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# أثر النمو السكاني على الأمن الغذائي في مصر

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**الكلمات المفتاحية**
الأمن الغذائي ، النمو السكاني ، نموذج الأسواق المتعددة ، الاكتفاء الذاتي ، الاستهلاك.

**المستخلص**

الزيادة السكان لها تأثير ملحوظ على ضمان توافر الغذاء. أظهرت العديد من الدراسات البحثية أنه مع نمو حجم السكان، هناك حاجة ملحة لزيادة كميات الغذاء المطلوبة لتلبية احتياجات السكان، مما يؤدي يؤثر سلباً على معدلات الامن الغذائي أو يؤدي إلى انعدام الأمن الغذائي. في السياق ذاته، من المتوقع أن يصل عدد سكان مصر إلى 125 مليون نسمة بحلول عام 2030، وهذا يفرض العديد من التحديات على القطاع الزراعي ويهدد الأمن الغذائي في مصر، المهددة بالفعل. تبحث هذه الورقة في تأثير النمو السكاني على الأمن الغذائي في مصر باستخدام نموذج الأسواق المتعددة الديناميكي. تُظهر نتائج التحليل التجريبي تحسنًا ملحوظًا في إنتاج المحاصيل قيد الدراسة بمعدلات متفاوتة. يأتي محصول القمح في مقدمة المحاصيل، حيث يتضح أن إنتاج مصر من القمح قد ارتفع إلى حوالي 20.46 مليون طن عام 2030 مقارنة بنحو 9.10 مليون طن عام 2021/2020، بالإضافة إلى زيادة إنتاج الذرة إلى 10.94 مليون طن عام 2030 مقابل 7.59 مليون طن عام 2021/2020. ويعود السبب في ذلك إلى تحسن إنتاجية المحاصيل المذكورة أعلاه ، بالإضافة إلى التوسع الأفقي الذي اعتمدته الحكومة المصرية في الوقت الحاضر، إلا أن معدلات الاستهلاك لا تزال تتجاوز بكثير ما يتم إنتاجه محليًا. لذلك، من المناسب لمصر أن تتحقق من معدل النمو السكاني لديها من أجل تجنب الانفجارات السكانية وما يصاحبها من عواقب. تشمل تدابير التحكم في السكان المقترحة وضع حد أقصى لعدد الولادات المسموح بها لكل أسرة.علاوة علي زيادة معدلات الانفاق علي البحث العلمي، بُغية استنباط أصناف جديدة مرتفعة الإنتاجية.

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# The impact of population growth on food security in Egypt

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**ABSTRACT**

The increase in population has a notable effect on ensuring food availability. Numerous research studies have demonstrated that as population size grows, there is a corresponding rise in the need for food, which can potentially result in shortages and food insecurity. Meanwhile, Egypt's population is expected to reach 125 million by 2030. This poses many challenges for the agricultural sector and threatens food security in Egypt, which is already threatened. This paper examines the effect of population growth on food security in Egypt using a dynamic multimarket model that extends from the base year 2020 to 2030.The empirical analysis shows a remarkable improvement in the production of the crops under study at varying rates; the wheat crop comes at the forefront of crops, as it is clear that Egypt's production of wheat has increased to about 20.46 million tons in 2030 compared to about 9.10 million tons in 2020/2021, in addition to an increase in maize production to 10.94 million tons in 2030 compared to 7.59 million tons in 2020/2021. The reason for this is due to the improvement in productivity of the aforementioned crops, in addition to the horizontal expansion adopted by the Egyptian government at the present time (included in the study), However, consumption rates still far exceed what is produced locally. So, it is therefore pertinent for Egypt to check her population growth rate in order to avoid population explosions and their attendant consequences. Suggested population control measures include placing a ceiling on the number of births allowed per family.

