

WATER, WHEAT, AND WAR NEXUS

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***Abstract** The purpose of this study is to analyse the nexus between water, wheat and war in Egypt. Currently, the obstructed diffusion of the wheat market in Egypt prevents it from acquiring its fair share among other countries in terms of production versus its consumption. Water and Wheat self-sufficiency, on the other hand, looks to be a pipe dream that will take a long time to materialise. The study presents the market volume, share, and segments locally in the global market lighting. Then, outline the supply and demand factors while measuring the price elasticity of its supply and demand curve. To ensure a comprehensive contextual analysis, the paper will use the top-bottom analysis approach. This framework helps to discover the primary factors causing the problems faced by the research at hand. This resulted in detecting the regulations, tactics, moves, and facilities provided to the wheat sector by the Egyptian Government while taking into consideration the global impact of the Russian –Ukraine War.*

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Introduction

Food security is in the heart of Egypt's 2030 Vision as a national security issue and we are working on expanding agricultural land, reducing imports, and adapting to climate change, Minister of Agriculture Assayed al-Qasir said (Today, 2022). Wheat is the main food and the first cereal crop in Egypt where its grains are used as food for humans, and straw is used as fodder for animals. The average consumption is about 145 kg per capita per year, which is considered the highest in the world (The Conversation, 2022).

When urbanization takes place, externalities such as decreased water availability and drainage tend to affect yields in adjacent fields. The wheat policy is a priority for the Egyptian government. So, the government has taken measures to increase wheat production and support producers by encouraging farmers to cultivate wheat and buying wheat from the farmers at a high price. Recently, a great deal of attention has been directed toward increasing wheat productivity per unit of land, especially in newly reclaimed soils, to minimize the gap between Egyptian production and consumption (AIMonitor, 2022).

Egypt lies in a dry region of the world and management of water resources in dry areas is necessary to maintain the limited quantities of water available in these areas and to achieve an appropriate level of development, food security and stability (El-Marsafawy & Mohamed, 2021). From a water resources waste point of view, it was explained that the water resources waste due to wheat crop waste and losses are considerably high (6.0 billion m³ due to the total wastage from the wheat crop available for consumption in Egypt), therefore, Egypt as a country facing water stress needs to adopt a water waste and losses reduction strategy that can partially alleviate their water scarcity problem (ElFetyany, Kamal, Helmy, & Nasr, 2021).

The concept of sustainable food systems is gaining prominence in recent years, aiming to “ensure food security and nutrition for all in such a way that the economic, social and environmental bases to generate food security and nutrition of future generations are not compromised” (Catharien Terwisscha van Scheltinga, 2021). Water plays an important role in the food system. Water quantity and quality are considered environmental drivers in the food system approach, of particular relevance in water-scarce areas (Catharien Terwisscha van Scheltinga, 2021). Water is present in the entire food value chain, from food production to processing and consumption (Catharien Terwisscha van Scheltinga, 2021). Many countries are net food importers using food subsidy systems, as water resources do not allow national food self-sufficiency (Catharien Terwisscha van Scheltinga, 2021).

As this leaves countries in a position of dependency on international markets, prices and export bans, it is imperative that every domestic drop of water is used efficiently (Catharien Terwisscha van Scheltinga, 2021). Arid and semi-arid countries are particularly sensitive to increasing population rates in connection with (lack of) economic growth, but also to droughts and climate changelike Egypt where subsidies have become embedded as a citizen's right and are therefore strongly linked to the legitimacy of a ruling regime (Catharien Terwisscha van Scheltinga, 2021).

Egypt has experienced several food crises, including a severe one in 2008 when drought and wildfires forced Russia to impose a wheat export ban, leaving major client Egypt to buy elsewhere at sharply rising prices and this shows how sensitive the issue of food self-sufficiency (Catharien Terwisscha van Scheltinga, 2021). In the context of population growth, the aspiration of Egypt to become a more self-sufficient country in the future, by expanding agricultural lands or by increasing water efficiency, will be challenged by the fact that water availability is difficult to increase in the future and Smart water allocation decisions are required (Catharien Terwisscha van Scheltinga, 2021).

The research conducted relies mainly on a desk study of a literature review including, reports and journal articles and studies to assessing the study objectives.

Literature Review

The wheat industry can be identified as a perfectly competitive market where it has many sellers and producers. As there are many producers in the wheat market, one wheat producer cannot influence the market price of wheat. While another point of view see that the wheat market does not show market leader characteristics and can better be described as a more complex oligopoly dominated by the main producers with main dominance between the United States, Canada, and Australia, where price leadership is provided by the United States.

Wheat policy in Egypt has been gradually reformed from one of massive government intervention to a much more market-oriented one , Nevertheless, food security concerns and the concern for an excessive dependency on imports mean that the GOE does continue to intervene in several markets, including the wheat markebut policy makers try to look ahead to design new policies which aim to achieve greater food security (Croppenstedt, 2007).

Water, energy and food are essential for human well-being, poverty reduction and sustainable development (Olivier Dubois, 2014). Global projections

indicate that demand for freshwater, energy and food will increase significantly over the next decades under the pressure of population growth and mobility, economic development, international trade, urbanisation, diversifying diets, cultural and technological changes, and climate change (Olivier Dubois, 2014). Agriculture accounts for 30% of the global energy consumption and 92% of the total global water consumption [Monforti-Ferrario and Pascua, 2015] [Hoekstra et al., 2012].

The WEF model integrates system dynamics modeling and water, energy and food nexus in one single model it simulates the nexus of the dynamics of Egypt's consumption and production of agricultural products, and the water and energy use for agricultural production and their compounding effects on Egypt's food gap as a difference between the consumption of agricultural products and production at the domestic supply chain which is currently supplied from import. (Ali, 2019). The food gap translates into water and energy quantities by estimating and analyzing the water and energy use in agricultural production for a historical period to indicate the required water and energy to produce the food gap domestically and this approach aims to bridge a current gap between water and energy managers and policymakers (Ali, 2019).

The advantage of using dynamic modeling in the WEF model is that it acknowledges the complexity between agricultural production and consumption, and incorporates it under one model (Ali, 2019). The food gap is the difference between the consumption of agricultural products and production at the domestic supply chain (Ali, 2019). This approach allows investigating the interdependencies between food-water and food-energy and it bridges an important gap between the food, water, energy resources managers and policymakers (Ali, 2019). It presents a conceptual approach to better understand and systematically analyse the interactions between the natural environment and human activities, and to work towards a more coordinated management and use of natural resources across sectors and scales (Olivier Dubois, 2014). This can help us to identify and manage trade-offs and to build synergies through our responses, allowing for more integrated and cost-effective planning, decision-making, implementation, monitoring and evaluation (Olivier Dubois, 2014).

A recurring criticism of the Water-Energy-Food Nexus is that it adds relatively little to already existing integrated approaches to resources management, such as the integrated landscape approach or integrated water resources management (IWRM) (Olivier Dubois, 2014). However, The Nexus approach

considers the different dimensions of water, energy, and food equally and recognizes the interdependencies of different resource uses to develop sustainably (Olivier Dubois, 2014).

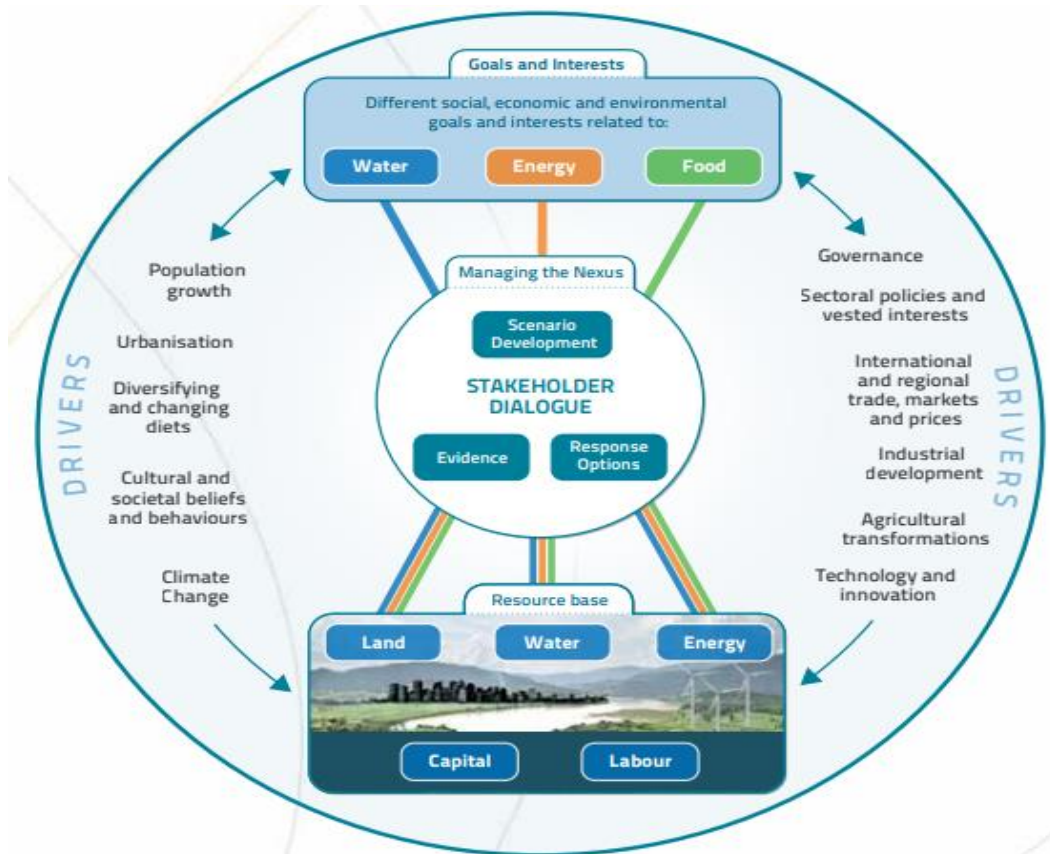


Figure 1 FAO approach to the Water-Energy-Food Nexus

Interactions take place within the context of globally relevant drivers, such as demographic changes, urbanisation, industrial development, agricultural modernisation, international and regional trade, markets and prices, technological advancements, diversification and changes of diets, and climate change as well as more context-specific drivers, like governance structures and processes, cultural and societal beliefs and behaviour (Olivier Dubois, 2014). Here we will apply FAO approach to Water-Energy- Food Nexus on the Egyptian Context through approaching the factors of Supply and factors of demand on the wheat as a main and strategic food in Egypt.

