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Sustainability assessment of the main cereals market in Morocco: Evaluating production and import

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Abstract
Agriculture is a fundamental pillar of Morocco's economy, contributing an average of 12,5% of GDP over the period 2000-2020 and helping to fight the rural exodus. Cereal crops play a major role in national agriculture, in which the main cereals, particularly wheat, occupying an important place in the dietary habits of rural and urban populations, although barley has a predominant place in animal feed. Moreover, food security in Morocco is based on cereal crops. This study aims to evaluate the evolution of the area under crop, the yield, and grain production in Morocco between 1930 and 2020, and the imports of main grains, based on the statistical approach in order to deduce the food security in the cereal sector.
The results obtained show that the area cultivated to the main cereals has almost doubled between the decade 1930-1940 and the decade 2010-2020. Soft wheat is the type of cereal that has increased significantly compared to durum wheat and barley. As for cereal production, it is subject to strong fluctuations due to the drought, with a coefficient of variation of 46%. The favorable agro-ecological zone produces 44% of the main cereals in Morocco. Moreover, grain imports multiplied by 917%, particularly bread, a basic element of the diet, where each Moroccan consumes an average of 255 kg per year of wheat, almost fourfold the world average. In addition, Morocco moved from self-sufficiency to dependence on food grain imports after independence, where the import dependency ratio (IDR) reached 39,8% compared to 60,2% for food self-sufficiency (SRR). This indicates the failure of the agricultural policy in the cereal sector. Also, in this study, the requirement of food-grain (R) has been calculated in the time horizon to 2030 and 2050, especially for wheat.

Keywords: Main cereals, Yield, Import Dependency Ratio, Food security, Morocco

1. Introduction

Agriculture is often called "open air workshop" because most of its productions are created directly in natural conditions. The agricultural sector is central to the economies of the least developed countries (FAO 2001). It provides a significant percentage of Gross Domestic Product (GDP), reaching 20,4% in 2020. It employs 55% of the workforce (World Bank 2019), and is a major source of foreign exchange. It is one of the main levers for fighting extreme poverty, increasing prosperity and ensuring food security with a world population estimated to grow by 8,5 billion by 2030 and reach 9,7 billion by 2050 (Raven et Wagner 2021; Valin 2019). Moreover, the emergence and spread of the COVID-19 virus in all continents has given clear signals about the role of the cereal sector in food security.

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The Mediterranean region, especially its Southern and Eastern shores, has been one of the most affected regions, as the majority of countries have experienced significant growth in demand for cereal products (FAO 2021; Gasc 2020). Therefore, agriculture is an important economic sector, and a decisive factor in the balance or imbalance of society, and the stability of countries, including much of the South.

Morocco, a Mediterranean country, has placed agriculture at the heart of its development policy since the early years of its independence (FAO 2014; Janan 2021; Qarouach 1987). Morocco's agricultural sector has benefited from several agricultural policies, various agricultural and rural development programs, and structural reforms to enable the country to ensure its food security and contribute to its economic growth.It is a fundamental pillar for the economy as it contributes 11-14% to GDP with an average of 12,5% during the period 2000-2020 while 20% between 1965 and 1980 (Banque Mondiale 2021). The GDP growth rate is linked to the growth of internal agricultural production. This is reflected in a decline of 3,7 points, from 6,2% in 2013 to 2,6% in 2014, due to the drought that affected Morocco during in last year (General Council for Agricultural Development, 2017).

It is one of the main sectors of activity at the national level (Harbouze et al. 2019), and it contributes to nearly 38% of total employment and nearly 73,7% of employment in rural areas and provides more than 65% of the income of rural populations (Intidami et Benamar 2020; Belmahi et al. 2023). Thus, the fight against rural exodus and the consolidation of the socio-political stability of the country (Balaghi 2014). The saying attributed to Marshal Lyautey, the first French Resident General in Morocco during the colonial, which is still valid today, globally summarizes the situation in which the sector finds itself: "Governing is raining" to illustrate that the entire economic and political equilibrium in Morocco still remains dependent on the climate (El Mourabit 2018).

The agricultural land represents about 69% of the national territory, but the cultivable land does not exceed 18% of the total area of the country. The main cereal crops (wheat and barley) occupy a predominant place in national agriculture. It covers 5,3 million ha (Harbouze et al. 2019), i.e., 59% of the national Useful Agricultural Area which reaches 8,8 million ha. The value of crop production represents on average 68% of agricultural GDP. Main cereal crops in Morocco (wheat and barley) account for 93% of the land cultivated in arid and semi-arid regions (Balaghi 2006). The Useful Agricultural Area marked by the fragmentation of agricultural land where 70 of the farms having less than 5 ha and more than half (55%) of the farms having less than 3 ha (Sahli et Amrani 2019), for a rural population reaches 36% according to the forecasts of the High Commission for Planning in 2021, Therefore the cereals occupy a prominent place in the national agriculture and can be considered as the dashboard of agriculture.

Durum wheat is a traditional crop in Morocco, and occupies an important place in the food habits of the Moroccan population (Benabdelouahab et al. 2016). It is mainly used to prepare bread, couscous, and pasta. Durum wheat semolina is also used to make various kinds of dry cakes, and other traditional dishes (Naserllah et al. 2005). In rural Morocco, the use of durum wheat in bread-making is a common practice. Approximately 85% of the annual production of durum wheat is used in bread-making, of which bread made from durum wheat is a fundamental component of the daily diet (Nassif et al. 2012). On the other hand, soft wheat is a fundamental cereal in Moroccan cereal cultivation. But its

production varies according to the Moroccan regions because of the climatic conditions and the characteristics of the soil.