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# 1. Introduction

The increase in population has a notable effect on ensuring food availability. Numerous research studies have demonstrated that as population size grows, there is a corresponding rise in the need for food, which can potentially result in shortages and food insecurity (Oguntegbe et al., 2018). The relationship between population growth and food production is intricate and can differ based on the given circumstances. Several research investigations have discovered a favorable association between population growth and food production, indicating that a larger population can stimulate agricultural efficiency (Joseph et al., 2017). However, additional research has indicated that the increase in population can result in the issue of food insecurity, especially in regions that have insufficient resources, e.g., land and water (Vasylieva, 2020). Achieving long-term food security necessitates the effective handling of population growth by implementing strategies like family planning, education, and agricultural investments. Furthermore, it is imperative to enhance agricultural productivity and equitable resource allocation to ensure food security in the midst of population growth (Chiari, 2017). One of the most significant dilemmas society faces today is the provision of nutritious and environmentally sustainable food for everyone, without exception (Ghosh, 2014). The issue is especially severe in Africa, where approximately 25% of the population still lacks sufficient nourishment to sustain an active and healthy life (Hall et al., 2017).

Ensuring food security in Egypt is a pressing matter, and multiple studies have analyzed the diverse aspects of this issue. According to Sarris, streamlining Egypt's agricultural production system can help mitigate risks and improve food security (Sarris, 1985). Her research centers on addressing the food gap and promoting food security in Egypt, specifically as it pertains to sugar. This includes advocating for policies to enhance self-sufficiency and diversify sources of imported sugar (Shehata, 2015). In the same context, Thomson's analysis examines the mutual dependence of food security and food aid in Egypt, underscoring the resource implications and equity impact of a food system reliant on external resources (Thomson, 1983). Likewise, Deng et al. anticipate that Egypt's growing population and restricted cultivated land will impede food security, suggesting the implementation of advanced technologies and strict management of land use to ensure grain production (Deng et al., 2014). On the contrary, Ahmed's research analyzes the impact of global food price increases and economic crises on food security in Egypt, indicating that the country's economy is highly susceptible to such disturbances (Ahmed, 2014). Overall, these studies highlight the need for strategic planning, policy interventions, and sustainable agricultural practices to ensure food security in Egypt.

As a result of what has been mentioned previously about the impacts of Population growth on food security, it poses potentially substantial threats to economic growth, food security, and poverty reduction prospects in Egypt. Because of the great pressure on land and water resources, adding more challenges to the Egyptian agricultural sector means providing more food for this population. This study aims to examine the potential effects of population growth in Egypt on the agricultural sector in general and food security in particular through

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the multi-market model, which was specially built to simulate the performance of the Egyptian agricultural sector.

The other sections of the paper are organized as follows: Section 2 provides the paper's methodology and the data sources on which it relied. Section 3 examines the hypotheses that have been chosen to identify a future population growth rate scenario. Section 4 explains the results of the baseline and the simulation. Finally, Section 5, Conclusions, and Recommendations.

## 2. Methodology and data sources

It is certain that rapid population growth, at a rate higher than agricultural production, has a negative impact on food security and poverty. For this purpose and in order to identify the links between population growth, crop production, farm income, and poverty in a wholly and partly integrated framework, we apply the multimarket model for this paper.

The MM model is based on neoclassical microeconomic theory. In the model, an aggregate producer represents a national level in the production of a commodity. On the production side, the supply functions are derived under producer profit maximization and based on the price of all commodities under study. On the demand side, the demand function is determined at the national level for two groups of households rural and urban (Nyankori, 1996). The model structure and equations are explained below;

- The price set:

The price set consists of a set of equations that express the relationship between producer prices (PP), consumer prices (PC) and world prices (PW) on tradable goods. Domestic prices are linked to world prices, however these prices are determined externally according to world prices. Fixed prices, while the prices of non-tradable goods are determined by the conditions of supply and demand, which means that these prices are estimated within the model to adjust the equality of supply and demand as explained later in the discussion of equilibrium conditions. The first 8 equations in this set describe the relationship between producer prices (PPi) and consumer prices (PCi):

$$PP_i = \frac{PC_i}{1+MARG_i} \qquad (1)$$

where:

i: a specific commodity

MARG: Local Marketing Margins

Border prices (Pm) for traded products (im) wheat, corn, livestock, fertilizers, and pesticides are linked to the world price by the exchange rate, product subsidies (Psubim), and domestic marketing margins (MARG)