Global Wheat Market

The Egyptian domestic market is not in isolation from the global one which is considered a vital source to sustain and meet the local consumption baseline. Consequently, the Russian –Ukrainian War was having a mediating impact on the Egyptian Wheat market. For 2021/22, global wheat production is up by 0.3 million metric tons (MT) to 778.8 million as production is revised up for Argentina (+0.5 million MT to 21.0 million) and Pakistan (+0.5 million to 27.5 million) and is partially offset with a reduction to the European Union (-0.6 million MT to 138.4 million) (Andrew Sowell, 2022).

Total wheat consumption is forecast up by 2.7 million MT to 788.1 million (Andrew Sowell, 2022).

The USDA has scaled down its estimate for global wheat consumption for MY 2021-22 to 787.1 million mt, down 2.5 million mt from 789.6 million mt seen earlier (Nandy, 2021). In 2017/18, the global per capita food use of wheat stood at 66.9 kilograms per year (Shahbandeh, 2020).

Wheat Prices Globally and in Egypt

Despite additional consumption demand, both July/June trade year (TY) imports and TY exports are lowered as global wheat prices continue to remain elevated and the trade pace is slower than anticipated (Andrew Sowell, 2022). Rising global wheat prices hit a 10-year high at US\$523 per ton on March 7 (The Conversation, 2022). Ukraine and Russia account for about 30 per cent of the world's traded wheat and still have crops from last year to ship. "There is no end in sight to the upswing because 30 per cent of the world's wheat exports have been cut off from the global market," said Carsten Fritsch, an analyst at Commerzbank (Terazono & Pooler, 2022). Ukraine Invasion Threatens Global Wheat Supply where Russia and Ukraine together supply more than a quarter of the world's wheat and coming disruptions could fuel higher food prices and social unrest (Swanson, 2022).

Wheat In Egypt

Wheat occupies about 33% of the total winter crop area in Egypt and is the major staple crop, consumed mainly as bread (Sharaf, 2008). More than one-third of the daily caloric intake of Egyptian consumers and 45% of their total daily protein consumption is derived from wheat (Sharaf, 2008). The fragile state of Egypt's food security stems from the agricultural sector's inability to produce enough cereal grains, especially wheat, and oilseeds to meet even half of the country's domestic demand (Tanchum, 2022). Cairo relies on large

volumes of heavily subsidized imports to ensure sufficient as well as affordable supplies of bread and vegetable oil for its 105 million citizens. Securing those supplies has led Egypt to become the world's largest importer of wheat (Tanchum, 2022). In 2021, Cairo was already facing down food inflation levels not seen since the Arab Spring civil (Tanchum, 2022).

Egypt's massive wheat imports are driven by the widespread consumption of the traditional round flatbread known as eish baladi (Tanchum, 2022). Egyptians consume 150-180 kilograms of bread per capita, more than double the global average of 70-80 kg (Tanchum, 2022). Keeping the price of Egypt's staple food affordable has been the bedrock of regime stability since the Free Officers revolution brought then-President Gamal Abdel Nasser to power 60 years ago, then Nasser's successor acceded to World Bank and International Monetary Fund (IMF)-mandated subsidy cuts on wheat flour, cooking oil, and other staples, it triggered Egypt's infamous 1977 "bread riots" (Tanchum, 2022). Now Egypt again is facing a severe wheat shortfall amid soaring prices (Tanchum, 2022). According to estimates from the United States Department of Agriculture (USDA), Egypt's wheat production in marketing year (MY) 2021/22 will reach 9.0 million metric tons (MMT) while its consumption will total 21.3 MMT, leaving a 12.3 MMT shortfall to be made up with imports (Tanchum, 2022). Even prior to Russia's invasion of Ukraine, the prices for those imports were at record levels (Tanchum, 2022).

As detailed in a previous Middle East Institute publication, the global average price for cereal grains increased 27.3% in September 2021 compared to September of the previous year and since then it has continued to climb at an even faster rate (Tanchum, 2022). The price of soft wheat used in bread manufacture stood at \$271 per ton at the end of the third quarter of 2021, a 22% year-on-year increase (Tanchum, 2022).

Egypt's Local Production & Imports

FAS Cairo (Post) forecasts Egypt's wheat production in the marketing year (MY) 2022/23 (July – June) to reach 9.8 million metric tons (MMT), up by 8.9 percent compared to 9 MMT in MY 2021/22 (USDA, 2022). In 2022 cultivated area of wheat has reached about 3.6 million acres, with more than 10 million tons of production (Egypt Today, 2022).

Post attributes the rise to an increase in total area harvested which is set to come in at 1.53 million hectares (HA) compared to 1.4 million HA the previous year (USDA, 2022). The latest US Department of Agriculture forecast (March 28, 2022) suggests that Egypt's imports in 2022 will be down

by 8.3% i.e., by around 1 million tones, which is more than one month of the consumer under the Egyptian Bread Subsidy Program (eric-schroeder, 2022).

Market Year	Imports	Unit of Measure	Growth Rate
2018	12354	(1000 MT)	-0.43%
2019	12811	(1000 MT)	3.70%
2020	12149	(1000 MT)	-5.17%
2021	12000	(1000 MT)	-1.23%
2022	11000	(1000 MT)	-8.33%

Figure 1 Egypt Wheats Import YOY (indexmundi.com, 2022)

Egypt's Wheat Industry

There are two main sources of wheat in Egypt Domestic wheat & imported wheat. Egypt produces half of the 20 million tons of wheat that it consumes with irrigation and imports the other half (Senthold Asseng, 2018). Egypt is also the world's largest importer of wheat. The population of Egypt is currently growing at 1.9% - 2.2% annually, and projections indicate that the demand for wheat will triple by the end of the century (Senthold Asseng, 2018). In Egypt, the wheat season for the supply of local wheat took place in April 2022.

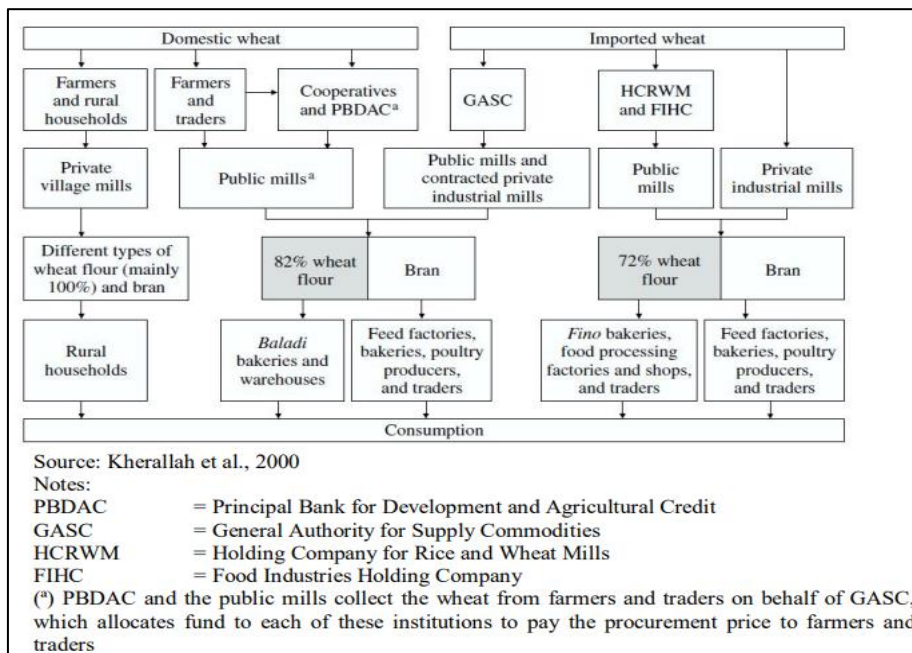


Figure 2 Structure & Marketing Channels for wheat sector (ElAsraag, 2015)

The domestic wheat industry provides an important contribution to employment and value-added in the agrifood sector (AGRIS, 2015).

