC average exceeds the world average[278].

In order to meet the nutritional needs of a growing population, industrial agriculture, which fits in with the global economic organisation and production style, has gained in importance. Reflecting the dynamics of urbanisation and production technologies, industrial agriculture is identified with mass production of monocultures. Industrial agriculture is an

[277] FAO (2022), (https://www.fao.org/faostat/en/#data/SDGB), Date of Access: 04.05.2023

[278] Among the OIC member countries that are predominantly located on the African continent and are in the severe food insecurity category, the food security problems of Mozambique, Yemen and Somalia on the Gulf of Aden, with favorable climatic conditions should be sought outside of climatic conditions. Bahrain in the Persian Gulf, Comoros, an island country neighboring Mozambique, Guinea and Guinea-Bissau located below Gambia and Senagal which have no climate problems, Maldives located under India and Uganda having Lake Victoria are similar countries that do not suffer from water and land shortages but posess different non-productive processes.

intensive and competitive agricultural practice that produces monoculture products in large agricultural areas. The production method, based on the idea of producing the same type of product every year with an increase compared to the previous period, can continue the accumulation process with intensive chemical inputs[279].

Industrial agriculture raised awareness among consumers in the 1970s due to its intensive agricultural carbon footprint and production style that jeopardizes future food security. While the pollution created exacerbates extreme weather events caused by the climate crisis, it also creates water scarcity by using 69% of the world's water resources with wild irrigation, disrupts soil mineral balance and biodiversity with uncontrolled chemical use and increases food-borne diseases. The multi-stakeholder and monopolistic structuring of the agricultural value chain "from farm to fork" increases inefficiencies through food losses and waste. Moreover, price volatility driven by market dynamics and global shocks such as the 2019 pandemic further disrupt food production and access to food [280].

These problems have brought sustainable agriculture to the agenda. Sustainable agriculture can be defined as the production of sufficient quantities of foodstuffs at affordable cost and quality to feed the growing world population. For the purpose of sustainable agriculture, primarily crop and animal production should be combined as in the pre-industrial agriculture process to provide sufficient income to the producers at an acceptable level. It should minimize the use of chemical inputs in the production process and increase the welfare of soil, air, water and living beings; institutional structures should be established/developed to ensure that agricultural production and inputs are sold at their real value.

The early sustainability literature, which emphasized self-renewal of agricultural resources and productivity now covers climate crisis, food security, food waste and supply

[279] Tarimorman (2023), TARIM 4.0 (https://arastirma.tarimorman.gov.tr/koyunculuk/Menu/76/Tarim-4-0) Date of Access: 04.05.2023

[280] TSKB (2022) “Sürdürülebilir Gıda Sistemleri Tema Çalışması Raporu” Mart 7,28:5-51.

chain and shocks, circular economy, organic agriculture, biodiversity and rural development[281].

Organic agriculture is the production of sufficient, but not maximum quantities in harmony with nature, preserving and improving soil fertility and water quantity and quality while minimizing pollution. Maintaining genetic diversity, providing a safe and sufficient income level for agricultural producers, continuing the production process through regional resources, producing nutritious and healthy products while maintaining plant and animal production together as in the pre-neo-liberalism period are among the important objectives of organic agriculture. In this context, production should be compatible with the ecology of the region. Traditional methods such as rotation, organic fertilization and pest control should be used.

Organic agriculture is practiced in 130 countries, mainly in Australia, Argentina and European countries. In Turkiye, the "Regulation on the Principles and Implementation of Organic Agriculture", which entered into force in 2005, the "Organic Agriculture Law", which entered into force in 2004 and the "Regulation on the Production of Plant and Animal Agricultural Products by Ecological Methods" which entered into force in 1994 are the main legal bases.

Agricultural producers are directed to organic agriculture through research, training, marketing and financial support. The adoption of economic policies based on continuous growth and development leads to socioeconomic problems such as income inequality and income insufficiency or unemployment. These problems manifest themselves most clearly in the form of food and food-based health problems, environmental pollution and alienation from nature. At this point a crisis of legitimacy comes to the fore and states, international organizations, corporations and regional supranational institutions such as the European Union seek alternative ways of reaching consensus.