(2)

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$$Pm_{im} = \bar{P}w_{im} * er * (1 + MARG_{im}) * (1 + Psub_{im})$$

Border prices for the sole export product, rice (Px), are linked to world prices at the exchange rate

$$P_x = \overline{P}w_x * er \qquad (3)$$

Consumer prices (PC) for traded products (im), wheat, maize, livestock, fertilizers and pesticides, linked to the frontier price by the marketing margin and support to potential consumers (Csubim).

$$Pc_{im} = \bar{P}m_{im} * (1 + MARG_{im}) * (1 + Csub_{im}) \qquad (4)$$

It is assumed that poor and non-poor households within any setting face the same prices. Therefore, there is one price for each commodity during each season.

$$Pc_{i,poor} = Pc_{i,rich} \qquad (5)$$

- Supply set

Supply set: The supply of outputs from food and non-food crops, wheat, rice, maize, alfalfa, and livestock, represents domestic production as a function of:

$$q_i^s = q_i^s(p, w, z^s) \qquad (6)$$

$q_i^s$ : supply of the agricultural product, P: price of the product, w: input price

$z^s$ : : Change in product supply

The supply equations for products are written as follows:

$$dq_i^s / q_i^s = e_{ii}(dp_i / p_i) + e_{ij}(dp_j / p_j) + \qquad (7)$$
$$e_{if}(dp_f / p_f) + e_{iE}(dE / E)$$

$q_i^s$ denotes quantity supplied, e denotes elasticity, p for prices, E is a constant factor such as educational attainment, i denotes crops and f indicates inputs (fertilizers, pesticides, mechanical labor),

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- Input demand set

This group describes the demand for agricultural inputs, fertilizers and pesticides, automated labor, and the demand for inputs as a function of:

$$x_i^s = x_i^s(p, w, z^d)$$

$X_i^s$ is the demand for inputs, p is the price of the product, w is the price of the inputs, $z^d$ the change in demand for the inputs. The total demand (TD) of the three inputs is simply the sum of the demand (HD):

$$TD_i = \sum_h HD \qquad (8)$$

Total water demand (TWD) is:

$$TWD_i = \sum WD_i \qquad (9)$$

Total land demand (TlD) is: $TLD_i = \sum LD_i$ (10)

- Consumption set;

The consumption set shows the demand for food and non-food commodities wheat, rice, corn, alfalfa, livestock. Demand is a function of:

$$q_i^d = \sum_h N_h \; q_{hi}^d \, (y_h, p, t, z^d) \qquad (11)$$

$q_i^d$ Final demand for the first crop $N_h$ Population in household category h

t: consumption tax rate , $y_h$ household category h per capita income. Finally, the total demand for the six consumer goods, which is the sum of household demand:

$$Cons_i = \sum_h Hcon \qquad (12)$$

- Income set

Agricultural income in household groups (YAIh) is the sum of values from crop and livestock production, minus input costs:

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$$YAI_h = \sum (PP_i * q_i^s) + (PP_i * Slovstok_{i,h}) - \sum_{in} (PC_i * TD_i^D) \quad (14)$$

Total household income ($YH_h$) is the sum of agricultural income and outside the model non-farm income.

$$Yh_h = YAI_h + \overline{YNAI}_h \quad (15)$$

- Set of equilibrium conditions

Conditions of equilibrium in crop and input markets depend on the possibility of trading for both crops and inputs. As for non-tradable commodities such as alfalfa, the state of equilibrium is equality between supply and demand, and any trade in non-tradable goods internationally is taken as the difference between local supply and local demand, and this the equilibrium condition determines both the equilibrium price and quantity. In contrast to tradable crops, prices are frontier prices determined outside the model by exogenous variables (the nominal exchange rate is outside the model) correcting for trade distortions such as (import tariffs) and the international marketing margin.

$$Scr_i + M_i = Cons_i + \overline{FEED}_i \quad (16)$$

$$M_{in} + S_{in} = TD_{in} \quad (17)$$

Finally, the balance of trade (BOT), the balance of government revenues and expenditures (G), changes in the consumer price index (CPI), and changes in real income are:

$$BOT = \sum_i NE_i . \quad (18)$$

$$G = \sum_i t_i p_i q_i^d + \sum_i \left\{ \frac{tm_i}{1+tm_i} + \frac{tx_i}{1+tx_i} \right\} p_i N\bar{E} + \bar{G} . \quad (19)$$

$$t_m = \frac{p - p^b}{p^b}, t_x = \frac{p^b - p}{p^b} .$$

$tm_i, tx_i$ Effective rates of protection on net exports, $NE_i$ Net exports.