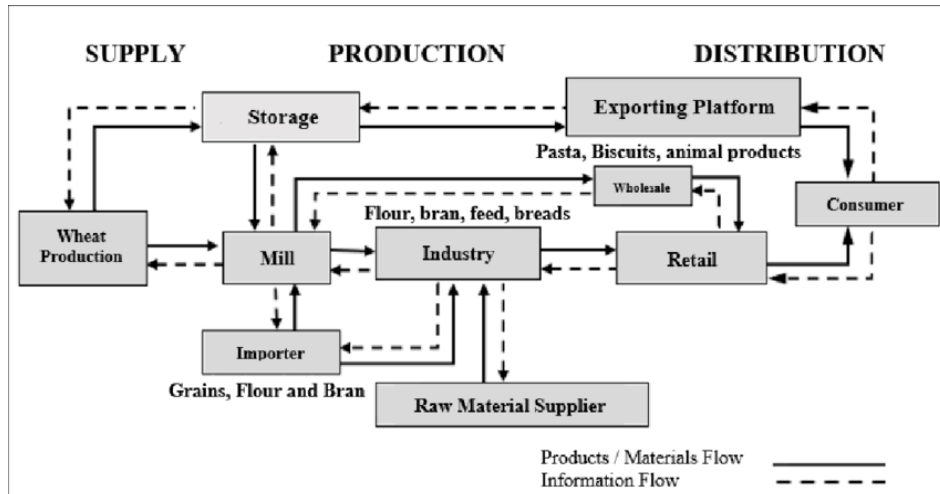


Figure 3 -Wheat Supply Chain Source (Oliveira, Araújo, & Silva, 2020)

At the same time, assuring access to this important staple food by all Egyptian citizens, a quarter of whom live under the poverty line, has also been a central aspect of the country's social policies (AGRIS, 2015). The strategic importance of the wheat sector has resulted in a strong involvement of the State at all levels of the wheat value chain (FAO & European Bank, 2015). The private grain trading and storage enterprises lack representation through existing industry chambers, which limits effective dialogue between the private sector and the government (FAO & European Bank, 2015).

It is critical to address these barriers to the more active involvement of the private sector if a more sustainable and efficient wheat sector is to emerge in Egypt (FAO & European Bank, 2015). Private industry became a major player in the wheat market in Egypt during the past five years, gaining more market share every year in the wheat trade. Wheat has many substitutes like quinoa, Corn flour, millet..etc. and for manufacturers, food and industrial scientists, the malleability and unstable identity of wheat is what they value about it (Jennifer Atchison, 2009). It is easy to hide (Jennifer Atchison, 2009). Its capacity to be broken down as different constituent parts, and recrafted into other things is fundamental (Jennifer Atchison, 2009).

Egypt's Agriculture Market Overview

Agriculture in Egypt market is projected to grow at a CAGR of 3.2% during the forecast period (2022-2027) (Mordor Intelligence , 2022). During the

pandemic, agriculture stood out to be the most resilient sector (CLEMENS BREISINGER, 2020). Impacts on Egypt's agri-food system were less severe than elsewhere in the economy and most damages were in nonfarm components of the agri-food system due to falling consumer demand (Mordor Intellegence , 2022). The government made investments and reforms in the food system in Egypt, with the country's food sector managing to address the effects of the coronavirus (COVID-19) pandemic (Mordor Intellegence , 2022).

Agriculture is a major component of the Egyptian economy, contributing 11.3 percent of the country's gross domestic product (USAID, Middle East , Egypt, 2022). The agricultural sector accounts for 28 percent of all jobs, and over 55 percent of employment in Upper Egypt is agriculture-related (USAID, Middle East , Egypt, 2022). Egypt's agriculture sector is dominated by small farms using traditional practices that do not meet international standards (USAID, Middle East , Egypt, 2022).

Egypt aims to increase the gross domestic product (GDP) contribution of its agriculture sector to 12 percent by 2024, in addition to increasing agricultural production by 30 percent by 2024, according to the Minister of Planning and Economic Development (Egypt Today Staff, 2021). An increasing number of projects to ensure food security, government initiatives to boost domestic production, and focus on sustainable and green farming are the factors driving the market (Mordor Intellegence , 2022).

The Ministry of Agriculture and Land Reclamation (MALR) lead the 2020 to 2023 Agricultural Innovation Project (AIP) (Mordor Intellegence , 2022). The initiative aims to promote innovations in technologies to improve several issues in agriculture such as inefficient farming techniques that lower farm output and food production, poor post-harvest facilities, and marketing infrastructure (Mordor Intellegence , 2022). The focus on creating innovative solutions would increase income for small-scale farmers in the country (Mordor Intellegence , 2022).Some of the major crops grown in Egypt include Sugrabeet, Sugarcane, Wheat, Maize, Rice, Tomato, Potato, Onion, Orange, Grapes, and Dates among others (Mordor Intellegence , 2022).

Egypt's Wheat Key Market Trends

Agriculture is a vital component of the Egyptian economy. The government has increased its support for the development of the agricultural sector by launching several campaigns and initiatives.

- *Shari:*

As part of the International Fund for Agricultural Development (IFAD's) rapid response during the pandemic, under the PRIDE project, the Egyptian government developed an e-marketing platform called "SHARI" which allowed smallholder farmers to market and sell their products online to reduce the risks of exposure and also secure markets for them in case of lockdown and movement restrictions (Samar Samir, 2021).

1. Digital Platforms:

The government also aims to introduce new solutions such as market linkages for smallholders that are fostered by improving their competitiveness in the value chain, facilitating roundtables, and developing out-grower schemes and public-private partnerships, etc. to boost production. For instance, in 2019, the Food and Agriculture Organization (FAO) and the Egyptian government launched a program to enhance agricultural productivity through digital technology (FAO- News Egypt, 2019). Implementation of digital technology helps farmers access information to better manage crops and livestock and thus help them make better agricultural decisions (FAO- News Egypt, 2019).

2. Mobile Irrigation Application:

New app allows Egypt's farmers to save water, boost crops through Mobile Irrigation Application (REUTER, 2021). The system, developed by the Ministry of Water Resources and Irrigation and Cairo's MSA University, uses a sensor buried in the soil to measure moisture levels and a transmitter to send the data to the user, who accesses it through a mobile app (REUTER, 2021).

3. Regional Trainings & Rural Agribusiness Strengthening program

Further, the government launched a campaign to boost wheat production in 2017 with the main objective of increasing grain crop productivity per unit area (Feddans) by 15% in three years (2015-2017), to increase grain crop productivity by 18.5 ardebs per acre to about 20 ardebs per Feddans, thus increasing the total production (Mordor Intellegence , 2022).

Meanwhile to build capacity in the private sector, USAID established a regional training center to increase and improve the productivity of farmers, Labour's, packhouse managers, and buyers (Mordor Intellegence , 2022). This program contributes to rural income growth, poverty reduction, food security, and nutrition in Egypt (USAID, Middle East , Egypt, 2022). This is further likely to strengthen the importance of agriculture in Egypt (USAID, Middle East , Egypt, 2022).

4. *Horizontal Expansion*

In 2022, almost 240 feddans have been added to the wheat-cultivating plot in Egypt as a result of expansion, consequently wheat is grown on 3.6 Million feddans across the country, which will increase the grain supply to silos and storages to more than 10 million tons (AbdeulKarim, 2022). The Egyptian government has completed recent studies that it conducted to identify the obstacles to cultivating the wheat crop, which Egypt needs in huge quantities during the coming summer, as part of a state plan to add 1.5 million acres of new wheat within 3 years, by encouraging its cultivation and reclamation of new quantities of land and cultivation in quantities of wheat (Sky News Arabia, 2022).

5. *Vertical Expansion*

The government is applying policies aimed to expand wheat cultivation and raise productivity per feddan [1.04 acres] within the scope of Egypt's Vision 2030. These policies have already begun to bear fruit, as the area planted with wheat increased by 260,000 feddans [270,000 acres] this year to reach 3,654,000 feddans [3.8 million acres] (AlMonitor, 2022). This vertical expansion by maximizing productivity per feddan using new varieties of wheat (22 types) with high productivity and disease resistance, in addition to an increase in productivity per acre by using and developing new varieties that are resistant to drought, insects, and salinity" (AlMonitor, 2022).

Egypt has 3 million and 600,000 acres, and that the productivity of these lands can be increased, by paying attention to developing new strains, and maintaining the health of leaves and plants, especially during the month of March and April, when the plant is exposed to diseases such as yellow rust (Akhbar ElYoum, 2022). It is also mentioned nessecary of using good fertilizers, taking into account irrigation dates, while not using nitrogen fertilizers after the stage of subtracting the ears, while planting new varieties of wheat strains, especially disease-resistant and higher productivity, to increase the average production acre in Egypt (Akhbar ElYoum, 2022).Egypt's total quantities exported from the agricultural sector recorded about 3.971 million metric tons during the period from September 2020 to June 2021, compared to 3.755 million metric tons during the same period from 2019/2020, with a growth of 5.7 per cent (Mordor Intellegence , 2022).

The country's "Sustainable Development Strategy toward 2030" focuses on increasing self-sufficiency concerning agricultural products to make the most of the water and land resources sustainably (AlMonitor, 2022). Thereby creating additional demand for Egyptian produce. Most of Egypt's exports are

destined for the EU, Russia, North Africa, and the Middle East (AlMonitor, 2022).

Egypt's wheat Market Segmentation

Multi-market models fall short of the complexity of GCSEs but do include direct and indirect effects in a small number of markets (Sadoulet & De Janvry, 1995). In that sense, they are an improvement over single market partial equilibrium analysis (Sadoulet & De Janvry, 1995). They typically consist of a producer and consumer core and allow for the analysis of the impact of price and non-price policies on production, factor use, prices (for non-tradable), incomes, consumption, government revenues and expenditures and balance of trade (Sadoulet & De Janvry, 1995).

The analysis focuses on those markets which are assumed to be strongly interlinked, either on the demand or the supply side (Sadoulet & De Janvry, 1995). Prices in those markets included in the analysis are endogenous (Sadoulet & De Janvry, 1995). The bias in estimating welfare changes as a result of policy reforms is diminished but remains. It follows that multi-market (Sadoulet & De Janvry, 1995).