Soft wheat is another fundamental cereal in Moroccan. It was introduced in Morocco in 1912 when the country was colonized by France, and is used for various purposes, including bread and cookie making (Jlibene 2009). As for Barley, it is also cultivated by farmers for several purposes that vary according to the production system: in modern agriculture areas, which are marked using improved high-yielding varieties and the use of inputs. The objective is the production of grains for animal feed. However, in subsistence farming areas, which account for more than 80% of the barley area, it is sown for animal feed, hay production and human consumption, especially in drought years (Saidi et al. 2007).

The per capita consumption of grain in Morocco is among the highest in the world, with each Moroccan consuming an average of 255 kg per capita per year of wheat. This is almost four times the world average, reflecting the key role of grains in ensuring national food security (Bishaw et al. 2019). Grains are considered one of the basic food products in Morocco and are present in every daily meal of Moroccans.

Morocco was an exporter of main cereals from the 14th century until 1960. However, after 1960, Morocco became an important importer of main cereals (Akesbi 1997) due to several factors, including demography, urbanization, changes in eating habits, and agricultural policies, aggravated by the impact of climatic drought (Qarouach 1987).

Given the importance of main cereals in national agriculture and their place in the dietary habits of rural and urban populations, this study aims to assess the evolution of the area under cultivation, and yield the main cereals in Morocco during the period of 1930-2020 (91 years), as well as to evaluate the sustainability of the main cereals market in Morocco by assessing production and imports to deduce the level of food security in the cereal sector.

2. Methodology and data

For the evaluation of the statistical characteristics of the main cereals and food security in Morocco, we relied in the first step on statistical approach, especially, descriptive statistical analysis and graphical representation, to show the evolution of the cultivated area, and production of the main cereals in Morocco from 1930 to 2020, in addition to the cartographic representation of cereal production by agro-ecological zones. In a second step, we evaluated the food situation in Morocco (food self-sufficiency) according to the FAO, based on two statistical indicators (FAO 2001):

Import Dependency Ratio (IDR):

$$\text{IDR} = \frac{\text{Imports (in million quintals)}}{\text{Production} + \text{Imports} - \text{Exports (in million quintals)}} \times 100 \quad \text{(formula 1)}$$

Self-Sufficiency Ratio (SSR):

$$\text{SRR} = \frac{\text{Production (in million quintals)}}{\text{Production} + \text{Imports} - \text{Exports (in million quintals)}} \times 100 \quad \text{(formula 2)}$$

After that, we estimated the requirement of food-grain by the Moroccan population in 2030 and 2050, according to the demographic projections of the High Commission for

Planning, considering the consumption of wheat in Morocco which reaches 255 kg/capita/year.
For data of the area under crop, production, and yield of the main cereals extend from 1930 to 2020 were taken from the Directorate of Strategy and Statistics of the Ministry of Agriculture, Maritime Fishing and Rural Development and Water and Forests (MAMFRDWF). As for cereal imports extend from 1971 to 2021, were obtained from the web page of the National Interprofessional Office for Cereals and Leguminous https://www.onicl.org.ma/portail/.

3. Study area

Morocco is located in the extreme northwest of Africa. It extends over an area of 710,850 km². The country is dominated by the mountain ranges of the Rif and the Atlas. It opens up to both the Atlantic and the Mediterranean, situated between latitudes 21 and 36 N and longitudes 1 E and 17 W. It is a vast region of transition between the temperate and tropical climates. Within the country, it is characterized by four mountain ranges: the Rif, the Middle Atlas, the High Atlas, and the Anti-Atlas. These mountains are oriented from northeast to southwest, dividing the country into two distinct zones. To the west and north of the mountainous reliefs, there is a region subject to disturbances originating from the North Atlantic, while to the east lies the Anti-Atlas and the Saharan zone, where the effects of the Sahara become predominant and extend significantly into the north.
In terms of precipitation, cumulative rainfall in Morocco varies from 700 to 800 mm on the northern reliefs and from 20 to 600 mm on the coastal areas. Inland, cumulative rainfall decreases from west to east and from north to south, with values ranging from 200 to 600 mm west of the Atlas Mountains and from 200 to 400 mm in the east. In the desert plains of the south, rainfall is less than 25 mm. Morocco's climate has been marked in recent decades by an increase in hot extremes and a decrease in cold extremes throughout the country, and a decrease in rainfall in Morocco, except for the Saharan region and the Casablanca-Safi coastal fringe. According to climate forecasts, this aridification phenomenon could increase during the 21st century (Driouech et al., 2021; Hammoudy et al., 2022; Sebbar, 2013), which represents a real threat to the agricultural sector, particularly cereal growing, which is mainly rainfed and cultivated in arid and semi-arid lands.

