

A double-edged sword? Trade and nutrition in Morocco

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Abstract

Purpose – The impact of international agri-food trade on food security and nutrition remains contested, and evidence on its implications for (micro)nutrient intake is still limited. This article explores how Morocco's agri-food production and trade patterns have shaped the nutritional availability over the past 3 decades.

Design/methodology/approach – Using FAO Food Balance Sheets and national food composition tables to estimate domestic supply, production, imports, and exports of 12 food groups and key nutrients (calories, proteins, fats, carbohydrates, vitamin A, iron and magnesium) from 1991 to 2021. Non-parametric trend tests and a Seemingly Unrelated Regression (SUR) framework, combined with an autoregressive specification, are used to assess structural changes and trade nutrition associations. Nutrient availability is benchmarked against FAO/WHO population-weighted requirements, while food group supply is evaluated relative to EAT–Lancet dietary recommendations.

Findings – Morocco largely meets national nutritional requirements, consistent with declines in undernourishment, stunting and anaemia. However, calories and fats now exceed recommended levels. Cereal imports have stabilized food supply but increased exposure to global shocks. Despite high vegetable exports, domestic availability remains below dietary recommendations, suggesting a trade-off between export growth and local nutritional adequacy.

Research limitations/implications – The data used reflect national-level supply and do not capture disparities in access across social groups. While nutrient composition values align with national data, the analysis cannot assess intra-household distribution or affordability.

Originality/value – The study provides a nutrient-level, country-specific analysis linking trade flows to dietary adequacy in a middle-income context.

Keywords Global supply chains, International agri-food trade, Globalization, Food security, Nutrition, Morocco

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1. Introduction

The impact of international agri-food trade on food security and nutrition remains heavily debated. While some studies highlight the potential benefits of trade (Bonuedi *et al.*, 2020; Dithmer and Abdulai, 2017; Van den Broeck and Maertens, 2016; Wood *et al.*, 2018; Zimmermann and Rapsomanikis, 2023), others are more sceptical (D'Odorico *et al.*, 2014; Geyik *et al.*, 2021; Gutiérrez-Moya *et al.*, 2021). The evidence is particularly contested for low- and middle-income countries. Major recent crises that disturbed global food supply chains, including the COVID-19 pandemic and the Russo-Ukrainian war, have led many countries to reassess food self-sufficiency policies (Hellegers, 2022).

While the existing literature provides valuable insights into the relationship between trade, food security and nutrition, several key research gaps remain. First, the implications of trade for micronutrient intake have not been sufficiently explored (Van den Broeck, 2025). While studies like Hoffmann *et al.* (2021) have shed light on the role of the European Union (EU) in global micronutrient trade (Hoffmann *et al.*, 2021), a more comprehensive understanding of the implications for poorer countries is still needed. Second, most research focuses on cross-country comparisons, neglecting the nuanced dynamics within specific countries, as the degree to which food security is ensured through domestic production varies significantly across countries (Baer-Nawrocka and Sadowski, 2019). This emphasizes the need for country-specific analyses to understand the complex interplay between trade, domestic production and nutrition as shown in a study on the United Kingdom (Macdiarmid *et al.*, 2018). Our study examines the implications of Morocco's agri-food production and trade patterns on the



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country's nutritional availability. We contribute to the scientific literature in three main ways. First, our analysis goes beyond mere energy supply, as we distinguish between 12 different food groups and calculate macro- and micro-nutrients, including calories, proteins, fats, carbohydrates, vitamin A, iron and magnesium. We account for trends in production, imports, exports and domestic food supply to reveal the role of trade. Second, by focussing on a single country, we can examine the nutritional implications of trade more in depth, and link it to the specific country context. This is key for understanding under which conditions trade can benefit or deteriorate the nutritional availability in a country. Three, we provide empirical evidence for Morocco, which is highly relevant for several reasons. It is a lower-middle-income country that has become a leading global exporter of agri-food products, particularly fruits and vegetables. Over time, it has implemented several policies to boost agricultural production and entered into free trade agreements (Yusuf, 2014), including with the EU. At the same time, however, Morocco continues to face various burdens of malnutrition, including undernourishment and micronutrient deficiencies, but also increasing rates of overweight and obesity.