The concept of sustainability encompasses these alternative ways of compromise in a holistic way. Socioeconomic, environmental, health and food-related activities are directly

[281] TSKB (2022) “Sürdürülebilir Gıda Sistemleri Tema Çalışması Raporu” Mart 9:5-51

related to sustainability of agricultural activities. Sustainability in agriculture refers to the achievement of sufficient income to continue agricultural production and to form methods of production in accordance with the characteristics of nature. Therefore, sustainable agriculture is grounded on economic, environmental and social pillars[282].

There are key points in this regard. While standards are set from the seed to the final product stage in the form of organic agriculture[283] and good agricultural practices[284] on one side, it is important to ensure that agricultural inputs are continuously provided and that the final outputs are offered to the society so that sufficient nutrition is provided in time. Therefore, raw materials, basic inputs and rural (agricultural) labor, fair trade conditions, the level of profitability that will allow agricultural activity to continue and the availability of usable clean nature are the sub-headings to be evaluated within the scope of sustainable inputs.

---

[282] Bathaei, A., & Štreimikienė, D. (2023). A Systematic Review of Agricultural Sustainability Indicators. Agriculture.

[283] Law No. 5262 on organic agriculture aims to ensure the development of organic products and inputs. Within the scope of the law, organic products include raw, semi-finished and finished certified products. Organic inputs define the materials used to produce products compatible with the ecological and biological environment. In this context, certification, control and inspection measures are taken. Organic farming activities cover all stages of products and/or inputs produced with plant, animal, soil, water and natural resource components until they reach the consumer, including slaughtering, processing, sorting, packaging, labeling, storage and storage, transportation, domestic and foreign sale and purchase (Law No. 5262, Article 1,2,3).

[284] Within the scope of the Regulation on Good Agricultural Practices published in the Official Gazette dated 07.12.2010 and numbered 27778; it covers agricultural production without harming human, animal and environmental health and protecting natural resources. In order for agricultural production to be included in good agricultural practices, it must be carried out with practices that are socially livable, economically profitable and productive, and environmentally plant, human and animal health and welfare. Good agricultural practices are carried out in line with the requirements of eligibility criteria, control and certification procedures (Official Gazette, 2010: Art.1,2,4,5).

Rural (Agricultural) Labor Force

The rural population is decreasing day by day and slowing down the rate of emigration of the young population can be seen as a necessity for the continuation of agricultural production. In general, population growth requires food and increased food production. By addressing the infrastructure needs from a social, cultural, educational and health perspective, the migration of especially the young population from the village can be reduced and the amount of production can be increased through efficiency based inputs and techniques.

The first is the pressure of industrialisation and urbanisation, in particular the demand for housing created by population growth and the opening up of agricultural and pasture land for development and social needs. The other is the negative impact on human, soil, plant and animal health, the environment and nature of chemical-intensive inputs used to increase productivity and efficiency. The use of such inputs also has a negative impact on nutritional value and taste. The other is the negative impact on human, soil, plant and animal health, the environment and nature of chemical-intensive inputs used for reasons of increased productivity and efficiency. The use of such inputs also has a negative impact on nutritional value and flavour.

Sustainable Rate of Profitability

Both abandonment and migration are caused by production prices that are currently unprofitable or even insufficient to cover costs. In order to maintain agricultural production, governments take measures in the form of subsidies and various protective measures. The level and intensity of these measures are parallel to the sustainability of agricultural production.

To offset the cost disadvantages of globalisation and sustainability to some extent, eco-tourism, agro-tourism and gastro-tourism have been developed, and tourism revenues

have begun to be generated through agriculture. Like the industrialisation of agriculture, the tourismisation of agriculture has begun.

Another important dimension of sustainability is that of transaction costs. The implementation of sustainable agricultural systems involves additional costs due to additional measures for good agricultural practices, the time-dependent waiting period for organic farming and the inability to establish fair trade relations. These costs prevent small producers from participating in the production process, hinder competitive conditions, shift the price advantage in favour of large producers in a process that develops into oligopolisation, and create inefficiencies.