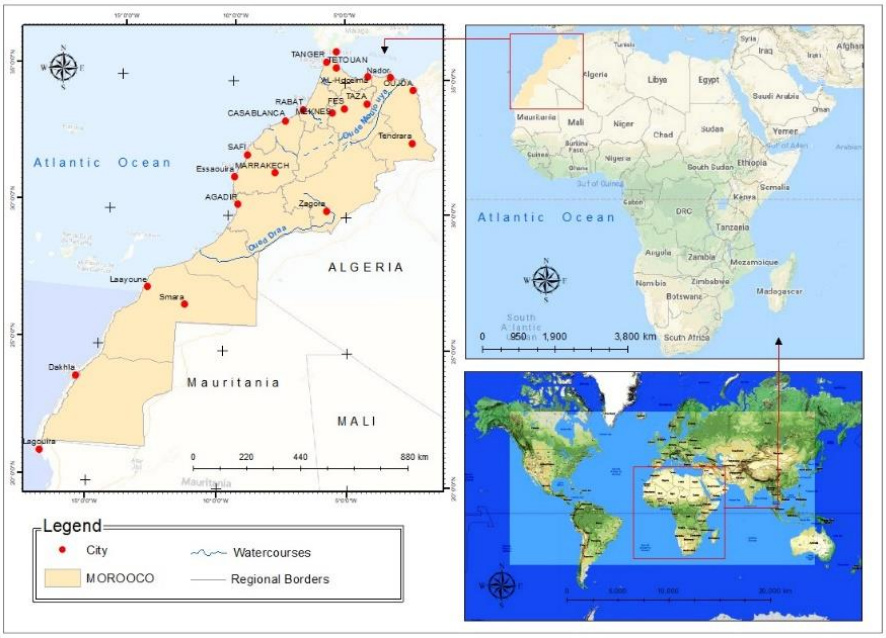

Figure 1: Location of the study area

4. Results and discussion

4.1 Evolution of the area cultivated with main cereals in Morocco (1930-2020).

It is important to note that the area under crop by three main cereals (soft wheat, durum wheat and barley) which averaged 2 843 000 ha in 1929-1939, increased to 3 420 000 ha in 1950-59 and to 4 290 000 between 1980-89, and to 5 008 000 ha during the decade 2000-2010 and decreased to 4 656 000 ha in 2010-2020 with a regression rate of 4% in comparison with the last two decades.

The area under crop by soft wheat increased from 252.000 ha in 1929-1930 to 1 852 000 ha in 2019-2020. In other words, it increases from 10% to 43%, that is, multiplied four times with a peak of 46% recorded in the 2013-14 agricultural year. Soft wheat is the most cultivated cereal type in the different rainfed and irrigated areas, where its area has increased considerably since the beginning of the 1980s due to the 1985-81 five-year plan, which officially considered soft wheat as a strategic crop to be developed, as well as to direct price subsidies to farmers-producers (21,2$/quintal), and to the millers who store the wheat and turn it into flour (Bishwa et al., 2019), in order to sustain the social stability given the high consumption of soft wheat. The area under crop to durum wheat has decreased from 38% in 1929 to 23% in 2020, while the area under crop to barley has constituted most of the area under crop in Morocco. It varied between 64% and 50% from 1929-30 to 1987-88, but from the latter crop year onwards, its share declined successively, reaching 34% in 2019-2020 (Fig. 2).

The increase in the area under crop in the first stage was explained by the deforestation and particularly the reduction of fallow (El Khyari, 1987). But its reduction in the second

stage can be justified by the regression of the surface area under crop by the main cereals in favor of legumes and arboriculture, as well as the effect of urbanization.

Cereal agriculture in Morocco is characterized by the supremacy of soft wheat, followed by barley and then durum wheat. The increase of the areas cultivated by soft wheat is due to the strong demand of this one as a source of bread and the role of the state by the operation of the promotion of soft wheat which was launched in 1985-1986 in order to double the cultivated area of soft wheat. Thus, the distribution of new selected varieties and fixed prices of harvested grain for producers, and fixed marketing margins for industrialists (Balaghi et al., 2014).

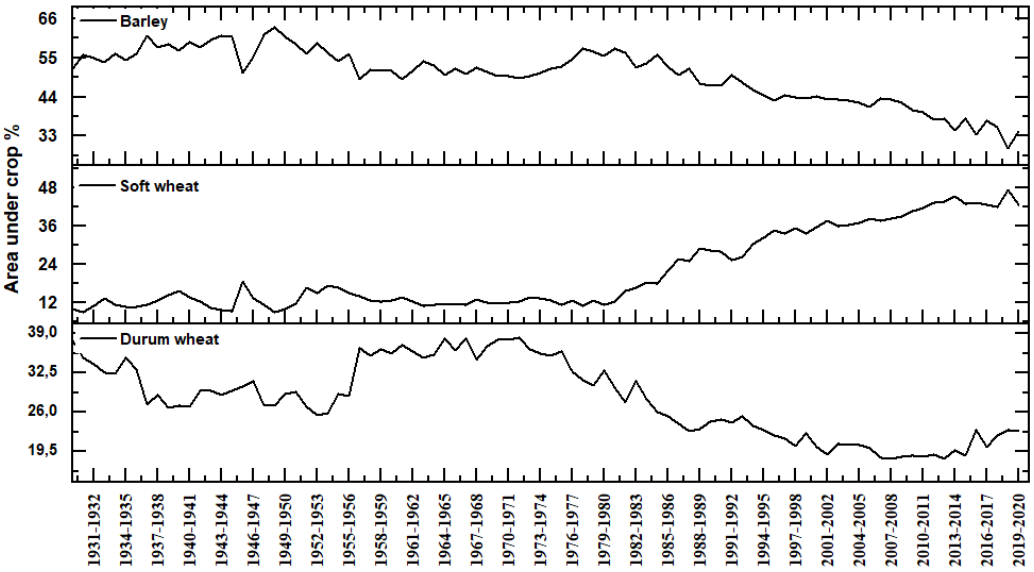

Figure 2: Evolution of the area cultivated with the three main cereals in Morocco (1930-2020), data source: AMFRDWF