Against this background, this article addresses three main research questions. First, how have Morocco's agri-food production and trade patterns evolved over the period 1991–2021, and how have these changes shaped the domestic availability of macro- and micronutrients? Second, to what extent does domestic nutrient supply meet population requirements and dietary recommendations? Third, does the expansion of export-oriented agricultural production coincide with improvements in domestic nutritional availability, or do tensions emerge between export growth and local dietary adequacy? By addressing these questions, the study aims to clarify the role of international trade in Morocco's ongoing nutritional transition.

2. Literature review

This section presents a brief review of the empirical literature that studies the links between agri-food trade, food security and nutrition. We structure it into two main parts, where the first part describes the effects of trade on caloric supply, dietary diversity and micronutrient flows, and the second part highlights two key concerns about trade dependency and obesity.

2.1 Effects of trade on caloric supply, dietary diversity and micronutrient flows

An abundance of studies has examined the impact of trade on caloric supply. Trade openness has been shown to positively influence dietary energy consumption, with one study finding that a one-standard deviation increase in trade openness results in an increase of 93 kcal per day (Dithmer and Abdulai, 2017). Natural experiments in Bangladesh during major crisis years (1977, 1988 and 1998) demonstrate that in the absence of private-sector food imports, per capita consumption among the rural poor would have decreased by 44–109 kcal per day (Del Ninno *et al.*, 2003). This emphasizes the critical role of trade in stabilizing food supply during crises. Poor trade facilitation in Africa has been associated with a 1.6% increase in undernourishment, a 0.36% decline in dietary energy supply and a 1.8% rise in food deficits, indicating that trade inefficiencies can worsen food insecurity (Bonuedi *et al.*, 2020). Overall, these studies suggest that trade liberalization improves caloric supply and reduces food shortages, reinforcing its importance in addressing hunger and undernourishment.

Recent studies focus not only on food availability but on food diversity as well, with most finding positive effects of trade. Intuitively, global food trade allows countries to export abundant domestic products and import those more efficiently produced elsewhere, increasing food diversity year-round. A comprehensive study analysing spatial and temporal trends in crop production, exports, imports and food supply diversity across 152 countries and 49 crops from 1961 to 2013 found that while crop production within countries diversified only marginally, the diversity of food products available for consumption increased rapidly through

trade (Aguiar *et al.*, 2020). Similarly, research quantifying food-system inequality from 1970 to 2010 suggests that increased trade has contributed to a more equitable distribution of food, leading to greater dietary diversity within countries over time (Bell *et al.*, 2021).

However, improvements in caloric supply and dietary diversity do not automatically imply improvements in nutritional adequacy. It remains unclear whether trade enhances the ability of nations, particularly low- and middle-income countries (LMICs), to meet their nutritional needs. As there is growing agreement that improving food systems for nutrients rather than boosting the overall food supply could more effectively address malnutrition, this question is key to understand the impact of trade on nutrition (Arsenault and Olney, 2021; Wood *et al.*, 2018) showed that trade contributes to nourishing between 146 and 934 million people, depending on the nutrient, by facilitating the cross-border movement of essential dietary components (Hoffmann *et al.*, 2021). further explored the global redistribution of key micronutrients such as iron, zinc and vitamin A through agricultural trade, with a particular focus on the EU's role. Their findings highlight that the EU, as a major player in micronutrient trade, acts as a net importer of iron from deficiency-prone regions while exporting vitamin A, often in animal products, to areas where it is needed. However, despite strong global nutrient networks, one study found that trade did not substantially improve nutrient adequacy in most LMICs, particularly for vitamin A and B12 (Geyik *et al.*, 2021).

This divergence in findings points to an unresolved question: does trade improve nutrient availability within specific country contexts, or do aggregate global patterns mask persistent national-level imbalances? As far as we know, no study has examined an LMIC individually. In contrast, one study analysed the contribution of imports to nutrition security in a high-income country, the United Kingdom, between 1961 and 2011 (Macdiarmid *et al.*, 2018). Their study found that while the UK maintained sufficient energy, macronutrients and most micronutrients to meet its population's needs, imports have become increasingly vital for ensuring an adequate supply of certain micronutrients, such as vitamins A and C, over time. Evidence from high-income countries therefore cannot be directly generalized to LMICs, where production structures and trade dependencies differ substantially.