Egypt's Wheat Consumption

FAS Cairo forecasts Egypt's wheat consumption in MY 2022/23 at 20 MMT, down by 2.43 percent from the MY 2021/22 estimate of 20.5 MMT. Post attributes the decrease to a 2.6 percent decrease in food, seed, and industrial use (FSI) consumption. The decrease in FSI wheat consumption is attributed to an increase in the price of European and white flat bread (non-subsidized) (USDA, 2022). Consumption in 2021-22 is put at 21.3 million tonnes, up from 20.8 million estimated in 2020-21 (Lyddon, 2021). The report gives the reason as increasing population, currently 102 million and expected to reach 119.8 million by 2030 (Lyddon, 2021). According to the Egyptian Ministry of Supply, domestic wheat production reached 9 million tons last year which was 8.9 million tons the year before (BBM, 2022).

It is certain that in a country the size of Egypt, which is quite dependent on wheat products, domestic production cannot be sufficient, resulting in huge investments in wheat imports. It is estimated that Egypt's wheat imports for 2021 reached 13 million tons (BBM, 2022). In 2020, this figure was 12.5 million tons. Russia is the main wheat supplier to Egypt. Another top client for Russia is Turkey (BBM, 2022).. Turkey and Egypt generally race to the top in Russia's wheat export (BBM, 2022). In addition to imports made directly by the private sector, wheat imported by Egypt is purchased through tenders

opened by the General Authority for Supply Commodities (GASC) which works under the Ministry of Supply and Internal Trade (BBM, 2022).

Wheat is imported from different countries, especially Russia, Romania, and Ukraine. On the other hand, while the Egyptian government is trying to reduce imports by regaining agricultural lands and increasing domestic production, it also plans to allocate an additional 4 million hectares for wheat cultivation in the next 3 years (BBM, 2022). The government is also increasing strategic storage capacity with the National Project of Grain Silos (BBM, 2022). The project aims to build new silos with a storage capacity of 1.5 million tons in 17 cities across Egypt (BBM, 2022). As a result, the total storage capacity of the silos in Egypt will reach approximately 3.6 million tons (BBM, 2022).

During the 2021 wheat procurement season, running from 15 April to 15 July, the Ministry of Supply and Internal Trade purchased about 3.428 million tonnes of local wheat, lagging the target of 3.6 million tonnes, and slightly less than 3.483 million tonnes purchased in 2020 (GIEWS Country Brief: Egypt , 2021). Depending on quality and moisture levels, the 2021 procurement prices ranged from EGP 705 to EGP 725 per ardeb (150 kg, corresponding to USD 298 to USD 307 per tonne), up from EGP 670 to EGP 700 (USD 284 to USD 297 per tonne) in 2020 (GIEWS Country Brief: Egypt , 2021).

The procurement prices are derived from a moving average of prices paid for imported wheat in the previous two months (GIEWS Country Brief: Egypt , 2021). The government aims to increase the country's self-sufficiency from about 50 percent in 2020 to 65 percent in 2025 (GIEWS Country Brief: Egypt , 2021). While increases in planted area (from 3.4 to 3.7 million feddans) as well as increases in average yields (from 2.7 to 3 tonnes per feddan) using improved seeds and better cropping practices are foreseen, a crucial part rests on lowering average per capita consumption from over 180 kg to 150 kg. In 2020, the weight of a subsidized bread was unified from 100 to 110 grams to 90 grams, resulting in a decline of wheat used for production of subsidized bread from 9.6 million to 8.76 million tonnes (GIEWS Country Brief: Egypt , 2021).

The key staple food crop in Egypt occupies about 33 percent of the total winter crop area, accounts for 9 percent of water resources and contributes 17 percent of the total value added in Egyptian agriculture (European Bank for Reconstruction and Development is an international financial institution, 2015). Consumed mainly as bread it provides, on average, one-third of the daily caloric intake of consumers and 34 percent of their total daily protein consumption (Wheat sector review, 2015).

Bread Prices in Egypt are Fixed for 30 Year

In Egypt, wheat is distributed between flour mills and pasta factories. Most of the wheat goes to flour mills and is used to produce different types of flour, mainly for making the subsidized Baladi bread. There are more than 410 flour mills in Egypt (BBM, 2022). Bread is very important in Egyptian cuisine (BBM, 2022). The Egyptians use the word "Aish" for bread, which means "life".

The bread subsidy system remains unchanged: Egypt allocates 150 loaves of subsidized bread per month to recipients (i.e., five loaves of bread per day) (USDA, 2022). Baladi (i.e., common, traditional) bread is sold at a subsidized price of EGP 0.05 per loaf (\$0.01 per loaf), this is less than one tenth of the actual cost (USDA, 2022). The government compensates bakeries for the difference in production cost (USDA, 2022). The current cost of subsidizing one loaf of baladi bread is EGP 0.60 (\$0.03) (USDA, 2022). The current subsidy system permits beneficiaries who consume less than the quota amount to convert their bread savings into points (1 point = EGP 0.01) (USDA, 2022).

In fiscal year (FY) 2021/22 (June – July), the government allocated EGP 87 billion (\$5.5 billion) for bread and food subsidies (Figure 2) (USDA, 2022). Of this amount, roughly EGP 51 billion (\$3.2 billion) is earmarked for the bread subsidy program (USDA, 2022). In the country, 270 million pieces of bread are produced daily in more than 30 thousand bakeries (BBM, 2022). The annual cost of the bread subsidy to the government is 45 billion Egyptian pounds (BBM, 2022). More than 70 million Egyptians hold smart cards which enable them to buy five loaves of bread daily (BBM, 2022).

All procedures are put into practice to ensure that Baladi bread prices remain unchanged. Indeed, bread prices in Egypt have remained unchanged for the past 30 years, making the price of this bread the cheapest in the world (BBM, 2022). According to the Egyptian Grain Industry, the amount of subsidized flour used for Baladi bread amounts to 8-9 million tons per year (BBM, 2022). Currently, 30,000 bakeries produce from 250 million to 270 million subsidized loaves of bread each day (USDA, 2022). The per capita share of subsidized municipal bread increased by almost 28.6 percent, reaching 3.6 loaves per day in 2021, compared to 2.8 loaves per day in 2019 (USDA, 2022).

On the Global front, the average price for cereal grains increased 27.3% in September 2021 compared to September of the previous year and since then it has continued to climb at an even faster rate (Tanchum, 2022). The price of soft wheat used in bread manufacture stood at \$271 per ton at the end of the third quarter of 2021, a 22% year-on-year increase (Tanchum, 2022). The price in the fourth quarter of 2021 shot up further as global inventories fell after experienced crop damage due to droughts, frost, and heavy rain (Tanchum,

2022). As of March 3, 2022, just seven days into Russia's Ukraine invasion, the end of day settlement price for the March 2022 soft wheat contract on the Chicago Board of Trade stood at nearly \$389 per ton (Tanchum, 2022).

With Russia being the world's largest wheat exporter and Ukraine the fifth largest, accounting for a combined total of 30% of global wheat exports, prices are likely to remain elevated and the cost for Egypt goes beyond just the import price at 10% increase over the previous year where Egypt's new wheat purchases and subsidies will now become an even greater fiscal burden for the treasury to bear (Tanchum, 2022).

COVID-19 Effect on the Egyptian Grain Market

The outbreak of COVID-19 disease shows vulnerability of the supply chains when unexpected events take place (Markopoulos, 2022). Applying measures against COVID-19 the global economy faced a shock after (practically) stopping the flows of goods; it is obvious that the world is possible to face shortages in the markets even if there are no actual problems to the food production (Markopoulos, 2022). The pandemic has caused strong fluctuations and increases in price due to restrictions and shipping restraints (BBM, 2022).

Grain prices are quite high around the world (BBM, 2022). The impact of Covid-19 on the grain market has been deep and prices are higher compared to the same period last year (BBM, 2022). The demand for wheat flour in the country was very high in 2020, along with the effect of the pandemic, it increased by 28% compared to 2019 with a sales value of 465 million EGP (Egyptian Pound) (BBM, 2022).

Egypt's Wheat Trade & Russian -Ukraine War

The Russian–Ukrainian conflict has disrupted the flow of wheat from the Black Sea and caused great ambiguity in the global wheat trade (USDA, 2022). As the war between Russia and Ukraine is causing major disruptions of wheat supplies, Egypt is not isolated from these catastrophic events, which is already affecting its imports of wheat from both countries (USDA, 2022). Accordingly, FAS Cairo forecasts Egypt's wheat imports in MY 2022/23 (July – June) at 11 MMT, down by 9.1 percent from Post's MY 2021/22 import estimate figure of 12 MMT (USDA, 2022).

Egypt's imports of wheat over the last five years amounted to 62.6 MMT, with 59.7 percent from Russia and 22.3 percent from Ukraine (82 percent combined), both major suppliers to the Egyptian market (USDA, 2022). As of the last quarter in CY 2021, wheat prices increased by an average of \$100/MT. This meant an additional cost to the

government budget allocated for the importation of wheat for the bread subsidy program in the current fiscal year ending in June 2022 (USDA, 2022). Total wheat imports during the first two and a half months of CY 2022 amounted to 1.78 MMT (USDA, 2022).

Domestic Wheat Procurement:

Wheat procurement season is set to start on April 1, 2022, instead of April 15, and will last until the end of August instead of mid-July (USDA, 2022). FAS Cairo foresees Egypt in MY 2022/23 (July-June) procuring some 5 to 5.5 MMT of locally produced wheat (USDA, 2022). The amount of locally produced wheat purchased by the government of Egypt was 3.5 MMT in calendar year (CY) 2020 and 3.6 MMT in CY 2022 (USDA, 2022).