4.2 Evolution of the production of the main cereals in Morocco (1930-2020).

The production of the three main cereals in Morocco is marked by permanent fluctuation according to climatic conditions. In addition, over a period of 91 years, it has gone from one year to the next, from simple to double, sometimes even quintuple and octuple.

The minimum production of the main cereals was recorded during the agricultural year 1944-1945 with a rate of 4198,2 thousand quintals. This period named in the contemporary history of Morocco, the year of famine especially cereals are the primary basis in the Moroccan diet. On the other hand, the 2014-2015 agricultural campaign has registered the record of grain production with a total volume of 114.587 thousand quintals (Fig. 3).

The agricultural campaigns can be divided into three categories according to the volume of grain production:

- From 1929-1930 to 1966-1967: grain production between 13.268.000 and 33.835.000 quintals in normal years, i.e., not dry at agricultural level.

- From 1967-1968 to 1993-1994: grain production between 49. 952. 000 and 92.431.000 quintals in normal years.
- From 1995-1996 to 2019-2020: total cereal production varies between 97 471 000 quintals and 114.587.000 quintals in normal years.

The production of the main cereals in Morocco is marked by its increase despite its regression during dry agricultural years. The rate of coverage of demand by national cereal production varies according to the nature of the crop year, increasing in wet years but decreasing in dry years, for example it reached 36% in 2019-2020 against 72% in 2017-2018.

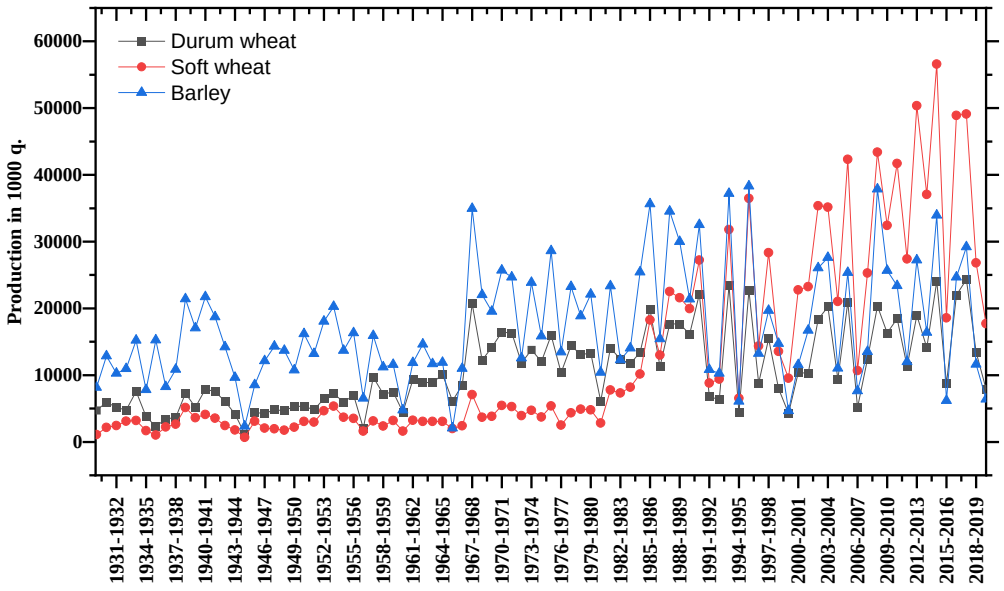

Figure 3: Evolution of cereal production in 1000 quintals in Morocco (1930-2020), data source: MAMFRDWF

4.3 Evolution of yields of the three main grains in Morocco (1930-2020)

An analysis of the evolution of the annual yield of the main cereals shows a very marked fluctuation from one agricultural year to the next. The yield of durum wheat in Morocco has evolved very slowly. It was on average 5 q/ha in 1929 -1939, then 6 q/ha in 1940 - 1949 and remained stable during the following decade without any increase for 10 years, then it increased by 2 quintals per hectare in 1960-1969, then a very slight increase of 1 q/ha in the decade 1970 - 1979, then it reached 12 quintals per hectare in 1980 - 1989, to know a decrease of 1 q/ha during the decade of the 90s, followed by an increase of which it reaches 14 q/ha during the decade 2000 and 2010 and 17 q/ha in 2010-2020. It has doubled 3,4 times for 91 years. However, the annual average yield is 9,9 q/ha during almost a century with a maximum of 24,4 q/ha in 2017- 2018 and a minimum of 2 q/ha was recorded in two agricultural years of 1935 - 1936 and 1944 - 1945.