Availability of Usable, Clean Nature

Access to efficient and clean food depends on the way in which agricultural production takes place. In addition to soil, water and air pollution, noise pollution should also be considered as it affects animal production. Agricultural production is subject to rent differentials due to land and soil structure, climate and rainfall conditions, water quantity, slope, forest and vegetation status and density, and geographical location. When climate change and environmental degradation are combined with housing construction, the establishment of industrial zones and facilities, and increased mining activities, negative externalities on agricultural land and environmental pollution increase.

Agricultural Trade

Specific standards and regulations are set for products that are subject to foreign trade. Agricultural products must be certified to meet the standard and inspected according to accepted standards, while laboratory results must be available to demonstrate that they have

been produced with appropriate inputs, and production must be in accordance with organic farming regulations[285] and good agricultural practices.

Roadmap for Sustainable Use of Agricultural Inputs

This study analyses the sustainable agricultural input use of OIC countries and their input use experiences in the period 2000-2020 through Club Convergence Analysis. As a result of the assessments made in this framework, possible roadmap recommendations for sustainable agricultural input use in OIC countries are listed as water and land use, agricultural practices and new agricultural technologies.

Water use

Water is one of the main inputs for agricultural activities, and productivity can be enhanced with the right irrigation methods. Water resources, which are vital for the agricultural sector, are not used properly in agricultural activities, over-consumed and polluted with harmful chemicals in high doses, and many wrong practices threaten the ecosystem. Sustainable agriculture aims to use water efficiently and irrigation methods and water saving technologies are used to reduce the impact of agricultural activities on water resources. Effective irrigation methods can be;

Drip Irrigation: Drip irrigation is a method in which water is applied drop by drop to the root zone of plants by applying pressure. This method prevents the waste of water and ensures

[285] Organic farming and good agricultural practices are two methods with specific standards in Turkey. Organic agriculture is the combination of traditional production methods with advanced technology, which prohibits the use of inputs that harm soil, ecosystem and living health, and prioritizes biodiversity and native breeds. Organic agriculture alone is not sufficient for sustainability. For this reason, it is carried out together with good agricultural practices to ensure sustainability (IFOAM, 2008).

that water is delivered directly to the roots of the plants. Drip irrigation also prevents the soil from accumulating salt.

Rain harvesting: Rain harvesting means collecting rainwater and then using it to irrigate crops. During periods of heavy rainfall, rainwater is collected in farm ponds and used to irrigate crops during dry periods. This method conserves groundwater resources and saves water while reducing water costs for sustainable agricultural practices.

Irrigation Management: Irrigation management is a method designed to ensure the effective and efficient use of water. Irrigation management prevents the waste of water and helps conserve water resources.

Dry Agriculture: Field agriculture practiced without irrigation in areas with annual rainfall of up to 500 mm or where the distribution of rainfall over the seasons is irregular. Dry farming is a mandatory method where rainfall is a limiting factor for plants.

In addition to these methods, recommendations that can increase efficiency in water use are as follows;

- Planting crops suitable for the basin climate and water potential by making crop pattern plans
- Reducing losses in water distribution systems
- Preventing over-irrigation through data-driven irrigation
- Reducing the intensity of water pollution by reducing the use of chemical fertilizers and pesticides
- Improving sustainable water management practices
- Informing and encouraging farmers about sustainable irrigation methods
- An appropriate irrigation method should be selected by considering factors such as soil characteristics of the land, quantity and quality of irrigation water, topographic

situation, land shape and size, plant type, climate characteristics, irrigation costs and social and cultural characteristics of the region.

Soil Utiliziation

Climate change, contamination of soil with chemicals (agricultural, urban, industrial, mining and radiation), erosion, improper cultivation and fertilization without soil analysis, deforestation, misuse of agricultural land (urbanization, industrialization and mining), lack of crop rotation are seen as threats to the existence of soil.

