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Towards Resilient and Policy-Driven Agri-Food Systems in North Africa: Insights from Algeria, Tunisia, Libya, and Egypt

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Abstract:

This study aims to provide a comprehensive framework to assist policymakers in the region in improving food security and ensuring the sustainability of agricultural supply chains amid increasing climatic and economic challenges.

The study presents a regional policy-oriented analysis of agricultural and food supply and distribution systems in North Africa, focusing on Algeria, Tunisia, Libya, and Egypt. It reviews the structural challenges facing agricultural supply chains, including the impact of population growth, climate change, excessive reliance on imports, and weaknesses in storage and distribution infrastructure. The study also highlights research gaps in the existing literature, which has often focused on isolated national studies without adopting a comprehensive regional comparative perspective.

Furthermore, the study discusses the impact of recent global crises, such as the COVID-19 pandemic and the Russia-Ukraine war, on food security in the region, resulting in price volatility and supply chain disruptions.

Using a comprehensive analytical approach, the study proposes innovative strategies to enhance the resilience of agricultural supply systems, including the integration of digital technologies, the adoption of climate-smart agricultural practices, and the development of public-private partnerships to improve infrastructure and reduce import dependency.

Keywords: *Agricultural Supply Chains, Food Security, North Africa, Policy Analysis, Climate Change, Supply Chain Resilience.*

JEL Classification: *Q13, Q18, Q54, F14, O13 .*

1. *Introduction*

The introduction of this study on supply and distribution systems for agricultural and food products in Algeria, Tunisia, Libya, and Egypt serves to outline the rationale behind the investigation and provide a contextual overview of the research. The dairy chains in North Africa, particularly in Algeria, Morocco, and Tunisia, have undergone significant changes due to demographic growth, urbanization, and evolving consumption habits. As a result, there has been a surge in the demand for animal products, leading to potential food dependency in the region .

The need to intensify cattle production to meet the growing demand has led to the emergence of fodder crops, which has implications for the agricultural and food supply chains in the region. Additionally, the Maghreb countries' typical Mediterranean climate, characterized by intense drought and excessive heat, poses further challenges to the production and distribution of agricultural and food products. These factors underscore the importance of studying the supply and distribution systems in these countries to understand the dynamics and potential constraints of their agricultural and food networks.

The background and rationale for examining supply and distribution systems in the agricultural and food sectors of North African countries, particularly Algeria, Tunisia, Libya, and Egypt, are multifaceted. Historical analyses of the dairy sector in Egypt, as presented in the Atlas of the traditional milk sector around Greater Cairo, highlight the significance of the dairy value chain, the economic contributions of animal products, and the contrasting roles of livestock between new and old lands. Additionally, the study emphasizes the socio-economic approaches of rural systems, constraints, and opportunities, thus underscoring the need for comprehensive research to address the challenges faced by the dairy industry in the region .

Similarly, research on the dairy chains in North Africa, including Algeria and Tunisia, reveals the historical importance of milk production by pastoral societies and the subsequent need to intensify cattle production to meet the growing demand for animal products. The study also underscores the impact of demographic expansion, urbanization, and evolving consumption habits on the dairy sector, thereby emphasizing the need to understand the drivers and constraints for the development of milk production, consumption, and trade in the region These insights collectively underscore the historical context and the significance of examining supply and distribution systems in the agricultural and food sectors of the mentioned North African countries. Algeria, Tunisia, Libya, and Egypt face significant challenges in the supply and distribution systems of agricultural and food products. Several factors, including demographic growth, urbanization, changing consumption habits, a harsh Mediterranean climate, and reliance on imports, affect the efficiency and sustainability of these systems.

The revised introduction will more clearly articulate the unique contribution of this study to the field of agricultural and food supply systems in North Africa. Unlike previous studies that adopt a country-specific lens, this research offers a comparative regional approach across Algeria, Tunisia, Libya, and Egypt. It integrates multiple dimensions—climatic challenges, demographic pressures, and policy environments—into a unified analytical framework. This allows for a deeper understanding of how systemic vulnerabilities interact and shape food supply chains. Furthermore, the study addresses critical gaps in the literature by linking global disruptions (e.g., pandemics, geopolitical conflicts) to regional supply chain resilience, thereby providing both theoretical insights and practical implications for food security planning .

In this context, the study problem revolves around: **To what extent do economic, climatic, and agricultural policy factors shape the supply and distribution systems of agricultural and food products in Algeria, Tunisia, Libya, and Egypt? What are the possible strategies to improve their efficiency and enhance food security?**

Sub-Questions :

- What are the main challenges facing agricultural supply and distribution systems in the studied countries?
- How does the Mediterranean climate (drought, heat) impact agricultural production and supply chains?
- What role do demographic growth and urbanization play in increasing food demand and changing consumption patterns?
- How do the studied countries manage their reliance on agricultural and food imports?
- What policies and strategies are implemented to enhance production and distribution efficiency and achieve food security?.