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$$\Delta CPI = \frac{P_w^c D_w}{y} . \Delta \bar{P}_w^c + \frac{P_1^c D1}{y} \Delta P_1 \qquad (20)$$

$$\Delta\ Real\ y = \Delta y - \Delta CPI. \qquad (21)$$

The model needs three types of data to calibrate against the baseline solution: 1) Production, consumption, income, and input levels must be determined for all commodities. a) Consumer and producer prices and border prices are set for all commodities, and marketing margins must be determined. 3) Parameters: They are the elasticities of supply, demand, and income. These elasticities play a very large role in determining the results of the model and quantifying the negative or positive impact of the policy being tested and of the possible alternative scenario. The supply, demand, and income elasticities of the variables included in the model, or, in other words, endogenous variables that are determined from within the model, show and quantify the response of these variables to the shock as a result of the policy being tested. For example, the demand elasticities for the selected crops contribute to the quantitative measurement of the impact of the tested policy on the required quantity of crops included in the model, and so on for the supply elasticities. As for the income elasticities, they explain the response of the required quantities of crops and commodities used in the model resulting from income changes in the tested groups because of the proposed policies. As for the basic data used in building the model, it goes back to the base year 2019/2020.

## 3. proposed scenario

Several studies predict that Egypt's population will rise markedly in the coming years, with an anticipated total of over 125 million by 2030 (A. M. Soliman, 2019). In the same framework, it is projected to continue growing and could reach approximately 120-150 million by 2050 (Ouda et al., 2017). These projections bring to light the swift population expansion in Egypt and the difficulties it creates in regards to food security, housing need, and healthcare provision (Alkitkat, 2011) (S. S. A. Soliman & Hopayian, 2019). Effective planning and resource allocation will be necessary to meet the growing demands of the increasing population in various sectors in general, and the agricultural sector in particular, as it is the sector responsible for providing the food needs of the population.

In addition to the rates of increase in population growth, the study deals in this part with the analysis of the increase in the production and supply sides, which is represented in the increase in crop area ("horizontal expansion) and the increase in acre productivity ("vertical expansion), where we derive the data for the horizontal expansion from the national agricultural projects, which amounted to about 2 million feedans. While we obtain vertical expansion data from the rates of increase in productivity per area unit of the main crops in Egypt (wheat, rice, and maize) during the period from 1960 to 2022, in order to stand on the development of crop productivity, and then predict the future of productivity until 2030. As shown in Figure 1. Shocks to the model would include population growth and increased

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yields of major crops. By 2030, when the population is expected to reach 125 million, it is also expected that the productivity of wheat, rice, and maize will reach about 3.18, 4.05, and 3.9 tons per feeden, respectively.