Soil management practices in sustainable agriculture are designed to make soils used in farming more productive, healthy and sustainable, to conserve natural resources, to increase soil fertility and to improve the quality of life of farmers. FAO's sustainable farming system is based on the principles of Conservation Agriculture and aims to increase productivity on arable land while at the same time rehabilitating degraded land.

The three principles of Conservation Agriculture are;

- Minimization of soil cultivation: Reducing mechanical interventions to the soil and switching to direct sowing without soil cultivation,
- Providing permanent organic cover on the soil surface: Ensuring permanent soil organic cover with crop residues and/or cover crops,
- Ensuring crop diversity: It is the realization of diversity in the crop pattern included in the crop rotation.

Conservation Tillage: Conservation tillage is a method used to protect and keep soil healthy by minimizing soil disturbance during agricultural operations. It involves the direct return of plant residues and other organic matter to the soil, thus enriching it in a natural way. Conservation tillage not only helps to increase agricultural productivity, but also helps to protect soil from erosion, reduce water loss and maintain soil structure and biodiversity.

Cover Crop: Cover cropping involves the use of cultivated plants to improve soil nutrients, increase soil fertility and control weeds. Cover crops cover the soil throughout the year, protecting it from the harmful effects of the sun and preventing water loss. In addition, plant residues increase the amount of organic matter and carbon in the soil, improving soil health.

Crop Rotation: Crop rotation is the successive planting and cultivation of different crops selected for specific objectives on the same land. This method is recognized as an effective method for increasing soil fertility, improving the management of water resources, reducing erosion, pests and diseases. Different plant roots help to maintain and improve soil biodiversity.

Organic agriculture is an agricultural method that aims to protect natural resources and ecosystems and utilizes organic materials instead of synthetic ones. The main objective of organic agriculture is to produce healthy and high quality products and to ensure the sustainability of soil, water resources, biodiversity and ecosystems. Organic agriculture is also defined as ecological or biological agriculture. The aim of organic agriculture is to protect the environment and human health and natural resources, to ensure biodiversity, to restore the ecological balance, to protect the environment from negative effects by preventing the use of synthetic chemical pesticides, hormones and mineral fertilizers, organic and green fertilization, alternation, to prevent soil and gene resources erosion, to use renewable energy resources and to save energy, to increase the resistance of the plant, to benefit from natural enemies in biological control, to support the economy and to increase not only the quantity but also the quality of the product in production.

Good agricultural practices cover all stages of production and marketing from the soil to the consumer's table. It is a form of agricultural production in which methods harmful to human health are not employed, the environment is not polluted, the welfare of people involved in production is not adversely affected and such processes are supervised.

Precision agriculture: an agricultural technique that uses advanced technologies to optimize agricultural production and aims to increase yields. Technologies such as sensors, data analytics, artificial intelligence and automation are used to optimize processes such as plant growth, irrigation, soil moisture, nutrient levels and pest control.

Closed farming: a method of agriculture in which plants are grown in a controlled environment. When growing plants in controlled environments such as greenhouses, vertical farms, soilless farming systems, etc., the use of land, water, pesticides and other chemicals required to grow the plants is reduced. Closed farming technologies offer advantages such as better control of environmental factors, increased productivity and continuous production in the off-season.

Agrivoltaic agriculture: an agricultural practice in which agricultural land is used in combination with solar energy panels. It aims to maximize the solar energy potential of agricultural land and sustain agricultural production at the same time.

Circular agriculture means keeping agricultural biomass and the wastes and residues generated by food processing processes within the food system as reusable resources. The basic principle of circular agriculture is the optimal use of land or resources to meet the need. In order to make the best use of the fields to be planted, diversity is increased by planting successive crops and adding mixed crops to the rotation. The residues (leaves and stems) of the crops produced in these fields are used as feed for livestock and biofertilizer for the soil.