On its part, the cultivation of soft wheat does not show considerable disparities with those of durum wheat with a difference of 2 or 1 q/ha during the nine decades studied. It went from 7 q/ha in 1929 - 1939 to 18 q/ha in 2010 - 2020, doubled by 2,5 times with an annual

average of 10.6 q/ha. The maximum yield of soft wheat is 26 q/ha in 2017 - 2018 as durum wheat and a minimum of 2,7 q/ha was recorded in the agricultural year 1944 - 1945.
As for barley, its yield has experienced a very low change compared to the two previous types of cereals. It decreased from 8 q/ha in 1929-1939 to 7 q/ha in 1940-1949 and remained stable without increase for 20 years in the following two decades, then an increase of 3 q/ha in the decade of 1970-1979 and remained the same in the following decade, to know a regression to 9 q/ha in 1990-1999 and in 2000-2010. Finally, it increases slightly to 11 q/ha in 2010 - 2020. The coefficient of variation of barley yield reaches 41% against 50% for soft wheat and 52% for durum wheat, because barley is less affected by climatic conditions knowing that its cultivation is left to marginal lands.
It is also noted that the yield of barley is more than the yield of wheat from 1929 to 1979 except for the agricultural year of 1965 - 1966. But from the 1979 agricultural year to the present time, the situation is reversed in favor of soft wheat followed by durum wheat, while barley becomes last in rank after a long period of dominance that corresponds to the half century (50 years). The fluctuations in cereal yields are mainly attributed to the great instability of climatic conditions (Fig. 4).

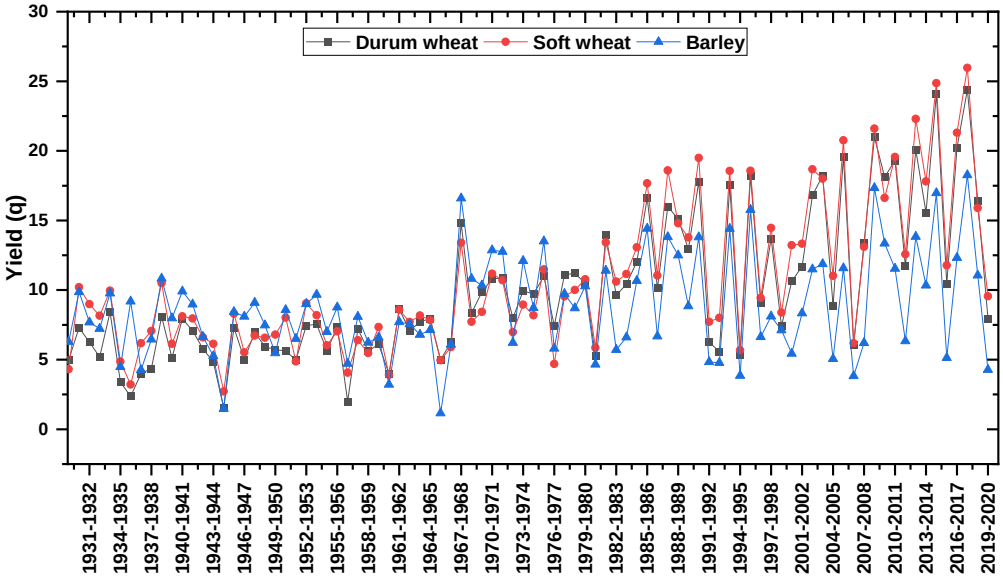

Figure 4: Evolution of the yield in quintals of the three main cereals in Morocco (1930-2020), data source: MAMFRDWF

4.4 Grain production according to the agroecological division of Morocco

These zones were determined according to rainfall and temperature by the Moroccan Ministry of Agriculture. Therefore, Morocco is subdivided into six agro-ecological zones (Balaghi 2014; Saidi, Sebbata, et Bencherqi 2007): Favorable, Intermediate, Unfavorable South, Unfavorable East, Mountain and the so-called Saharan agroclimatic zone.

Figure 5 illustrates the percentage and average annual production of main cereals according to the above-mentioned agro-ecological zones between 2000 and 2020. It can be observed that the favorable agro-ecological zone produces almost half of the main cereals in Morocco (44%), and 42% is produced by two agro-ecological zones: the intermediate zone and the mountain zone, while the three agro-ecological zones (unfavorable east, unfavorable south, and the Saharan zone) their production does not exceed 14%, despite its large area.

At the same time, the annual average of the production of the main cereals was marked by the same spatial hierarchy where we find the favorable agro-ecological zone in first rank by an average of cereal production of 29,4 million quintals per year, followed by the intermediate zone of 18,9 million quintals per hectare and in last rank the Saharan agro-ecological zone by an average grain production of 2,2 million quintals per year during the period of 2000-2020.