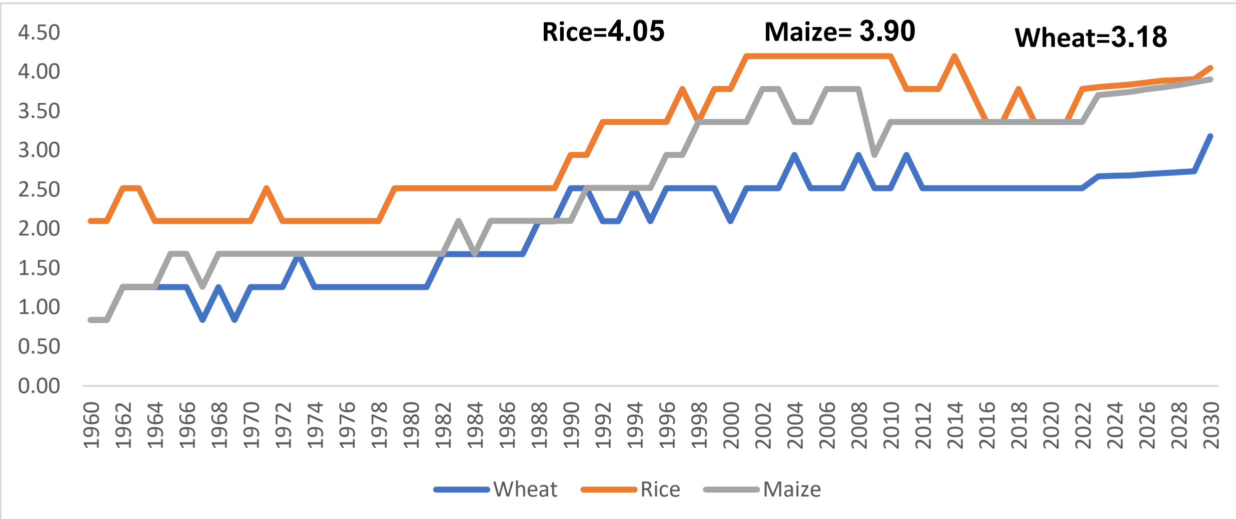


**Figure (1): Forecasting the productivity of wheat, rice, and maize crops until 2030.**

## 4. Simulating economywide effects

The impact of the shock on the main variables at the level of the agricultural sector was determined by comparing the values arising from the shock (scenario) in the target year (2030) with their counterparts derived from the simulation of the base line (business-as-usual scenario), which the model creates through a dynamic, and accordingly, it should be noted that the base scenario is not a prediction but provides a reasonable path for growth and economic structural changes of the agricultural sector, used as a basis for comparison with different periods of the results of the scenario listed above. The positive development in the productivity of the crops under study, especially the increase in the productivity of wheat, maize, and rice as shown in Figure (2), is in addition to the increase in the productivity rates of the rest of the crops at a rate of 1% annually. In order to show the effect of increasing productivity on total production as well as equilibrium prices.

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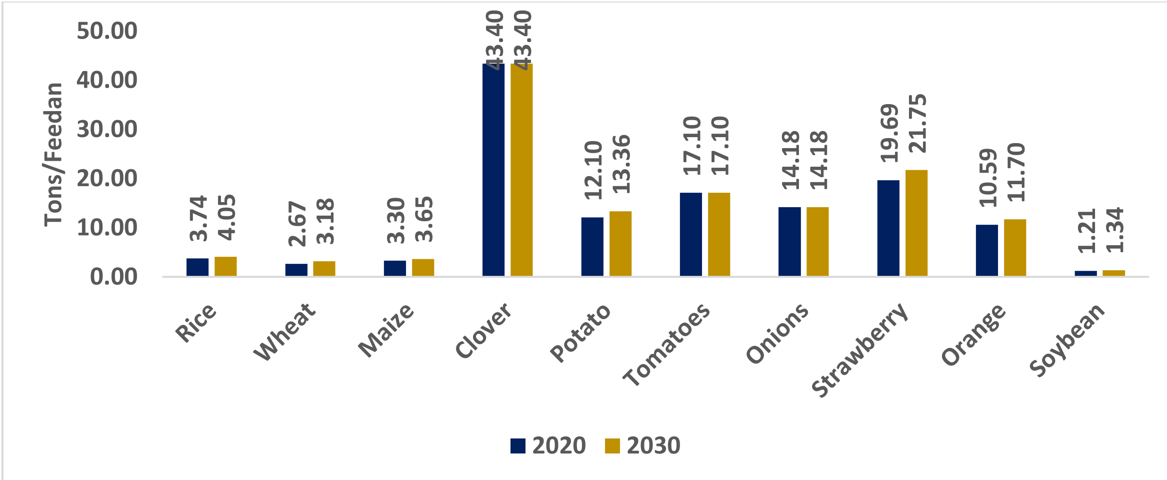


Figure 2: Yield per feedan of the crops under study. Source: Results of the multiple market model.