Factors Affecting Wheat Supply

Water Footprints

Water Shortage: The Nile River is the primary source of water flows to Egypt on a fixed quantity at around 55.5 BCM by an agreement with Sudan in 1959, representing 85% of the country's renewable water resources (Ali, 2019). Egypt maximizes its water supply from the Nile River by recycling the agricultural drainage water that provided an additional 11.9 BCM in 2016 (Ali, 2019). This is added to another sources of water. Environmental challenges in growing wheat and a water intensive crop both present major challenges for Egypt. As a result, low levels of arable land, growing populations and climate changes are placing more stress on critical resources such as water supply.

Water Disputes: Ethiopia plans to increase its energy production through its Nile-powered Grand Ethiopian Renaissance Dam (GERD) (Essam Heggy & Abotalib, 2022). While the 74-billion cubic meter (BCM) dam presents promising development opportunities for Ethiopia, the Nile's altered flow will increase the existing water deficit for Egypt—the quantification and mitigation of which are still largely unconstrained and under intense debate (Essam Heggy & Abotalib, 2022).

Water Pollution: Pollutants existing in the drainage system from fertilizers and pesticides used in agriculture can cause increases the water salinity, where it causes a reduction in yield (Ali, 2019). In addition, there is numerous pollution sources which include untreated and semi-treated industrial wastewater, sewage water, agricultural drainage water, and solid-liquid waste from Nile cruise activities (Ali, 2019).

Energy Footprints:

Desalination is the most energy-intensive water treatment process that consumes 75.2 TW h per year, about 0.4% of global electricity and 76 million ton of carbon emission (El-Hady, et al., 2021). In Egypt, the energy utilized for the desalination processes may come from many sources such as conventional fossil fuels, windmills, solar plants, and electricity grids. Not all areas that need desalination have access to electricity grid on regular basis (El-Hady, et al., 2021). Thus, the need for alternative energy resources is essential for direct community needs and for driving the desalination processes (El-Hady, et al., 2021).

This situation is expected to be exacerbated in the near future as 60 percent more food will need to be produced in order to feed the world population in 2050 (Olivier Dubois, 2014). Global energy consumption is projected to grow by up to 50 percent by 2035 (Olivier Dubois, 2014). Total global water withdrawals for irrigation are projected to increase by 10 percent by 2050 (Olivier Dubois, 2014).

Inputs to Wheat Production

Egypt has many inefficiencies in the value chain of wheat that can be classified as those controlled by the government (Wheat Storage / distribution, Technology, Water Waste and Country Economic and Political Status) and those uncontrolled by the government (Climate Change).

Climate Change: Agriculture consumes approximately 86% of total water resources in Egypt (Omar, Moussa, & Hinkelmann, 2021). Climate change in Egypt would decrease crop yields for most crops, with wheat yields expected to be reduced by up to 9% in 2030 and by close to 20% in 2060, which means that climate change would significantly affect the Nile River flow in Egypt that have an inverse relationship with the water salinity in the delta region, where such reduction in the Nile River flow would reduce the average self-sufficiency of strategic crops, net agricultural productivity, consumer-producer surplus and increase the number of laborers who lose their daily part-time income (Omar, Moussa, & Hinkelmann, 2021).

Technology (R&D): Adopting digital tools, including AI, represented in some efforts through collaborations between the Ministry of Agriculture and MCIT that cover automating land agriculture possession, farmer smart cards, crop recognition through satellite and AI, smart assistants to farmers, digitalizing agriculture documents, and creating electronic archiving (kamal, 2021). This

is in addition to transitioning to more modern irrigation systems. Also using AI to analyze weather and soil conditions, temperature, and water usage to help farmers optimize planning to generate higher yields by identifying the best crop choices and how to maximize the use of available resources (kamal, 2021). Other AI solutions can help cut costs while significantly increasing harvest yield and quality by deploying remote sensing, cloud computing, and using simulation modeling (kamal, 2021).

Using the nascent technology of cellular agriculture has the potential of achieving a green and sustainable economy while contributing to food security and encouraging localized production; leading to less land and water used and a feed-free approach with expected cost reduction and fewer carbon emissions. Also providing Small farmers, using traditional agricultural practices whom represent 80 percent of the farmers, with simple digital and connectivity tools can still offer a wide range of opportunities, including using mobile phones to educate, inform, and empower them and help them change the way they work by getting access to crucial information through mobile Internet as well as the use of sensors that enable real-time data collection on the pricing of goods at the local level, weather alerts, and the efficient management of resources and the applications of the IoT to enable smart agriculture, such as irrigation systems and value chain management (kamal, 2021).

However, Egypt is facing lack of sufficient incentives to invest in water-conserving technology, small budget allocation for research and development and lack of coordination the different stakeholders, and institutional framework underpinning it (kamal, 2021).

Storage: Egypt suffers from the destruction of very large quantities of wheat due to lack of proper storage. Classification of silos by building type are Concrete silos (cement), Metal silos and Horizontal silos whether owned by Public or private sector. On-farm wheat storage is quite common. Almost all wheat farmers use their own house to store their wheat (the exception is the Frontier, where most farmers do not have wheat storage capacity) because farmers very rarely rent storage space (Kherallah, Minot, & Gruhn).

The average quantity of wheat in storage is very seasonal; it reaches a peak after harvest in April/May at about 1.1 to 1.4 mt and declines gradually down to 150 kgs just before the next harvest season of the following year. Most of the wheat (86%) is stored for consumption throughout the year rather than for sale (Kherallah, Minot, & Gruhn).

Expectations: Expecting a decrease in water availability in the coming years may discourage the growth of wheat production. Also, local currency exchange

rate instability and other internal and external political factors are strongly affecting our ability to import required quantities, accordingly, promotion of economic integration with other countries and adopting new strategies across different fronts is mandatory.

Producers & Procurement Prices: Egyptian wheat production is based on small-scale farms, yet these farms are highly commercialized. Wheat yields are high because of the intensive use of labor, fertilizer, and irrigation. Cooperatives continue to play an important role in seed distribution, but private traders have come to dominate wheat marketing and the distribution of agricultural chemicals.

A recurring question among policy makers is why such a small portion of national production is available for purchase by the government. Results suggest that most of the wheat produced is consumed in the rural areas. Half is retained by wheat farmer households, 29–32% is purchased by the government, and the remainder is consumed by non-wheat-farming rural households and, to a lesser extent, wheat farmers who are net buyers. Wheat farmers sell two thirds of their marketed surplus to traders rather than to cooperatives, mills, and village banks that channel wheat directly to the government due to prices and location, where traders pay prices at least as good as other buyers (Kherallah, Minot, & Gruhn).

Government of Egypt would have to increase the procurement price substantially above international prices (Kherallah M. &, 2000). When procurement prices are above international prices, as they currently are, the government incurs the budgetary costs of subsidizing its wheat producers (Kherallah, Minot, & Gruhn). Increasing the incentive for farmers to sell the wheat they have set aside for home consumption will encourage them to purchase more subsidized flour and bread, resulting in higher costs to the consumer subsidy system (Kherallah M. &, 2000).

This finding supports conclusions of an analysis by Lofgren and Kherallah (1998) (Kherallah, Minot, & Gruhn). They found that raising the wheat self-sufficiency rate from 47% to 60 or 70% through higher producer prices would involve increased subsidy costs of LE 1.5 billion and LE 3.3 billion (0.7 and 1.6% of GDP) respectively resulting in difficulty in achieving wheat self-sufficiency through price policy alone (Kherallah, Minot, & Gruhn).

Following the supply law which expresses a correlation between the price of the commodity and the quantity offered, as producers offer greater quantities of the commodity when the price increases, and lower quantities when the price falls, it is mandatory for farmers to know the price of wheat as earlier

as possible whereas the date of the announcement of the price of wheat has a fundamental impact on the volume of its production.

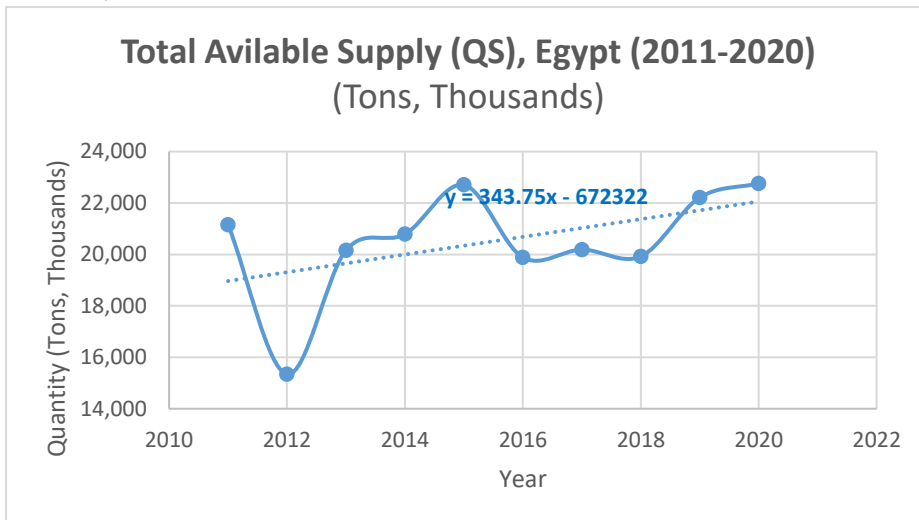


Figure 5: Total Available Supply (Qs) - Tons, Thousands

The supply elasticity of about 0.3 is in line with our regional time-series estimates from Egypt not reported in this paper (see Kherallah et al., 1999). It is also consistent with estimates from other developing countries (see Scandizzo & Bruce, 1980). Thus a 10% increase in the price of wheat would induce farmers to expand output by 3%. This suggests that farmers will react favorably to real and relative increases in rural wheat prices.