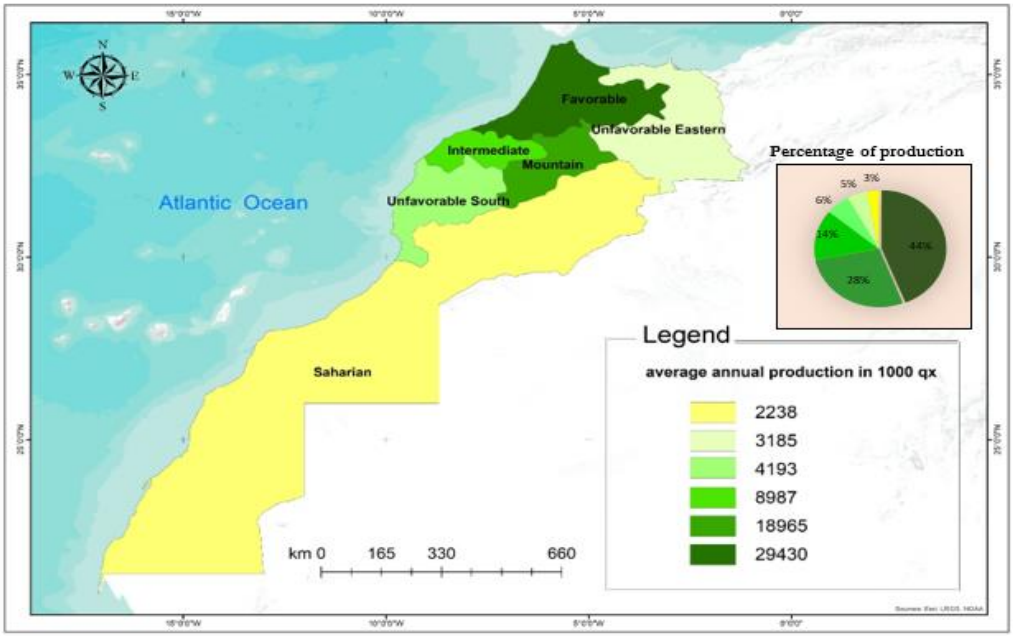

Figure 5: Percentage and average of grain production according to the 6 agroecological zones in Morocco between 2000 and 2020, (data source: MAMFRDWF, 2020).

4.5 Morocco's main cereal imports (1971-2021)

Soft wheat is the most imported cereal in Morocco with an average of 20,8 million quintals per year during the period 1973-2021, it is more than 5,6 times than durum wheat which reaches an average of 3,6 million q/year and more than 7,3 times than barley which reaches an average of 2,8 million q/year.

Regarding the imports of durum wheat and barley, they have the highest coefficient of variation compared to soft wheat during the last 50 years. It is also noted that imports of cereals increase in dry years such as 1982-1983, 1992-1993, 1998-1999, 2000-2001, 2007-2008, 2015-2016 and 2019-2020. During the last agricultural year, 57 million quintals of

grain were imported. The annual average of imports of grain production is around 27 million quintals. It also varies from one year to another depending on the volume of national grain production and the population growth rate.
The volume of grain imports has increased dramatically during the study period. It went from 5454 thousand quintals in 1971-1972 to 55.485 thousand quintals in 2012-2021 (Figure 6). In other words, the rate of import is multiplied by 917%. This raises a big question about the agrarian policy followed in Morocco and its results on the social and economic levels for 65 years in relation to the budgets devoted to it. For example, Morocco's agricultural strategy, the Green Morocco Plan (GMP), between 2008-2020, has led to Morocco's dependence on the global market as an exporter of vegetables and fruits and an importer of grains (Saidi et al., 2017). Environmentally, vegetables and fruits require more water than cereals, which indicates the need to cultivate them in areas that are not adapted to cereal cultivation, such as mountainous areas.

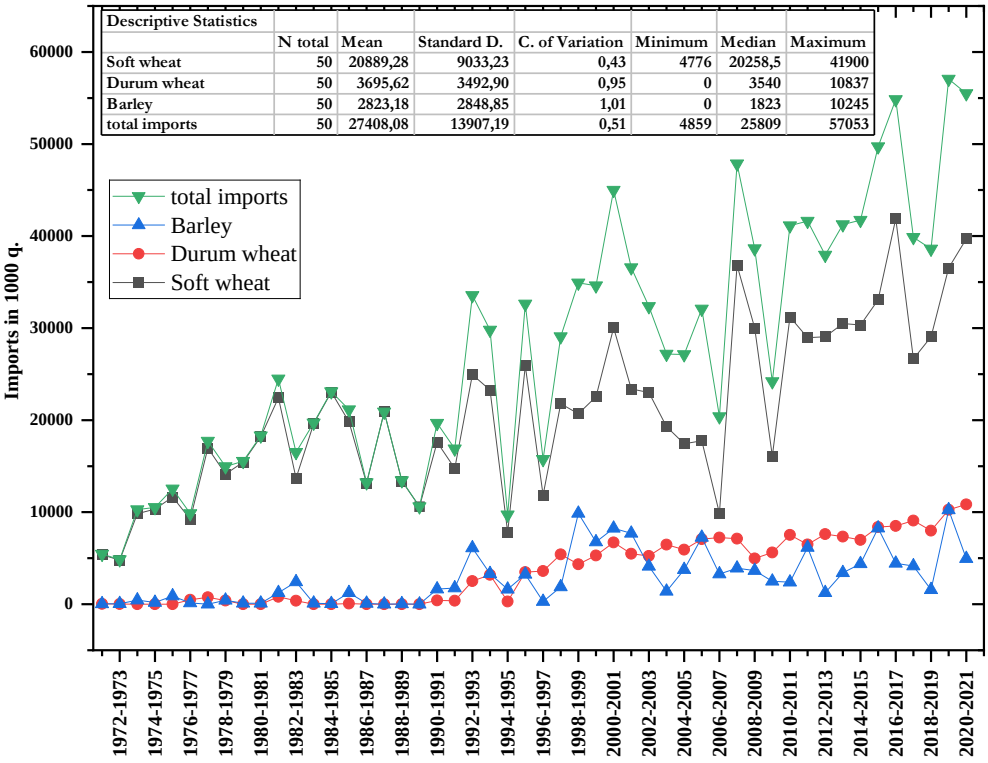

Figure 6: Evolution of grain imports in Morocco (1971-2021), data source: National Interprofessional Office for Cereals and Legumes, https://www.onicl.org.ma/portail/