Sub-Hypotheses :

- There is a direct relationship between climatic factors and the challenges facing agricultural supply and distribution systems in the studied countries.
- Demographic growth and urbanization increase pressure on agricultural and food supply chains, necessitating more efficient production and distribution policies.
- The Maghreb countries rely heavily on imports to meet local demand, making it essential to develop local production and improve storage and distribution strategies**.**
- Agricultural and trade policies directly impact the effectiveness of supply and distribution systems and can reduce import dependence if properly improved.
- The introduction of modern technology in production and distribution can enhance food system efficiency and reduce agricultural losses.

This study adopts a descriptive-analytical approach, which includes:

- Analyzing data and statistics related to agricultural production, imports, and distribution in the studied countries.
- Comparing agricultural and trade policies in each country to identify gaps and opportunities.
- Studying the impact of climatic and economic factors on the efficiency of supply and distribution systems.
- Conducting case studies on the dairy and cereal sectors as key examples of challenges and opportunities in the field.

Additionally, the comparative approach may be used to assess the performance of distribution systems across the studied countries, with the aim of proposing sustainable strategies to improve agricultural and food supply chain efficiency in the region.

2. *Literature Review and Research Gaps*

Numerous studies have addressed various dimensions of agricultural and food supply chains in North African countries. However, much of the existing literature remains fragmented, often focusing on national contexts or specific sectors, without providing a comprehensive comparative framework that integrates climatic, demographic, economic, and policy variables.

This section synthesizes key insights from prior research and highlights the gaps that this study aims to fill.

2.1. Dairy Sector Dynamics in North Africa

Research by *Taher Sraïri et al. (2013)* highlighted the evolution of dairy chains in Algeria, Tunisia, and Morocco. These studies emphasized the rising demand for animal products due to demographic growth and urbanization, and the emergence of fodder crops as a response. They also discussed the environmental and economic implications of import-reliant dairy systems, particularly in Algeria.

Limitation: These analyses were mostly country-specific and lacked a comparative regional perspective. They did not examine the interconnectedness of dairy systems across North Africa or their resilience to climate shocks and trade disruptions.

2.2. Post-Harvest Losses and Technological Constraints

Djihad et al. (2021) examined the challenges facing Algeria's agricultural sector, especially in relation to post-harvest losses and insufficient storage infrastructure. The study emphasized the low adoption of digital technologies among farmers and inefficiencies in stakeholder coordination within the supply chain.

Limitation: The findings were localized and did not explore parallel challenges in neighboring countries. Moreover, the study did not link these technical issues to broader food security outcomes at the regional level.

2.3. Agricultural and Trade Policies

Studies such as *Soliman et al. (2011)* critically evaluated Egypt's agricultural policy framework, identifying gaps in sustainable development strategies and weak support for research institutions. *Heemskerk & Koopmanschap (2012)* analyzed agribusiness development in Libya, particularly under water scarcity and import dependency.

Limitation: These studies focused on internal policy shortcomings without assessing their impact on regional trade integration, supply chain continuity, or comparative effectiveness in North African agricultural governance.

2.4. Value Chains and Crop-Specific Studies

Research like *Allal et al. (2023)* and *Salah Bachta et al. (2006)* delved into specific value chains (e.g., potatoes, dates, dairy) and discussed marketing systems, stakeholder roles, and price mechanisms.

Limitation: Although informative, these works lacked an integrated view that connects value chain performance with external shocks (e.g., climate, conflict), technological uptake, or cross-country policy benchmarking.

2.5. Impact of Global Crises on Food Supply

Few studies have examined how recent global crises—such as the COVID-19 pandemic and the Russia-Ukraine war—have affected food supply systems in North Africa. Given the region's heavy reliance on imported grains and fertilizers, these disruptions have had profound yet under-explored impacts.

Limitation: There is a lack of empirical analysis linking international crises to the structural vulnerabilities in North African agricultural supply chains.

3. Research Gaps Addressed by This Study

This study aims to fill the following key gaps in the literature:

- **Lack of a comparative regional analysis** integrating Algeria, Tunisia, Libya, and Egypt within a unified framework to assess agricultural and food supply systems.
- **Limited integration of cross-cutting variables** such as demographic expansion, climate change, and trade dependency in shaping supply chain performance.
- **Insufficient focus on post-harvest and distribution infrastructure**, including the role of digital technologies and logistical networks in reducing losses and enhancing efficiency.

- **Absence of contextualization of recent global disruptions**, such as pandemics and conflicts, and their ripple effects on regional food systems.
- **Shortage of policy-relevant, innovative strategies** grounded in empirical data that can improve resilience, reduce import dependency, and support sustainable food security in North Africa.

4. Agricultural Production in Algeria

Agricultural production in Algeria is a significant component of the nation's economy, with a focus on key crops and commodities. The country has made strides in the production of high-quality Deglet-Nour dates, particularly in the southern regions, where farmers have implemented post-harvest treatments such as solar drying processes to enhance the quality of the dates (Djihad et al., 2021). Additionally, the management of water demand has been a priority due to water scarcity, leading to the promotion of investment in Water Saving Technologies (WST) to improve water productivity and crop yield.