Organomineral fertilizers contain plant nutrients and organic matter together, which are found in chemical fertilizers, so that the nutrient content can be presented in a more standardized form. In organomineral fertilizers, plant nutrient minerals such as Nitrogen (N), Phosphorus (P), Potassium (K), Sulphur (S), Zinc (Zn) and organic matter from humic-fulvic acid and compost are combined together and used as base fertilizer. Organomineral fertilizers produced in the form of "organic matter + mineral fertilizer" by taking advantage of the positive effects of organic materials on soil fertility, on the one hand, reduce the loss of

nutrients by washing and on the other hand, increase the effectiveness of the minerals used by improving the fertility elements of the soil.

ANNEX

Survey

Dear Participant,

This questionnaire is applied to collect data for the project on sustainable agriculture among the member countries of the Organization of Islamic Cooperation. The data obtained from the survey will be used for academic purposes only. Thank you in advance for your interest and support.

1) Sex: ( ) Male ( ) Female

2) Marital Status: ( ) Married ( ) Single

3) Education Level: ( ) Primary E. ( ) Secondary E. ( ) Associate D.
( ) Undergraduate D. ( ) Graduate D.

4) Total Duration of Employment in the Sector (in months and years)……

5) Total Duration of Employment in Your Current Business (in months and years)
……..

6) Age ……

7) Country (currently working in) ……

A. Please indicate your level of agreement with the following statements.

STATEMENTS	STRONGLY DISAGREE	DISAGREE	NEITHER AGREE NOR DISAGREE	AGREE	STRONGLY AGREE
8) Soil and water are the source of all life and should therefore be strictly protected.	(1)	(2)	(3)	(4)	(5)

9) Indiscriminate use of agricultural chemicals is harmful to humans.	(1)	(2)	(3)	(4)	(5)
10) Clover and its cultivation increase soil fertility.	(1)	(2)	(3)	(4)	(5)
11) The application of animal manure can increase soil fertility.	(1)	(2)	(3)	(4)	(5)
12) The key to the future success of agriculture lies in learning to mimic natural ecosystems and farm in harmony with nature.	(1)	(2)	(3)	(4)	(5)
13) Farmers should only till as much land as they can take care of.	(1)	(2)	(3)	(4)	(5)
14) Farmers' primary goal should be to maximize the productivity, efficiency and profitability of their farms.	(1)	(2)	(3)	(4)	(5)
15) Most farms should integrate agriculture and animal husbandry.	(1)	(2)	(3)	(4)	(5)
16) Crop rotation and diversity can reduce farm pests.	(1)	(2)	(3)	(4)	(5)
17) Minimum tillage can reduce erosion and soil degradation.	(1)	(2)	(3)	(4)	(5)
18) If I don't use chemical fertilizers and pesticides on my farm, my farm productivity decreases.	(1)	(2)	(3)	(4)	(5)
19) One of the principles of agriculture is to reduce environmental damage.	(1)	(2)	(3)	(4)	(5)
20) Pest attack will increase due to the successive planting of a single type of plant on the farm.	(1)	(2)	(3)	(4)	(5)
21) Agricultural chemicals pollute the environment.	(1)	(2)	(3)	(4)	(5)
22) Machinery and new technologies should be used to increase agricultural production.	(1)	(2)	(3)	(4)	(5)
23) Weed cultivation is the best way to reduce pest and weed damage.	(1)	(2)	(3)	(4)	(5)
24) The best way to control pests and weeds and reduce their damage is through biological control.	(1)	(2)	(3)	(4)	(5)
25) Green manure application is not necessary due to existing chemical fertilizers.	(1)	(2)	(3)	(4)	(5)
26) Farmers' income will decrease due to crop rotation.	(1)	(2)	(3)	(4)	(5)
27) The appropriate method for controlling pests and weeds is the use of pesticides and poisons.	(1)	(2)	(3)	(4)	(5)

28) Farm productivity only increases due to increased fertilizer consumption.	(1)	(2)	(3)	(4)	(5)
29) Remnants of previous cultivation reduce fertile soil.	(1)	(2)	(3)	(4)	(5)
30) Crop rotation can cause soil erosion.	(1)	(2)	(3)	(4)	(5)