The response of the multiple market model is to increase the area for most of the crops under study, as shown in Figure (3), but increasing the area of wheat and maize crops is the most effective, given that the main objective of the horizontal expansion projects adopted by the government is the cultivation of strategic crops.

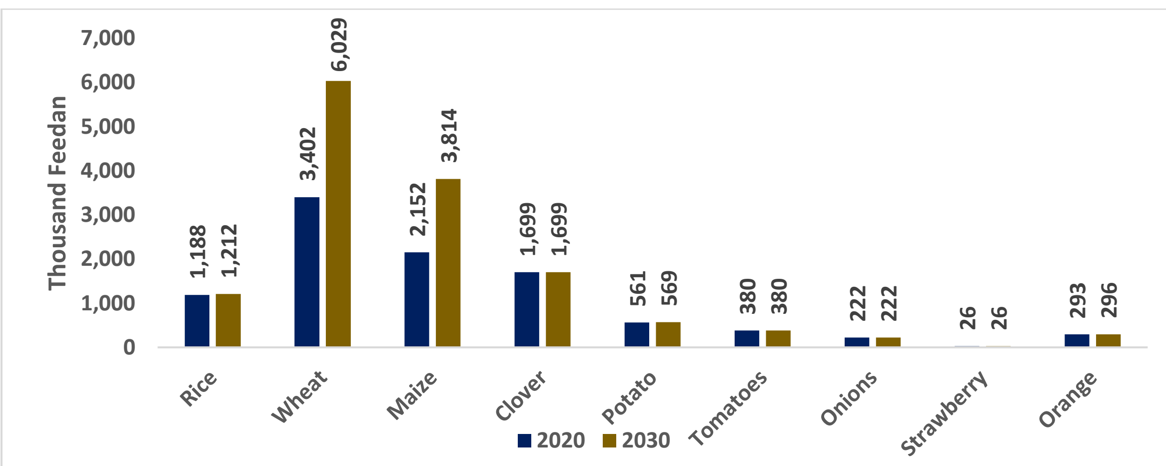


Figure 3: The cultivated area of the crops under study. Source: Results of the multiple market model.

There was a clear improvement in the production of the crops under study at varying rates, as Figure (4) shows the effects of productivity growth and the increase in the cultivated area on total production, and in it the wheat crop comes at the forefront of crops, as it is clear that Egypt's production of wheat increased to about 20.464 million tons in 2030 compared to about 9.102 million tons in 2020, in addition to an increase in maize production to 10.9 million tons in 2030 compared to 7.59 million tons in 2020. The increase in production for both wheat and maize is a clear indication of an improvement in the current situation to make

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the two crops available in the domestic market, but the future of consumption is still uncertain, as is both the import and export of all the crops under study.