Moreover, the Algerian dairy industry is notable, with the government controlling the price for drink milk reconstituted from imported milk powder, which is delivered only by ONIL. The structure of the Algerian dairy products is dominated by milk powder, cheese, and butter, with tariffs and duties on dairy products ranging from 5 to 47% (Taher Sraïri et al., 2013). These insights shed light on the agricultural landscape of Algeria, emphasizing the importance of post-harvest technologies and the dynamics of the dairy industry in the country.

Algeria's agricultural production is heavily reliant on key crops and commodities, with a significant focus on dairy products and cereal grains. The country's dairy industry is characterized by substantial import volumes, with milk powder dominating the market at an annual volume of 252,000 metric tons, followed by cheese and butter. The government exerts control over the price of drink milk reconstituted from imported milk powder, and tariffs on dairy products range from 5 to 47%. In contrast, the cereal grains, particularly potato production in the region of El Oued, face challenges such as irrigation, fertilization, pesticide applications, and post-harvest losses due to inadequate technologies and storage practices (Taher Sraïri et al., 2013).

These agricultural challenges are compounded by broader economic and policy issues, including constraints on imports, declining hydrocarbon revenues, and the government's efforts to increase agricultural output while curbing imports. The employment crisis in the agriculture industry is also attributed to the lack of skilled workers, entrepreneurial skills, and social legislation to improve working conditions, contributing to the low level of agricultural performance and food self-sufficiency in Algeria (Djihad et al., 2021). Addressing these challenges requires a focus on suitable research technologies to promote food security and the application of national research programs relating to agriculture and water resources, which remain weak in the country.

5. Agricultural Production in Tunisia

Tunisia's agricultural production is characterized by a focus on crops and commodities essential to the country's farming industry. The agricultural model for Tunisia emphasizes the need for supervising farmers and workers, providing them with necessary assistance and advice, and developing educational programs to enhance productivity and farming skills (Boubakri, 1988). Additionally, the availability of necessary equipment and accessible chemicals, along

with proper care advice from mechanics and specialists, is crucial for the sector's development. Furthermore, the dairy chains in Tunisia have historical roots in livestock rearing and the emergence of fodder crops to meet the growing demand for animal products due to rapid demographic expansion and urbanization (Taher Sraïri et al., 2013).

These insights underscore the importance of agricultural support systems, educational programs, and the development of livestock rearing to meet the demands of a growing population and urbanization trends in Tunisia (East & Africa, 2023).

In Tunisia, the agricultural sector is primarily driven by key crops and commodities such as cereals, olives, dates, and citrus fruits. These products play a crucial role in shaping the country's food and farming landscape. The production and distribution of these agricultural products are essential for both domestic consumption and export, contributing significantly to the Tunisian economy (Boubakri, 1988).

Furthermore, the dairy chains in Tunisia have undergone significant changes, influenced by demographic growth, urbanization, and evolving consumption habits. The demand for animal products, including dairy, has increased, leading to potential risks of food dependency for the region (Taher Sraïri et al., 2013). Understanding the dynamics of key crops and commodities, as well as the evolving trends in dairy chains, is crucial for policymakers and stakeholders in shaping the supply and distribution systems for agricultural and food products in Tunisia.

6. Agricultural Production in Libya

Libya's agricultural production is heavily influenced by its water availability and import-export dynamics. The country faces water scarcity, with the Great Man Made River serving as the primary source for inland irrigation, while coastal irrigation relies on the first aquifer. The agricultural strategy emphasizes agribusiness development, with a shift towards more efficient import-export systems. Additionally, the country's agricultural sector faces challenges such as salinization, limited water quantity, and poor soil and climatic conditions in certain areas. Importantly, Libya is self-sufficient in some agricultural products like vegetables, fruit, eggs, and meat, but heavily relies on imports to meet food requirements, with agricultural imports comprising over 25% of the total import bill (Heemskerk & Koopmanschap, 2012). These insights highlight the complexities and constraints of agricultural production in Libya, shedding light on the need for sustainable strategies to address water scarcity, improve production efficiency, and enhance import-export systems to ensure food security and economic stability.

Libya's key crops and commodities play a crucial role in the country's agricultural and food production landscape. The agricultural strategy in Libya emphasizes agribusiness development, with a focus on efficient import and export systems in agriculture. The country's water situation, particularly the availability and salinization of water, poses a significant challenge to agricultural production. The Great Man Made River serves as the primary source of water for inland irrigation schemes, while coastal irrigation water is abstracted from the first aquifer. Despite efforts to improve seed and variety programs, a long-term commitment of 10-15 years is deemed necessary for the development of the agricultural sector. Additionally, Libya heavily relies on imports to meet its food requirements, with agricultural imports accounting for more than 25% of the total import bill. Domestically, the country is 80% self-sufficient in vegetables, fruit, eggs, and meat, and meets about 25% of the demand for wheat, barley, olives, dates, citrus fruits, vegetables, and peanuts (Heemskerk & Koopmanschap, 2012).