A statistical estimate of the costs functions of the wheat crop and deriving some economic indicators, including Agricultural costs include fixed costs and variable costs, and the fixed costs reflect the value of the fixed factors of production which does not change by the change of production volume, while variable costs are those which their value changes by the change of the volume of production and include the costs of agricultural processes on the crop as well as the costs of the production factors required to complete cultivation.

Studying the variable costs in the study sample and comparing them with their counterparts at the level of Governorate and the country's level, they have reached about 2911 pounds, for a return of about 2921 and about 2712, respectively. The study of these costs as distributed on the most important items of wheat, as for the costs of seeds, they have amounted to about 175 pounds per feddan in the study area in exchange for about 240 pounds and 292 pounds for El Beheira Governorate and the country's level by about 5.9%, 8.2%

and 10.8 %, respectively. For irrigation costs, they have amounted to about 185 pounds in comparison with 360 pounds and 298 pounds on the three levels in the same order, each representing about 6.3 %, 12.3% and 0.11 %, respectively. The costs of chemical fertilizer have reached about 1139 pounds per acre in the study sample in comparison with about 605 pounds and 0.633 pounds, respectively, by about 39.1%, 20.7 % and 23.3 %, respectively.

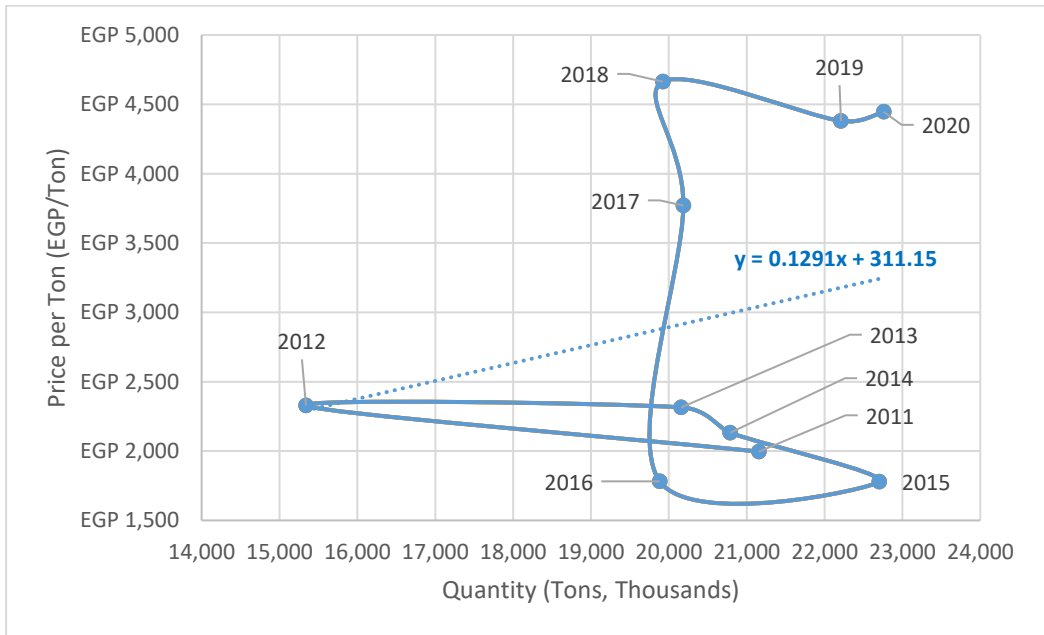


Figure 6: Wheat Supply Curve, Egypt (2011-2020)

Strategies Affecting Wheat Supply

Increasing wheat supply from domestic sources can be achieved through one or more of the following options: (1) increasing wheat area, (2) raising productivity per unit area, and (3) reducing food loss and wastage (Yigezu, et al., 2021). The first option is neither practical nor sustainable any effort towards area expansion in MENA has substantial environmental and natural resource implications (Yigezu, et al., 2021). The second option, increasing productivity through sustainable intensification, is feasible and desirable (Yigezu, et al., 2021).

This strategy has achieved its objective of increasing the global food supply, however food insecurity remains a major challenge in many parts of the world, including MENA and will not be sufficient to meet the food demand of a growing world population (Yigezu, et al., 2021). The third option is incredibly neglected but strategically crucial because one-third of the global food

production, which is equivalent to 1.3 billion tons, is lost or wasted every year (Yigezu, et al., 2021). Therefore, dealing with the growing challenge of food insecurity requires the development of effective.

To meet the projected population growth. Egypt has adopted the strategy of decreasing the gap between production and consumption through three different avenues: expanding the wheat area into the newly reclaimed lands, increasing grain productivity (vertical expansion), and decreasing wheat losses along the wheat value chain from field to fork (Yigezu, et al., 2021). Egypt achieved good progress in developing new wheat cultivars with high yield potential and developing good agricultural practices to maximize grain yield per unit area, however Expanding wheat areas is limited due to the scarcity of water resources (Yigezu, et al., 2021).

Although the improvement in total production is about four times during the last four decades, there is limited opportunity for further increases due to growing scarcity in water resources which constrains both area expansion and productivity gains (Yigezu, et al., 2021)

Storage factors affect grain supply like moisture, temperature, and humidity of the storage environment like On-Farm Storage, Storage in Shona: (Open-Air Storage), Storage in Silos. Extra loss take place due to Transportation Processing, and Marketing cycle. Other factors responsible for deterioration are poor containers, damage by rodents, insect pests, and microorganisms (Yigezu, et al., 2021).

Economic theory indicates that, in the absence of market failure, the benefits of wheat subsidies to farmers and consumers will be less than the fiscal cost of the subsidy (Kherallah, Minot, & Gruhn). Thus, investment in agricultural research and extension would have a higher return than continued subsidies. Government investment in the development of higher yielding wheat varieties would not only increase wheat production, farmer productivity and farm income, but should also help make more wheat available for the baladi bread and flour subsidy program without increasing per unit subsidy costs.

Factors Affecting Wheat Demand

Number of Buyers

According to Central Agency for Public Mobilization and Statistics (CAPMAS), Egypt population increased from 72.8 million in 2006 to 94.8 million in 2017 (the last census) and increased to 100 million on February 11, 2020, with an increase of 5.2 million from the last census (CAPMAS, 2020). Egypt is facing an annual population increase of approximately 2.6 million. The increase in the population by 1 million was the result of increasing the quantity of consumed wheat by 0.185 million (Khalil, 2020).

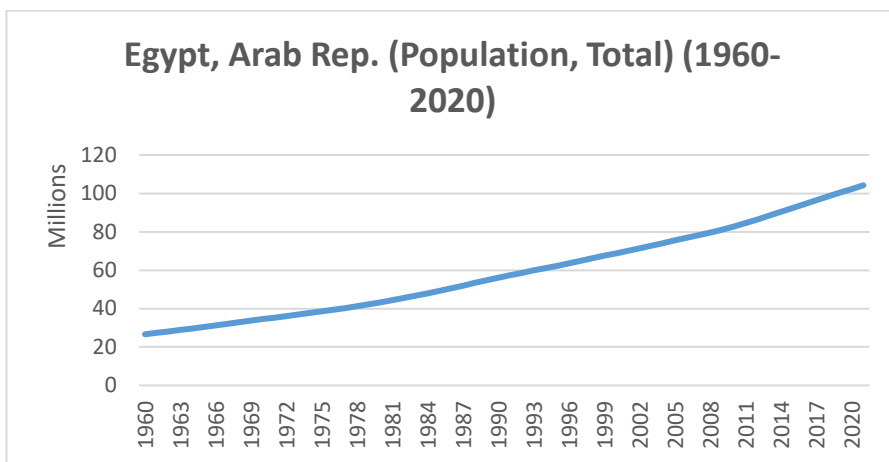


Figure 7: Egypt Population (1960-2020) (Worldbank, 2022)

Subsidies

Egypt has one of the biggest bread subsidy programs, under which more than 60 million Egyptians, get 5 loaves of round bread daily for 50 cents a month (Reuters, 2022). Wheat is a morally necessary commodity for the Egyptian individual, where the extent to which the quantities consumed per capita do not respond quickly to the change in price. However, consumption of wheat is directly proportional related to individual income. The increase in subsidies by 1 billion pounds leads to an increase in the quantity of wheat consumed by 0.059 million tons (Khalil, 2020).

Wheat Price

Wheat is a morally necessary commodity for the Egyptian individual, where the extent to which the quantities consumed per capita do not respond quickly

to the change in price. However, consumption of wheat is directly proportional related to individual income.

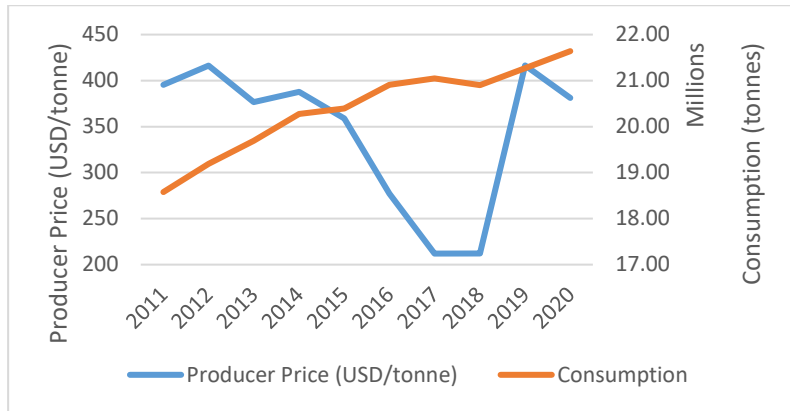


Figure 8: Wheat Price vs Consumption, Egypt (2011-2020) (FAO, 2022)

Household Income

Wheat is a morally necessary commodity for the Egyptian individual, where the extent to which the quantities consumed per capita do not respond quickly to the change in price. However, consumption of wheat is directly proportional related to individual income.