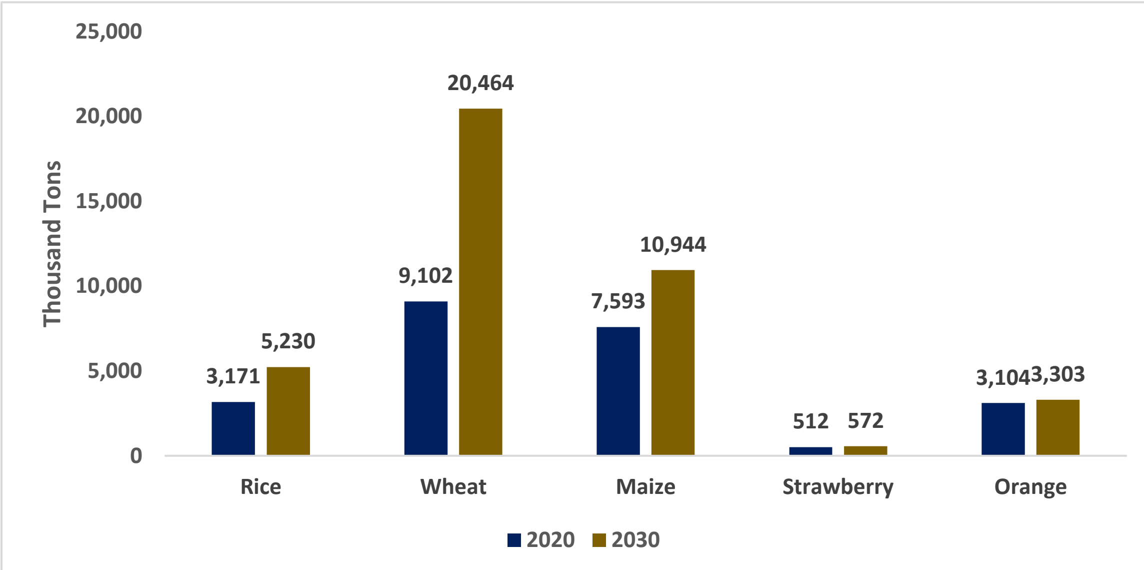

Figure (4): Total production by 2030. Source: Results of the multiple market model.

The increase in consumption rates that are expected to be reached by 2030 compared to 2020 is shown in Figure (5), where it is expected that consumption rates of wheat and maize crops will increase to about 26.68 and 21.597 million tons, respectively. It should be noted that the production rates referred to in Figure 4 are still less than the consumption rates shown, so the current situation of domestic production is still a little far from the consumption rates, especially in the wheat crop, but the consumption rates of the maize crop are still very far away, as they almost doubled from the production rates for the year 2030. This indicates the need to direct more investments in research and development directed at maize production in the coming period or to plant more maize by intercropping maize on cotton, which will relatively improve maize production.

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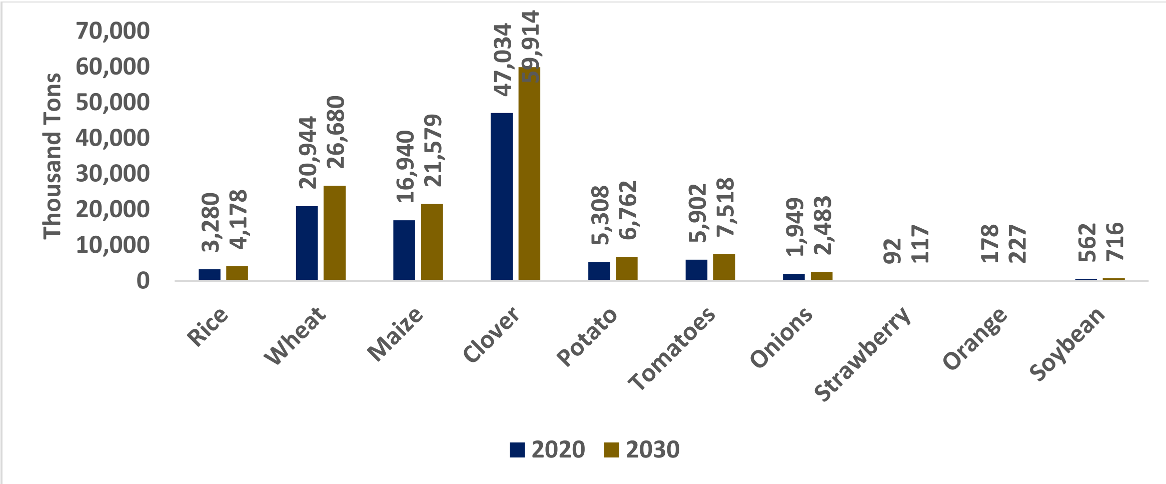


Figure (5): Total consumption of the crops under study by 2030. Source: Results of the multiple market model.

Figure 6 indicates a clear improvement in self-sufficiency rates for all crops. In more detail, the self-sufficiency rate of wheat will increase from 43% in 2020 to about 77% in 2030. This refers to the partial success of the government's policies in horizontal and vertical expansion, but there is still a need for wheat imports, estimated at 23%. It is also expected that self-sufficiency in rice will improve by the year 2030, to achieve a surplus of more than 25% - because of vertical expansion only. In addition, there is an improvement in the self-sufficiency of maize, but at non-significant rates, so the excess areas of rice can be used to be planted with the maize crop.