7. Agricultural Production in Egypt

Agricultural production in Egypt is characterized by the dominance of cereals, particularly wheat, maize, and rice, which are projected to remain the primary source of energy through 2015 (Dawoud, 2005). However, despite this dominance, Egypt is expected to fall short of self-sufficiency in wheat, necessitating an increase in national wheat production. The decline in self-sufficiency ratios of sugar, oils & fats are also anticipated, indicating a need for strategic interventions to address these shortfalls. Additionally, the production of fish, red meat, and milk is projected to remain insufficient relative to their consumption, highlighting the need for increased investment in agricultural research and extension to enhance production and dietary diversity.

Furthermore, the agro-food industries in Egypt play a significant role in the country's economy, contributing around 20% to the GDP and employing 8% of the industrial workforce (Soliman et al., 2011). The subsectors with the highest value added include sugar, oil and fats, and mill products, which collectively account for around 86% of the total value added of the agro-food industry. Moreover, the food processing subsector has experienced substantial growth, driven by both domestic demand and exports, particularly in fruit processing, frozen vegetables, cereals, and biscuits. These insights underscore the critical role of the agro-food sector in Egypt's economy and the need for continued support and development to ensure its sustainability and growth.

Egypt's agricultural sector is heavily reliant on key crops and commodities that play a crucial role in the country's food supply and economy. Rice, for example, continues to be a staple in the Egyptian diet, with high levels of consumption expected to persist. This trend presents opportunities for innovation and initiative in agribusinesses related to rice consumption, highlighting the importance of understanding consumption patterns in agribusiness planning (Dawoud, 2005). Additionally, the agro-food industry in Egypt, which contributes significantly to the country's GDP and employs a notable portion of the workforce, is primarily comprised of sub-sectors such as sugar, oil and fats, and mill products, with substantial growth observed in the food processing subsector driven by both domestic and export markets (Soliman et al., 2011). These insights emphasize the significance of key crops and commodities in shaping the agricultural landscape and food industry in Egypt, underscoring the need for strategic planning and policy considerations to ensure food security and sustainable agricultural development. (Sardo et al.2024)

8. Overview of Supply Chains in Algeria

The supply chains in Algeria play a crucial role in the distribution of agricultural and food products, with key stakeholders contributing to the dynamics of the distribution networks. For instance, in El Oued, the lack of substantial storage facilities results in potatoes being stored in sacks before transportation to the market (Djihad et al., 2021). Government policies, financing facilities, and technological usage significantly impact the post-harvest scenario in Algeria, influencing the agricultural sector's ability to provide food, raw materials, and employment opportunities. Improving the agricultural sector is essential for diversifying the economy and mitigating the effects of oil price fluctuations. Additionally, reducing post-harvest losses is critical for ensuring the availability of food in sufficient quantities in Algeria, particularly in

addressing challenges such as low yields and significant production losses due to various causes. These insights underscore the importance of understanding the supply chains in Algeria for effective agricultural and food product distribution.

Different stakeholders are involved in the supply chain of potatoes in Algeria. Growers are the first stakeholders interacting at this level. They rely on the use of productive inputs that they purchase at markets. The figure illustrates the stakeholders, information, and product flows of the potato supply chain in Algeria. In Algeria, twelve companies hold all the seed potatoes and are the ones that directly sell them to farmers. Seed potato production, owned by SAADHA, occurs on six secure perimeters. Farmers access this supply chain through cooperatives or private traders. Growers supply tubers to the open potato market (wholesale merchant) dealers from mid-June to early December. Agro-food companies are believed to purchase tubers from the open market. Potato expenditure consumers rely only on tubers collected by retailers and then sold in the deep market, so they never interact with the previous stakeholders. The open market of potatoes in Algeria involves many retailers who purchase this basic food product from wholesale merchants and then resell them in the local market. (Allal et al.2023)

Alongside marketing partners, four further stakeholders have been identified, which directly impact information or product flows of the supply chain at its agricultural level. Agricultural "agents" comprise two distinct stakeholders. The ANPV is both a regulatory and a supportive entity that collects reports of farmers' production and promotes tuber use of SAADHA's certified seed potatoes. Extension Officers are in charge of transferring innovative techniques of production to growers. The way growers can get technical aid depends on their status as cooperators or not. As cooperators, they benefit from the action of several Extension Officers. Non-cooperators, who represent 70% of the farmers in the study zone, seldom receive any technical advice related to modern techniques. They rely on supportive local dealers to ameliorate their expertise. Agricultural "consultors" are private actors providing regulatory aid to potato marketing partners. They advise industries concerned with the quality of tubers supplied to their processing more than by characteristics related to potato cultivation. Besides promoting tuber lifting and packaging at harvest, they emphasize controlling tubers' weight loss by ceasing withdrawal from the fields after October 1st. (Utami et al.2021)

9. Overview of Supply Chains in Tunisia

To provide an overview of the supply chains in Tunisia, it is best to discuss key stakeholders first. In Tunisia, as in many countries in the region, agriculture is taken care of by cooperatives in partnership with the Ministry of Agriculture, and supply chains for fresh products are taken care of by public companies in partnership with cooperatives. (Hanafi et al.2020)