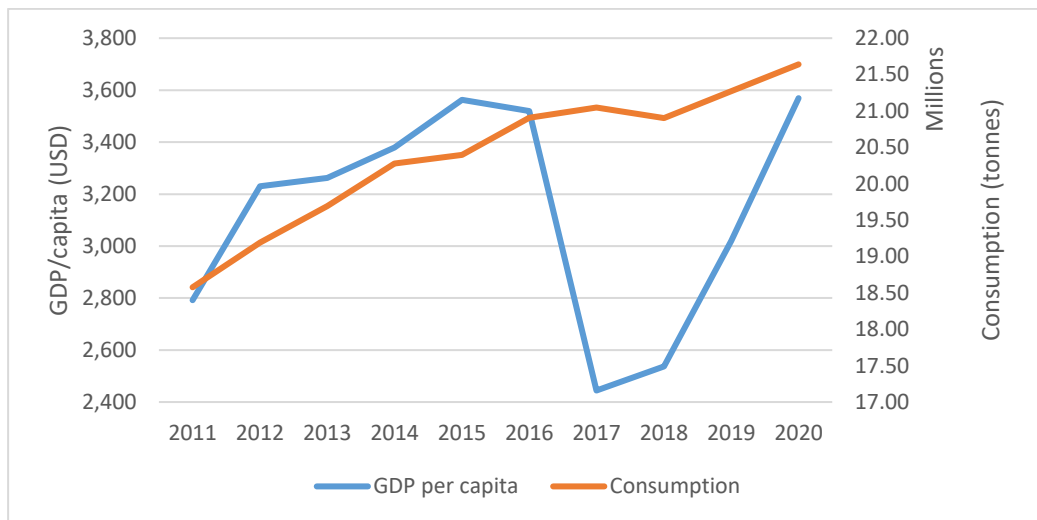


Figure 9: GDP per capita vs Consumption, Egypt (2011-2020) (FAO, 2022)
 (Worldbank, GDP per capita (current US\$) - Egypt, Arab Rep., 2022)

Tastes

Although Wheat is very essential and considered a strategic good still one of the most obvious determinants of demand is consumers' tastes. Tastes are based on historical and psychological forces that are beyond the realm of economics.

Expectations & Preferences

As nutritionists claims regarding wheat saying it may be harmful to the intestine prevents the absorption of food and affects the concentration, which can lead to depression. Consumers' expectations and personal health preferences along the time may affect wheat demand in specific communities. changing consumption patterns where wheat enters the industries of pasta - vermicelli, pancakes, and many foodstuffs in addition to the manufacture of starch, grinding residues are used as feed for animals.

Demand for wheat

Egypt produces half of the 20 million tons of wheat that it consumes with irrigation and imports the other half. Egypt is also the world's largest importer of wheat. The population of Egypt is currently growing at 2.2% annually, and projections indicate that the demand for_wheat will triple by the end of the century. Combining multi-crop and -climate models for different climate change scenarios with recent trends in technology, we estimated that future wheat yield will decline mostly from climate change, despite some yield improvements from new technologies.

The growth stimulus from elevated atmospheric CO₂ will is overtaken by the negative impact of rising temperatures on crop growth and yield. An ongoing program to double the irrigated land area by 2035 in parallel with crop intensification could increase wheat production and make Egypt self-sufficient shortly but would be insufficient after the 2040s, even with modest population growth. Additionally, the demand for irrigation will increase from 6 to 20 billion m³ for the expanded wheat production, but even more, water is needed to account for irrigation efficiency and salt leaching (to a total of up to 29 billion m³). Supplying water for future irrigation and producing sufficient grain will remain challenges for Egypt.

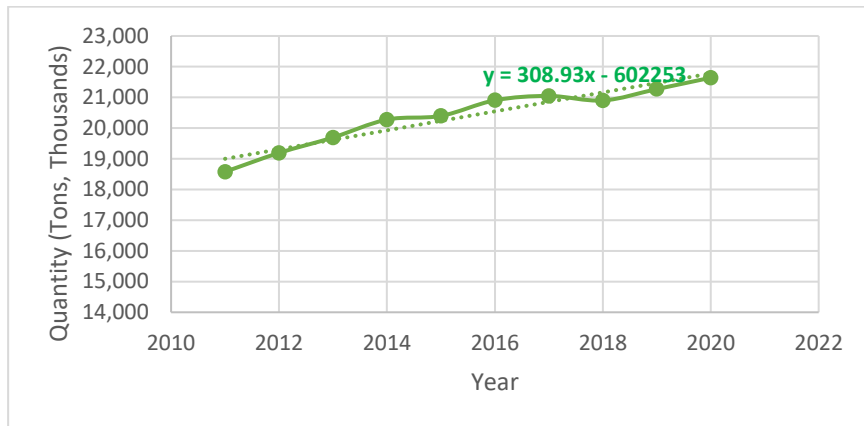


Figure 10: Total Quantity Demanded (Qd) - Tons, Thousands

Consequently, to ensure food security and fulfil the domestic wheat demand Egyptian government relies heavily on imported wheat. The wheat subsidy, population pressure and lower domestic production are the reasons for high wheat import in Egypt, Egypt is one of the largest wheat importers in the world and imports over half of its total wheat consumption. Egyptian wheat imports declined during 2019-20 to 12.68 million tonnes from 13.3 million a year before. The wheat import decreased due to a rise in domestic wheat production during 2019-20, wheat production increased from 8.77 to 8.9 million tonnes in 2019-2020, compared to 2018- 2019. The aggregate domestic wheat consumption in Egypt rose from 20.3 million tonnes to 20.8 million tonnes from 2020-to 21, which is due to high population growth.

Main findings indicate that the Russian Federation, Ukraine, and the United States of America represent the largest wheat exporters to Egypt, with export quantities amounting to 6.51, 2.13 and 0.219 million tons in 2017, respectively, indicating that wheat imports from the three countries accounted for 73.67% of Egypt's total wheat imports during 2017, estimated at 12.025 million tons. On the other hand, Argentina, Brazil and the USA represent the largest corn exporters to Egypt, with export quantities amounting to 2.64, 2.11 and 0.257 million tons in 2017, respectively, indicating that corn imports from the three countries accounted for 56.85% of Egypt's total corn imports during 2017, estimated at 8.807 million tons (Foreign Trade Database, Foreign Trade, 2017).

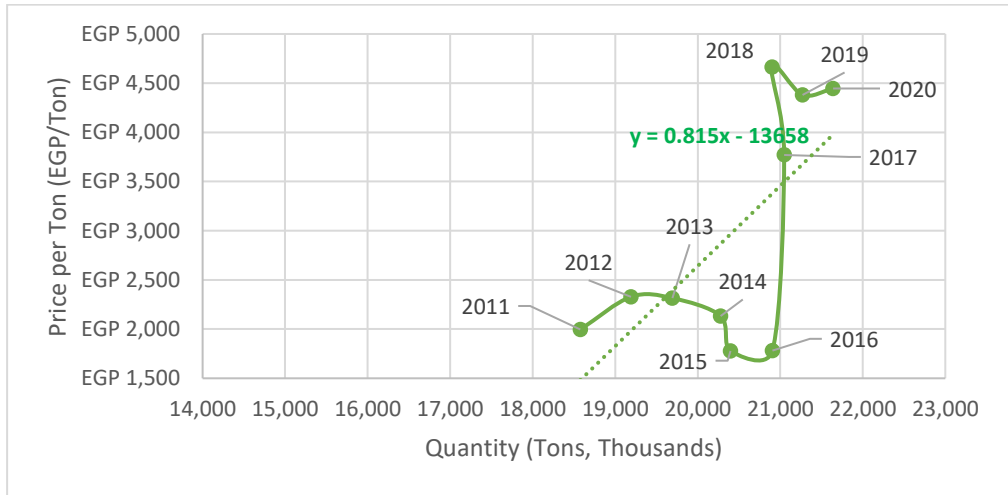


Figure 4: Wheat Demand Curve, Egypt (2011-2020)

Wheat is the main food crop in Egypt. The growing increase in population at a rate higher than the rate of increase in wheat and maize planted areas resulted in domestic production that fails to meet national consumption from the two crops. As a result, the Government of Egypt resorts to imports from abroad to cover domestic demand, which poses a burden on the Balance of Payments, where the imports value of the two crops reached US\$ 2.65 and 1.74 billion, respectively, representing 20.37% and 13.38% of the total value of food imports in 2017, estimated at US\$ 13 billion (Foreign Trade Database, Foreign Trade, 2017).