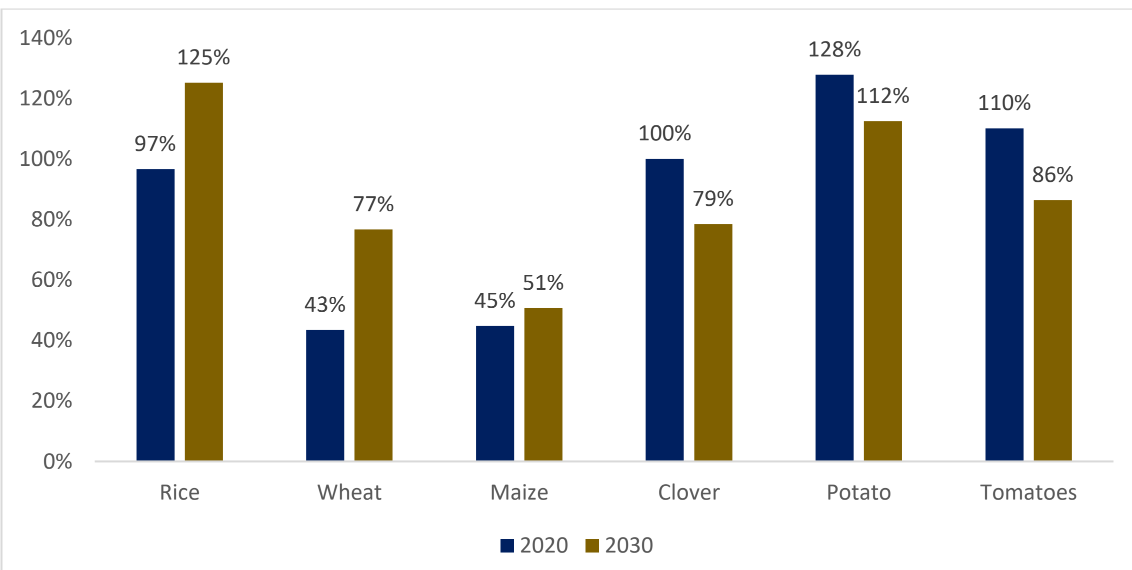


Figure (6): self-sufficiency rate of the crops under study by 2030. Source: Results of the multiple market model.

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## 5. Conclusion and recommendations

The increase in population has a notable effect on ensuring food availability. Numerous research studies have demonstrated that as population size grows, there is a corresponding rise in the need for food, which can potentially result in shortages and food insecurity. Meanwhile, Egypt's population is expected to reach 125 million by 2030. This poses many challenges for the agricultural sector and threatens food security in Egypt, which is already threatened. The study came at a time when the food insecurity problem in Egypt was associated with a range of issues such as population growth, resource distribution, security, consumption patterns, agricultural production, and socioeconomic status. The objective of this study was to analyze the impact of population growth on food security. This paper examines the effect of population growth on food security in Egypt using a dynamic multimarket model that extends from the base year 2020 to 2030. The study dealt with the use of one scenario, which contains two main factors: the first is the arrival of the population of nearly 125 million citizens. This factor negatively affects Egyptian food security. While the second factor is the increase in the total production of the main agricultural crops (wheat, rice, and maize) to 2 million feedan by 2030, the new areas are likely to be cultivated with wheat and maize feedan. this factor positively affects Egyptian food security.

The empirical analysis shows a remarkable improvement in the production of the crops under study at varying rates; the wheat crop comes at the forefront of crops, as Egypt's production of wheat has increased to about 20.46 million tons in 2030 compared to about 9.10 million tons in 2020/2021, in addition to an increase in maize production to 10.94 million tons in 2030 compared to 7.59 million tons in 2020/2021. The reason for this is due to the improvement in productivity of the crops, in addition to the horizontal expansion adopted by the Egyptian government at the present time (included in the study). However, consumption rates still far exceed what is produced locally. So, it is therefore pertinent for Egypt to check her population growth rate to avoid population explosions and their attendant consequences. Suggested population control measures include placing a ceiling on the number of births allowed per family. This is on the level of consumption, but on the level of production, the allocations for research and development in agricultural research centers must be increased so that Egypt can produce new varieties with high productivity.

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