Some state-owned companies (MDD): the retail supply chains for fresh produce. These companies have a monopoly on the wholesale and distribution of vegetables, potatoes, other tubers, melons, and grapes, in the production areas. There are two companies: the fruits supply chain in the North West "Maine" for the production areas of Aouina-Nabeul-Ben Arous, Bizerte, Kef, and Jendouba, and the fruits supply chain in the North East "Mande" for the production areas of Monastir-Mahdia-Sousse-Nabeul. The regulatory framework for this chain is Decree 85-468 (1985). They buy the produce in each wholesale market at pre-defined maximum prices per kg, and they are in charge of distributing the fruit and vegetable products in each supply area. The sales prices fixed by the government at the wholesale markets for these companies,

combined with the corresponding prices as fixed in each market, make it possible to fix the consumer prices at each supply area, together with a minimum take by the company. In the case of difficulties for the companies to achieve the fixed prices, the government puts in place compensatory measures (complementary purchases, selling losses, etc.). (Nacer, 2023)

Agriculture cooperatives. Producer cooperatives: there are "COTUM" cooperatives charged with producing and distributing seeds, transported by air to prevent disease, and with iodizing fertilizer with complex microbe (R.I.M, 1991). There are cooperatives producing seeds and tubers in the production areas of Manouba-Bessalem, Grand Tunis-Kalaa Kasserine-Mspannine-Zaghouan-Bou Salem Ben Arous. There are farmers cooperatives, charged with supplying the inputs, which are bought by the Ministry. Transport is done by SONAPRA. In case of short supply of inputs, a health crisis, bad meteorological conditions, etc., the Ministry grants by decree, and within the limits set, exceptional measures to protect farmers. (Clerk & Ewapi)

Agricultural irrigation cooperatives were constructed with the participation of private donors, such as the AfDB, with the COTUM dependent on the Ministry of Agriculture (R.I.M, 1993). There are presently 70 such systems with microtubers in Bizerte-Beja-Kef-Mahnara-Sfhax, Ben Arous, Grand Tunis-Wadi Khaled-Madjen Ben Guiroud. (Zhang et al., 2021)

Food producers and operators cooperatives set up with the help of such private donors as H.M. Junior Achievements and AIDI. There are cooperatives producing potato chips, tuna, tomatoes, pasta, macaroni, and biscuits with state subsidies. CFA probably promotes the processing of potatoes, tomatoes, and more generally cereals. (Bensaha et al.2023)

Key stakeholders in the supply chain of agricultural and food products in Tunisia play crucial roles in the distribution and delivery processes. The dairy supply chain in the Tadla region is well-defined and structured around a dairy plant and a network of collection cooperatives, implementing specific rules for managing raw material flows and quality control (Salah Bachta et al., 2006). Conversely, the Tunisian date supply chain faces geographical and organizational limitations, with poorly defined quality standards in the upstream segment and limited diversification in the downstream market. The coordination among actors in the date supply chain is mainly market-driven, providing limited room for enhancing market positioning. The stakeholders' efforts are focused on analyzing the existing situation and providing decision support for potential developments in response to strategic challenges, particularly in terms of structuring fragmented supply and managing quality throughout the supply chain.

These insights highlight the significance of stakeholder collaboration and the management of quality standards in the Tunisian agricultural and food supply chains, emphasizing the need for coordinated efforts to address the challenges and enhance the overall performance of the supply and distribution systems. (Abderahman et al., 2021)

10. Overview of Supply Chains in Libya

(Heemskerk & Koopmanschap, 2012) This overview highlights the complexities and dynamics of Libya's supply chains for agricultural and food products, emphasizing the importance of both local production and international trade in sustaining the country's food supply.

Key stakeholders in the agricultural and food product distribution networks of Libya encompass a diverse range of entities and organizations. The Ministry of Agriculture and key

agricultural associations play a pivotal role in shaping the sector. The Ministry has been actively involved in assessing and strategizing the development of various agricultural segments, such as the dairy, poultry, and vegetable sectors. For instance, the Ministry's assessment of the dairy sector revealed that local dairy production covered 32% of the national demand for milk, and efforts are underway to revitalize dairy production units following the decline caused by previous political and environmental challenges (Heemskerk & Koopmanschap, 2012).

In addition to the Ministry, agricultural associations, such as the poultry producers' association, have been instrumental in negotiating with the government on matters like frozen chicken imports. Furthermore, international investments, like the consortium from Rieti, Italy, have also contributed to the development of the agricultural sector, as evidenced by their investments in vegetable production for export to Europe. The role of these stakeholders is critical in addressing the challenges posed by population growth and increasing food demand, especially in the context of poor soil and climatic conditions (Abdudayem & H. S. Scott, 2014). These stakeholders collectively contribute to shaping the dynamics of the agricultural and food distribution networks in Libya.

11. Overview of Supply Chains in Egypt

Egypt's supply chain for agricultural and food products involves various stakeholders and a complex distribution structure. The country has experienced significant changes in food consumption patterns over the years, with a notable increase in fish consumption, and a continued high demand for rice. These shifts in consumption patterns have implications for agribusiness planning, production decisions, and food security policies. In addition, Egypt's agricultural trade dynamics are influenced by its relationships with international markets, such as the European Union (EU) and Arab countries. The EU serves as a major client for Egyptian merchandise exports, absorbing a significant portion of the country's agricultural exports, despite a trade deficit in agricultural imports. This highlights the importance of understanding international trade dynamics and agreements in shaping Egypt's supply chain for agricultural and food products (Dawoud, 2005).