4.5 Required quantity of food-grain in Morocco

The results obtained based on the Import Dependency Ratio (IDR) and the Self-Sufficiency Ratio (SSR) are as follows:
IDR= 33,28% as an average for the period 1971-2021
SRR= 66,72% as an average during the period 1971-2021

Food self-sufficiency in Morocco has decreased to 60.1% over the last decade, while the country's import dependency has increased to 39.8%. This trend has resulted in a significant impact on Morocco's trade balance, particularly in light of the 44.9% increase in food imports valued at 26,859 million MAD in 2022 compared to 2021 (Foreign Exchange Office, 2022). The main reasons behind this surge in imports are the rise in global food prices due to climate change and military conflicts between grain exporting countries, such as the ongoing war between Russia and Ukraine. Given Morocco's high dependence on food imports, it is particularly vulnerable to such shocks, which can lead to significant economic and social consequences. In this study, the requirement of food-grain (R) has been calculated in the time horizon to 2030 and 2050, especially for wheat which is the most consumed in Morocco (2,55 quintal/capita /year) due to the habits of the population, below:

R_{2030}= 2,55 quintal x the total population of Morocco in 2030 (39 329 985) = 100.291.461 quintal

R_{2050}= 2,55 quintal x the total population of Morocco in 2050 (43 561 789) = 111.312.062 quintal

Therefore, we can say that Morocco will have to import about 46,3 million quintals of wheat at 2030 horizon and about 57,3 million quintals in 2050 of wheat to ensure the food security of the population if we take into account the average annual production of wheat over the last ten years (2012-2022) which did not exceed 54 million quintals. Increased cereal imports will worsen Morocco's food trade deficit, where cereals accounted for an average of 36 % of the value of food imports between 2008 and 2018. This trend will continue over time, with an urbanization rate of 64% in 2021 (World Bank, 2023), and higher wheat consumption in Morocco compared to the global rate. In addition, Moroccan cereal farming remains exposed to climate change and is still greatly impacted by annual and interannual rainfall fluctuations. It is important to emphasize that the climate in Morocco is mainly arid to semi-arid and is affected by the effects of global warming, which lead to an increase in temperatures of about 1.1°C for the period 1984-2016, higher than the global scale (Driouech et al., 2020), and a significant decrease in precipitation in the north of the country between 1951-2010 (Woillez, 2019). This part of the country is marked by rainfed lands favorable for the cultivation of cereals.

These climatic conditions lead to prolonged and frequent droughts, with one dry agricultural year every 2,6 years in the 21st century (Karrou et Oweis, 2014) compared to one in five years between 1940 et 1994 (Barakat et El Handouf, 1997). Similarly, Balaghi and Benaouda (2009) concluded that climate change leads to an increase in aridity, a decrease in the capacity of agricultural land to be cultivated and in the period of the growing season. Other research, such as that by Hakam et al, (2023), has shown significant changes in crop health, particularly in the early 21st century. In the last six years (2010-2016), only 7% of the crop area was healthy, a stark contrast to the 50% recorded between 1984 and 2000 in the Sebou Basin in Morocco, which ranks first in main cereal production compared to other Moroccan watersheds. Moreover, Gommes et al., (2009) predicted that

the yield of main cereals will remain more or less fixed until 2030, after which it will fall sharply from 19% to 36% by 2050 and 2080 in the pessimistic scenario. In contrast, in the optimistic scenario, the yield of main cereals will decline by 10-20%. The scenario pessimistic, which depicts a world with a rapidly increasing global population, economic growth is reliant on polluting technologies and enlarging differences between North and South. However, the optimistic scenario describes a world where the focus is on local solutions, in terms of economic, social, and environmental sustainability, with the world's population continuing to grow, but at a slower rate.

Here we note that, the sustainability of the market for main cereals in Morocco is extremely vulnerable to price fluctuations on the international market, due to its heavy dependence on imports. In 2020, Morocco became the 11th largest importer of wheat in the world (OEC, 2020). In that year, cereal prices have since increased compared to previous years (OECD-FAO, 2021), which could lead to a decrease in access to food for poor people living in rural and peri-urban areas, where the number of undernourished people increased from an average of 1,6 million (4.4%) between 2018 and 2020 to 2,1 million inhabitants (5,6%) between 2019 and 2021 (FAO 2023). However, food insecurity in the country cannot be entirely attributed to this factor alone (Behnassi et al., 2021). The situation is expected to remain fragile due to climate change at the national level, including recurrent drought, the impact of military conflicts between producing countries, and the impact of extreme weather events in certain major exporting countries. The priority issue in Morocco is to sustainably increase agricultural production and to carry out structural reforms in the agri-food sector to meet the needs of a growing population.