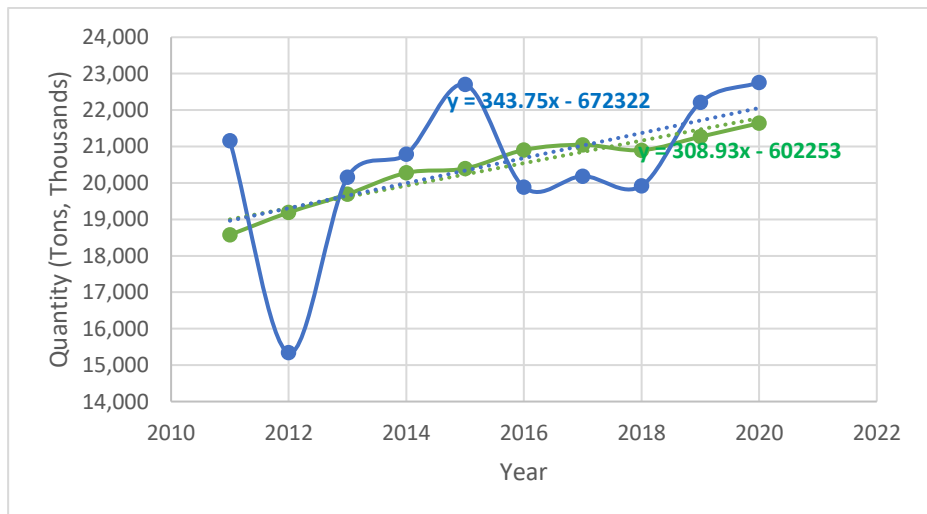


Figure 12: Total Quantity Supplied (Qs) Vs Quantity Demanded (Qd)

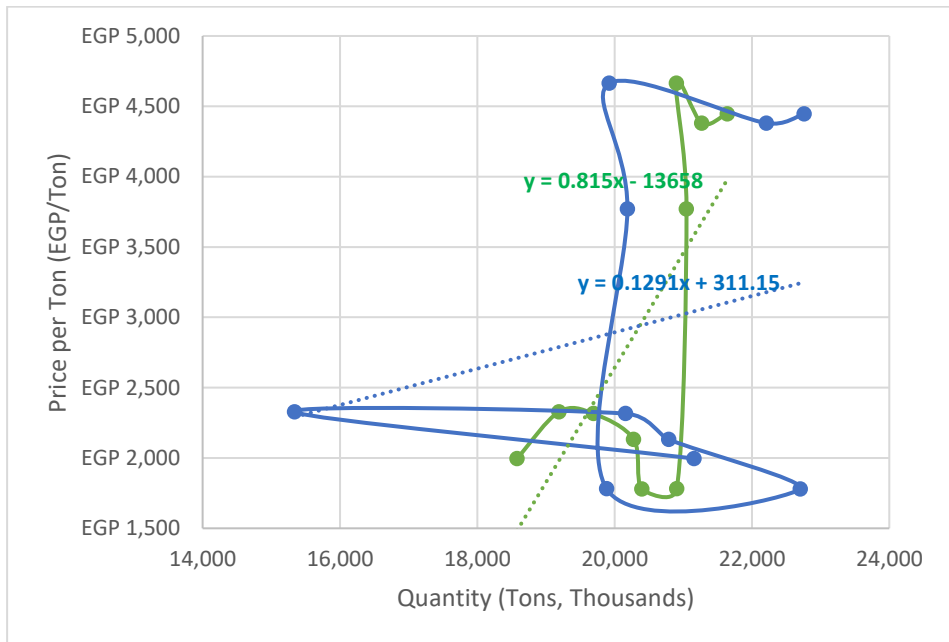


Figure 13: Wheat Supply and Demand, Egypt (2011-2020)

Elasticity of Wheat

The Russian Federation, Ukraine and France represent the top wheat exporters to Egypt in 2020, with export percentages amounting to 61%, 24% and 6%, respectively, indicating that wheat imports from the three countries accounted for 91% of Egypt's total wheat imports during 2020, estimated at around 11 million tons (Statista, 2022). Data in table 1 indicate that the estimated model is statistically significant, with no estimation problems that might negatively affect the model's efficiency. The validity of the estimated model has also been verified. The estimated price elasticities of demand for Russian wheat in the Egyptian market, presented in table 2, indicate that a 1% increase in wheat export prices leads to reducing demand for the crop by 11.89%, which means that demand for wheat in the Egyptian market is elastic (Estimation of Demand for Major Crops in Egypt, 2019).

Price Elasticity of Supply for Wheat

The price elasticity of supply measures how much the quantity supplied responds to changes in the price. The supply of a good is said to be elastic if the quantity supplied responds to changes in the price. Supply is said to be inelastic if the quantity supplied responds only slightly to changes in the price (Mankiw).

Computing the Price Elasticity of Supply

Price elasticity of supply = Percentage change in quantity supplied / Percentage change in price. Since the government mainly relies on imported wheat to supply its bread and as we can see from the below table, the Supply of wheat was affected in Q1 2020 for both substitutes and that was due to a factor other than price, it was due to COVID-19 outbreak, And it's elastic also in 2016 due to Shortage in wheat supply, Imports were increased to fill the deficit with a slight price increase.

Table 1: Price elasticity of supply (AGRIS, 2015)

Year	Supply	Price EGP	Supply Change	Price Change	Elasticity of Supply	Elasticity Status
2011	21,157	1,996.16				-
2012	15,340	2,327.99	-0.32	0.15	2.08	Elastic
2013	20,160	2,315.21	0.27	-0.01	49.33	Elastic
2014	20,788	2,132.37	0.03	-0.08	0.37	Inelastic
2015	22,702	1,778.53	0.09	-0.18	0.49	Inelastic
2016	19,883	1,781.65	-0.13	0.00	75.54	Elastic
2017	20,187	3,770.02	0.02	0.72	-0.02	Inelastic
2018	19,923	4,663.53	-0.01	0.21	0.06	Inelastic
2019	22,211	4,380.35	0.11	-0.06	1.73	Elastic
2020	22,760	4,446.00	0.02	0.01	1.64	Elastic

Price Elasticity of Demand for Wheat

The price elasticity of demand measures how much the quantity demanded responds to a change in price. Demand for a good is said to be elastic if the quantity demanded responds substantially to changes in the price. Demand is said to be inelastic if the quantity demanded responds only slightly to changes in the price (Mankiw).

It depends on some factors as follows,

- Availability of Close Substitutes.
- Necessities versus Luxuries.
- Definition of the Market.

Computing the Price Elasticity of Demand

Price elasticity of demand = change in quantity demanded / Percentage change in price. Since The product is necessary and as we can see from the below table, the price of wheat was increased with Increasing demand except for 2016 due to devaluation in Q4 2016 with a slight increase in price and 2020 due to Covid 19.

Table 2: Price elasticity of demand (AGRIS, 2015)

Year	Demand	Price	Demand Change	Price Change	Elasticity of Demand	Elasticity Status
2011	18,577	1,996.16				-
2012	19,191	2,327.99	0.03	0.15	0.21	Inelastic
2013	19,693	2,315.21	0.03	-0.01	4.69	Elastic
2014	20,277	2,132.37	0.03	-0.08	0.36	Inelastic
2015	20,397	1,778.53	0.01	-0.18	0.03	Inelastic
2016	20,905	1,781.65	0.02	0.00	14.03	Elastic
2017	21,047	3,770.02	0.01	0.72	0.01	Inelastic
2018	20,900	4,663.53	-0.01	0.21	0.03	Inelastic
2019	21,270	4,380.35	0.02	-0.06	0.28	Inelastic
2020	21,640	4,446.00	0.02	0.01	1.16	Elastic

Conclusion

Based on the analysis and the estimates, the following policy suggestions need to be addressed to accomplish the country's demand for wheat:

1. A necessary policy is required for substitutable consumption of wheat regarding rice, corn, and barley.
2. Government should focus on alternative wheat production policies to fulfil the wheat consumption domestically.
3. Egypt's government should concentrate on exploring additional water resources for irrigated agriculture and alternative wheat production technology especially the use of saline water and biochar soil amendments to offset the salinity effect.
4. In the future, the Egyptian government should manage the annual domestic wheat production above the population growth to maintain or reduce wheat imports.
5. Government should control the consumer price index; attain higher GDP per capita for wheat consumption accessibility for the low-income group.

6. The appropriate policy is required for wheat imports and wheat production to fill the gap between demand and supply for wheat.
7. Indonesia shifts the consumption pattern from rice to wheat due to high-income growth and urbanization a similar shift is required in Egypt to change the wheat consumption pattern to other domestically produced substitute commodities (like rice, corn, and barley).
8. It is also suggested that the Egyptian government must focus on pro-poor agriculture growth to meet the wheat demand and alternative staple food.
9. Wheat imports can also be reduced by imposing import tariffs and shifting the population to substitute commodities.
10. It is also suggested that mapping is required to fill the wheat consumption so the ministry of food and agriculture should cope with the increasing wheat consumption.
11. Adopting innovative production techniques with new wheat varieties will be beneficial to enhance wheat production.
12. The global wheat market does not show market leader characteristics and can better be described as a more complex oligopoly involving a shared dominance between the top wheat global producers where price leadership is controlled.
13. The wheat industry in general can be identified as a perfectly competitive market as the wheat market may have many sellers and producers. If any producer leaves the market, there is no effect on the market price. However, the Wheat Market in Egypt is an example of a homogeneous oligopoly, where the government in addition to several large companies has almost an identical share in the market. (50% each).
14. Wheat is a product of critical importance to Egypt and wheat policy is a priority for the government. In the light of the Russian-Ukraine conflict, Egypt shall diversify wheat suppliers from around the globe to maintain food security, while incentivizing local wheat production and supporting scientific research to produce new varieties of high productivity and resilience to future harsh climate conditions (Increasing temperatures and water scarcity).
15. The government is heavily involved in the wheat value chain, controlling most of the buying, trading, storing, milling, bread production and distribution for “Baladi” bread. The government operates inefficiently via

multiple entities lacking transparency, which opens the opportunity for increasing the private sector involvement and reducing subsidies.

The amount of food loss and wastage in Egypt is estimated at 20.62%, associated with the loss of 4.79 billion m³ of water and 74.72 million G.J. of energy. If Egypt managed to eliminate the loss and wastage of wheat-based food, it would have been able to reduce imports by 37%, from which it would save about 1.1 billion USD every year.

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