In Egypt, the supply and distribution of agricultural and food products involve various key stakeholders that play crucial roles in shaping the industry. These stakeholders include government bodies, agricultural research institutions, private enterprises, and market regulatory authorities. The government in Egypt has historically played a significant role in agricultural policies and institutions, with a focus on addressing challenges such as unemployment, rural poverty, and environmental impacts on agricultural systems (Soliman et al., 2011). Additionally, private agricultural enterprises have been involved in the industry, although there have been challenges related to financing agricultural research institutions and participating in efficient agricultural and food marketing.

Furthermore, changes in food consumption patterns in Egypt have influenced agribusiness planning, with a notable increase in fish consumption due to improved supplies from aquaculture (Dawoud, 2005). Understanding the nature of demand for food and analyzing consumption patterns is essential for making informed decisions regarding agricultural production, import, and export. These insights highlight the complex interplay of stakeholders and consumption patterns in shaping Egypt's agricultural and food distribution systems.

12. Impact of Global Crises on Grain and Food Imports in North Africa

The agricultural and food supply systems in North Africa have been severely affected by recent global crises, particularly the COVID-19 pandemic and the ongoing Russia-Ukraine war. These events have exposed and intensified the region's heavy reliance on food imports, especially grains such as wheat and corn. During the COVID-19 pandemic, global supply chains faced severe disruptions due to lockdowns, port closures, and transportation delays, resulting in significant volatility in food prices and delivery schedules. For North African countries like Egypt, Algeria, and Tunisia—where wheat imports account for a large portion of national consumption—this led to concerns over food availability and affordability (FAO, 2022; World Bank, 2021).

The Russia-Ukraine war has had an even more direct and destabilizing impact. Prior to the conflict, Russia and Ukraine together supplied over 30% of global wheat exports, with North African countries among the top importers. Egypt, for example, relied on the two countries for over 80% of its wheat imports (FAO, 2022). With the disruption of Black Sea export routes and imposed sanctions, wheat availability dropped and prices surged to record levels in 2022, triggering budgetary and food security challenges across the region (World Bank, 2022). Tunisia and Libya, both facing economic fragility, struggled to absorb the price shocks, further highlighting their vulnerability to global market fluctuations.

These crises have underscored the structural weakness of overreliance on imports and the urgent need for North African governments to diversify supply sources, invest in local production, and enhance storage and logistics infrastructure. They also reaffirm the importance of building resilient agricultural systems that can withstand geopolitical and epidemiological shocks.

13. Policy and Regulatory Frameworks

Policy and regulatory frameworks play a crucial role in shaping the import and export of agricultural and food products in the studied North African countries. In Egypt, previous agricultural strategies have been criticized for lacking a comprehensive vision for sustainable agricultural development, neglecting environmental impacts, and failing to involve private agricultural enterprises in financing research institutions (Soliman et al., 2011). The implementation of policies related to agricultural production and marketing, including the drying of internal lakes for agricultural use, has faced scrutiny for its adverse environmental and economic effects. Additionally, the lack of efficient agricultural and food marketing systems has been highlighted as a challenge, especially in the face of international trends towards liberalization of agricultural trade.

In Algeria, and Tunisia, specific policies have been implemented to address the surge in food demand and create wealth and labor opportunities through the use of natural resources, particularly in the dairy sector (Taher Sraïri et al., 2013). These policies have led to different approaches in the organization of dairy chains within the three countries, with Algeria heavily relying on imports of milk powder, while Morocco and Tunisia have focused on encouraging locally produced raw milk. The dairy sector's impact on the environment, water resources, and groundwater pollution has been a significant concern, along with the volatility in feed and food prices, which has added pressure on the actors within the dairy chains. These case studies demonstrate the importance of policy and regulatory frameworks in addressing the complex challenges and opportunities within the agricultural and food sectors in these North African countries.

Import and export regulations play a significant role in shaping the trade dynamics of agricultural and food products in North African countries. In Algeria, dairy product imports accounted for a substantial portion of the country's food imports, with the government exerting control over the price of reconstituted milk made from imported milk powder. Tariffs and duties on dairy products in Algeria ranged from 5 to 47%, with milk powder dominating the import volume, followed by cheese and butter. Similarly, Morocco imposed tariffs ranging from 17.5% to 102% on dairy products, with butter being the primary import, followed by milk powder and cheese. In contrast, Tunisia's dairy imports were limited, not exceeding 34.3 million US $ in 2009, with milk powder being the most imported dairy product. It is noteworthy that the Maghreb countries do not export dairy products, although some milk powder imported by Algeria is smuggled to neighboring countries (Taher Sraïri et al., 2013).