5. Conclusion

This paper analyzes the sustainability of the main cereal market in Morocco, focusing the assessment of production and imports. The results show that the area under cereal cultivation has almost doubled from between the 1930-1940 decade and the 2010-2020 decade, increasing from 2843000 ha to 4656000 ha. However, this spatial expansion does not align with the objective of achieving food self-sufficiency, which is important for reducing dependence on the world market. Indeed, these crops are cultivated in rainfed areas, which are vulnerable to unexpected drought risks, particularly in the context of climate change. agricultural drought has increased in Morocco to one in 2,6 years in the 21st century (Karrou et Oweis, 2014) compared to one in five years between 1940 et 1994 (Barakat et El Handouf, 1997).

Regarding yield, barley had a higher yield than wheat from 1929 to 1979, except for the crop year of 1965-1966. However, from 1979 to the present, the situation has reversed in favor of soft wheat followed by durum wheat, with barley being the lowest yielding cereal after a long period of dominance spanning half a century. When analyzing the evolution of cereal yield in Morocco from 1929-1930 to 2019-2020, it is noted that there has been a stronger interannual fluctuation due to rainfall and its distribution during the agricultural season, where the coefficient of variation for cereal yield reaches 46%.

In terms of grain production, the lowest production was recorded during the 1944-1945 crop year at 4198.2 thousand quintals, due to the severe drought that hit the country during the 20th century with an intensity of agricultural drought reached 70%. In contrast, the

2014-2015 crop year achieved a record high of 114.587 thousand quintals in cereal production, due to the favorable climatic conditions, particularly a good spatial and temporal rain distribution, during growing period for grains. Furthermore, a comparative analysis of cereal production and consumption, particularly for wheat, that the gap is widening in favor of imports, having increased by 911% between 1971 and 2021.

Moreover, the research revealed that Morocco has moved from self-sufficiency after independence to structural imports, while the IDR was around 39,8% compared to 60,2% for food self-sufficiency (SRR) in the last ten years (2012-2021). This situation will worsen in the future as it will have to import 46,3 million quintals at 2030 horizon and about 57,3 million quintals of wheat in 2050, to ensure the food security of the population if we consider the average annual production of wheat over the last ten years, which did not exceed 54 million quintals per year.

The problems of food security in Morocco are due to several factors such as the growth of population, urbanization of agricultural land, the place of cereals in the Moroccan diet, where each Moroccan consumes an average of 255 kg/year of wheat, almost fourfold the world average (66,7 kg/capita/yr), but also, the impact of the orientation of agricultural policies, where the state devotes irrigated lands to high-value crops in order to increase exports of fruits and legumes and bring in foreign currency to achieve macroeconomic balances, but to no avail. This situation has been aggravated by the impact of drought on rainfed areas for cereal production.

In this context, Morocco has experienced a significant increase in the price of wheat, rising from $30 to $70 per quintal, due to several factors, including the severity of the drought in 2022, the increase in grain prices in the global market caused by the Ukrainian crisis, the impact of climate change on wheat-producing countries, and the rise of international freight rates. As a result, Moroccan household food expenditures have increased, which will lead to a new proportion of the population joining the undernourished, who were about 2,1 million (5,6%) between 2019 and 2021, compared to 2,1 million inhabitants (4,4%) between 2018 and 2020 (FAO 2023). These results are identical to those obtained by Gole et al., (2022) who showed that the war between Ukraine and Russia led to an increase in food prices in Arab countries characterized by high consumption of flour and pasta, especially grain imports from the Black Sea (Ukraine and Russia) accounted for nearly 50 % of Morocco's total imports. These two countries were previously the only suppliers of soft wheat in the Moroccan market. However, due to the shortage, professionals in the sector have turned to North and South American countries to fill the gap in the food supply (Mengoub et al., 2022) in a context of rising world cereal prices with declining world grain stocks in 2022-2023, according to FAO forecasts. Similarly, Ait Ali et al., (2022), estimated that the combined effect of higher grain and oil import prices could cost Morocco between 1 - 2 % of national income this year. The value of food imports in Morocco amounted to US$ 6.5 billion, whereas agricultural exports were valued at US$ 4.2 billion. Cereal imports make up more than half of Morocco's agricultural imports (Mengoub et al., 2022), despite being the dominant crop in Moroccan agriculture, occupying 59% of the national useful agricultural area of 8.8 million hectares.

For this, Morocco is required to meet the challenges related to food security and the sustainability of the supply of the national market in grains at acceptable prices, in accordance with the second sustainable development goal, which relates to the end hunger,

achieve food security and improved nutrition, and promote sustainable agriculture. To achieve these goals, it is necessary to re-evaluate the Green Morocco Plan, rather than continuing it under the name of the "Green Generation 2020-2030" initiative, because it has made Morocco dependent on the international market as an exporter of vegetables and fruits and an importer of grains. Environmentally, vegetables and fruits require more water than cereals, which indicates the need to cultivate them in areas that are not adapted to cereal cultivation, such as mountainous areas. The objective is to ensure a sustainable and local supply of basic grains to the population, while promoting climate-smart agriculture to adapt to and mitigate the effects of climate change. Adoption of agricultural technologies such as direct seeding, and the establishment of a national system for monitoring the agricultural season and agro-meteorological forecasting of cereal crops, particularly in rain-fed agriculture, are the best solutions for ensuring food security for the main cereals. although, government subsidies for basic foodstuffs, including the main cereals, play a crucial stabilizing role in times of crisis, ensuring food security for the population. However, these subsidies are insufficient and unsustainable. Further research is needed to ameliorate these results, including the relationship between the "Green Morocco Plan" strategy and food security.

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