In Egypt, the competitiveness of agricultural exports has been a subject of study, particularly in relation to products such as rice, potatoes, onions, oranges, cotton, and grapes. Various scholars have applied the Market Penetration Rate (MPR) to assess the competitiveness of Egypt's exports in international markets. For instance, studies have shown fluctuations in Egypt's penetration of EU markets, with strong competition from both EU and non-EU countries affecting the penetration rate. In the case of rice, Egypt aimed to increase its penetration rate in markets such as Sudan and Romania by lowering export prices. Similarly, the penetration of Egyptian cotton in foreign markets was influenced by factors such as the mixing of cotton varieties during harvesting or ginning. Additionally, the penetration rate of Egyptian grapes was found to be high in markets like the UAE, Netherlands, Belgium, and England, attributed to the re-export of imported quantities (Soliman & Bassiony, 2012).

14. Challenges in Agricultural Supply Chains

The challenges in the agricultural supply chains of the studied countries are multifaceted, with a significant focus on infrastructure-related obstacles. One key challenge is the lack of efficient and effective flow among various stakeholders, leading to a disconnect in decision-making at different stages of agribusiness activities . This hinders the timely availability and accessibility of crucial data and information for farmers, impacting their ability to align production with market needs. Additionally, the post-harvest sector in these countries faces issues such as traditional and time-consuming practices, deficient infrastructure, and poor governance in managing investment programs and financial credit schemes (Djihad et al., 2021). These challenges contribute to non-competitive agriculture, poor integration into foreign markets, and inefficient post-harvest methods, highlighting the need for substantial improvements in the supply chain infrastructure and decision-making processes.

Infrastructure plays a pivotal role in the efficient distribution of agricultural and food products. In Algeria, the agricultural sector faces infrastructure challenges that hinder post-harvest processes and overall efficiency. The Ministry of Post, Telecommunications Technology, and Digital Technology is involved in implementing a reliable computer system for agriculture, but the exploitation of ICT by farmers remains low, calling for targeted information campaigns. Additionally, despite significant investment, the agricultural development plans have yielded meager results, with bureaucratic hindrances making it difficult to adapt technological innovations. The post-harvest sector in Algeria suffers from deficiencies

in infrastructure, low productivity, and inadequate technology, particularly in comparison to other countries (Djihad et al., 2021).

15. Conclusion

the study on supply and distribution systems for agricultural and food products in Algeria, Tunisia, Libya, and Egypt has revealed several key insights. The rapid demographic expansion and urbanization in the Maghreb region have led to evolving consumption habits, increasing the demand for animal products and posing potential risks of food dependency. Additionally, the Mediterranean climate in the region, characterized by intense drought and erratic rainfall, presents challenges for intensified agriculture and agricultural spaces. Furthermore, the post-harvest scenario in Algeria has been affected by the lack of substantial storage facilities, leading to considerable post-harvest losses in the cereals sector. Government policies, financing facilities, and technological usage play crucial roles in addressing these challenges and are essential for the sustainable development of the agriculture sector in the region.

These findings call for specific recommendations to address the identified constraints and capitalize on the opportunities for agricultural and food product supply and distribution in the region. It is imperative to focus on improving storage facilities, implementing effective agriculture policies, and leveraging technological advancements to reduce post-harvest losses and enhance the sustainability of the agriculture sector. Moreover, strategies for diversifying the economy and ensuring food availability in sufficient quantities need to be prioritized to mitigate the effects of population growth and urbanization. The study underscores the importance of proactive measures to address the challenges and capitalize on the opportunities for the supply and distribution of agricultural and food products in the region.

In particular, the study proposes the integration of digital technologies—such as blockchain for traceability, IoT for monitoring logistics, and AI for demand forecasting—into agricultural supply chains. Additionally, the promotion of climate-smart agriculture (CSA), including drought-resistant crop varieties and precision irrigation systems, is crucial for adapting to regional environmental constraints (El Jaouhari et al., 2024). Lastly, public-private partnerships (PPPs) should be actively fostered to mobilize investment, enhance storage and distribution infrastructure, and reduce import dependency, especially for staple grains.

To translate findings into impact, this study proposes the following innovative and context-specific strategies for improving agricultural supply chain efficiency and food security in North Africa:

1. Adoption of digital platforms for market information sharing, input distribution, and supply chain coordination to reduce post-harvest losses and increase transparency (Yang et al., 2021).
2. Investment in climate-resilient agriculture, including early-warning systems for drought and floods, integrated pest management, and water-saving technologies (Sardo et al., 2024).
3. Enhancement of cooperative models and value chain governance, particularly in dairy and cereal sectors, to improve bargaining power and distribution efficiency.
4. Diversification of import sources and development of regional grain reserves to mitigate risks from global supply shocks.
5. Promotion of localized agri-food innovation hubs, linked to universities and research institutions, to stimulate sustainable practices and entrepreneurship.

16. *Bibliography List :*

- Djihad, T., Alghorbany, A., Izzuddin Bin Muhamad, A., & Mahmudul Alam, M. (2021). Government Policies, Financial Scopes and Technological Usages for Agricultural Development and Post-Harvest Loss Reduction in Algeria. osf.io
- Boubakri, N. (1988). Importance of Agriculture in the Development Process: an Agricultural Model for Tunisia. [PDF]
- East, M. & Africa, N. (2023). Tunisia. worldbank.org
- Heemskerk, W. & Koopmanschap, E. M. J. (2012). Agribusiness development in Libya : a fact-finding mission. [PDF]
- Dawoud, S. (2005). An analysis of food consumption patterns in Egypt. [PDF]
- Soliman, I., Mashhour, A., & Gaber, M. (2011). A review of The National and International Agro-Food Policies and Institutions in Egypt. [PDF]
- Sardo, M., Chiarelli, D. D., Ceragioli, F., & Rulli, M. C. (2024). Optimized crop distributions in Egypt increase crop productivity and nutritional standards, reducing the irrigation water requirement. Science of The Total Environment, 175202. [HTML]
- Allal, L. G., Bennekrouf, M., Bettayeb, B., & Sahnoun, M. H. (2023, September). Potatoes Supply Chain Challenges and Opportunities in Algeria: A Literature Review. In 2023 International Conference on Decision Aid Sciences and Applications (DASA) (pp. 646-651). IEEE. researchgate.net
- Utami, S. K., Mardiana, M., Herawati, N., & Hidayah, B. N. (2021). Soybean Farming Income between Cooperators and Non-Cooperators during Farmer Field School Program in Central Lombok-Indonesia. In E3S Web of Conferences (Vol. 316, p. 02030). EDP Sciences. e3s-conferences.org
- Hanafi, S., Marlet, S., Jamin, J. Y., Imache, A., Zaïri, A., Bahri, H., ... & Bouarfa, S. (2020). Participation in a complex and conflicting context: implementing a shared diagnosis in a northern Tunisia irrigation scheme. Irrigation and Drainage, 69, 60-69. cirad.fr
- Nacer, I. H. (2023). From Rags to Riches to Rags Again: Deconstructing the Narratives of Crony Capitalism and Neoliberal Ideology Through the Example of Algeria. erf.org.eg
- Clerk, R. & Ewapi, N. (). Blonde Jo AnnCaudill, Former^ Couuty Moreheadian, Is 'Miss Dixie'Stepped Dp. scholarworks.moreheadstate.edu. moreheadstate.edu
- Zhang, C. H., Benjamin, W. A., & Miao, W. (2021). The contribution of cooperative irrigation scheme to poverty reduction in Tanzania. Journal of integrative agriculture. sciencedirect.com
- Bensaha, A., Bensaha, H., & Bensaha, L. (2023). A new reading of the animal production subsidy program for the Saharan regions: Opportunities and constraints. Online Journal of Animal and Feed Research, 13(4), 313-320. ojafr.ir
- Salah Bachta, M., Le Gal, P. Y., Rhouma, A., & Kuper, M. (2006). De l'eau aux dattes : aperçu de la filière datte tunisienne et perspectives d'interventions. [PDF]
- Abderahman, R., Karim, R., & Kevin, D. (2021). Halal food supply chains: A literature review of sustainable measures and future research directions. Foods and Raw materials. cyberleninka.ru

- Abdudayem, A. & H. S. Scott, A. (2014). Water infrastructure in Libya and the water situation in agriculture in the Jefara region of Libya. [PDF]
- Yang, M., Fu, M., & Zhang, Z. (2021). The adoption of digital technologies in supply chains: Drivers, process and impact. Technological Forecasting and Social Change. exeter.ac.uk
- Lemeilleur, S., Maître d'Hôtel, E., Lepiller, O., & Hobeika, A. (2019). Uncertain impacts of new technologies: the case of digital agriculture and blockchains. [PDF]
- El jaouhari, A., Arif, J., Samadhiya, A., Naz, F., & Kumar, A. (2024). Exploring the application of ICTs in decarbonizing the agriculture supply chain: A literature review and research agenda. ncbi.nlm.nih.gov
- Soliman, I. & Bassiony, H. (2012). Egyptian Agricultural Exports Competitiveness. [PDF]
- El Jaouhari, A., Arif, J., Samadhiya, A., Naz, F., & Kumar, A. (2024). Exploring the application of ICTs in decarbonizing the agriculture supply chain: A literature review and research agenda. *Frontiers in Sustainable Food Systems*.
- FAO. (2022). *The impact of the Ukraine-Russia conflict on global food security*. Food and Agriculture Organization of the United Nations. https://www.fao.org
- Sardo, M., Chiarelli, D. D., Ceragioli, F., & Rulli, M. C. (2024). Optimized crop distributions in Egypt increase crop productivity and nutritional standards, reducing the irrigation water requirement. *Science of The Total Environment, 175202.*
- World Bank. (2022). *Global Economic Prospects – June 2022: Risk of stagflation rises amid war in Ukraine*. https://www.worldbank.org
- Yang, M., Fu, M., & Zhang, Z. (2021). The adoption of digital technologies in supply chains: Drivers, process and impact. *Technological Forecasting and Social Change*, 166, 120634.
- FAO. (2022). *The impact of the Ukraine-Russia conflict on global food security*. Food and Agriculture Organization of the United Nations. https://www.fao.org
- World Bank. (2021). *COVID-19 and food security: A global perspective*. https://www.worldbank.org
- World Bank. (2022). *Global Economic Prospects – June 2022: Risk of stagflation rises amid war in Ukraine*. https://www.worldbank.org