2.2 Key concerns about trade dependency and obesity

While trade has enhanced food availability and diversity, it has also increased reliance on a few key exporters (Kummu *et al.*, 2020), raising concerns about food system resilience amid global shocks. Analysing four key nutritional components (dietary energy, proteins, fat, and the quantity of vegetables and fruits) (Kummu *et al.*, 2020), found that while food supply diversity increased for most of the world, this came at the cost of increased trade dependency. As a result, many countries are now more vulnerable to shocks originating in a few major exporting nations. Similarly, an analysis of national dietary energy supply and production from 1965 to 2005 classified countries based on their food availability, self-sufficiency and trade dependence. The findings indicate a dramatic decline in food self-sufficiency across many LMICs, leaving a growing proportion of the global population dependent on food imports or export revenues (Porkka *et al.*, 2013). The frequency of food shocks has risen due to factors such as extreme weather events and conflicts, posing a growing threat to food security. In effect, there is a strong link between these disruptions and global instability, underscoring the need for resilient food systems that can adapt to uncertainties (Cottrell *et al.*, 2019). In this context, a country's level of independence on a few trading partners often shows a higher vulnerability to global food supply disruptions, making risk reduction a key priority in national food policy (Macdiarmid *et al.*, 2018). Therefore, strategies to enhance food diversity should align with a country's economic and agricultural context. Low-income countries may prioritize production diversification, whereas middle- and high-income countries can leverage economic capital to access nutritional diversity through international markets (Remans *et al.*, 2014).

Another main concern is the link between trade and obesity. Despite evidently improving food availability, international trade raises concerns about declining dietary quality and increased calorie consumption, potentially contributing to diet-related non-communicable diseases (NCDs) like obesity. In Brazil, merchandise trade openness was shown to have a positive and significant impact on the prevalence of overweight and obesity between 1988 and 2008, suggesting that trade increased the availability of processed foods high in calories (Miljkovic *et al.*, 2018). Due to the highly competitive processed food and caloric beverage industry in the United States, calorie availability in Canada rose by ~ 170 kcal/day per capita after the Canada–U.S. Free Trade Agreement. This rise likely contributed to an average weight gain of 1.8–12.2 kg, varying by sex and activity level (Barlow *et al.*, 2018). At the global level, a study of 175 countries from 1975 to 2016 found that greater trade openness was linked to higher obesity rates, with a 10% increase in trade openness leading to a 0.8% rise in obesity prevalence (An *et al.*, 2019). They found that the openness index is correlated most strongly with obesity in lower-middle-income countries, followed by upper-middle- and low-income countries, but showed no link in high-income countries.

However, a recent report by the FAO on the global state of agricultural commodity markets suggests that political and social globalization, which shape lifestyles through information flows and societal connections, have a greater influence on obesity rates than economic globalization with trade and foreign direct investment (FAO, 2024b). Supporting this perspective, a comprehensive review on the effects of economic globalization on nutrition found no conclusive evidence directly linking trade openness to increased obesity or other diet-related noncommunicable diseases (Cuevas García-Dorado *et al.*, 2019). Another study found that trade openness, when measured through tariff levels, had a significant association with underweight but not with overweight, indicating that trade policies may reduce undernutrition more than contribute to overnutrition (Nandi *et al.*, 2014). Aligning these perspectives requires acknowledging that trade may contribute to obesity in some contexts, but its impact is often mediated by other globalization forces, lifestyle changes and national policies.

2.3 Research gap and contribution

Overall, the literature presents a dual narrative: trade may enhance caloric supply and dietary diversity, yet its effects on micronutrient adequacy, diet quality and resilience remain contested, especially in LMICs. Much of the evidence relies on cross-country analyses and aggregate energy indicators, offering limited insight into within-country dynamics over time.

This study addresses these gaps through a nutrient-level, country-specific analysis of Morocco (1991–2021). By tracing production, imports, exports and domestic nutrient supply against population requirements and dietary benchmarks, we assess whether trade supports or undermines national nutritional adequacy.

3. Data and methods

3.1 Research context

Over the course of a decade, Morocco has become a leading global exporter of agri-food products, particularly fruits and vegetables. The total value of exports for fruits and vegetables has experienced a remarkable growth of 117% between 2008 and 2021 (UNCTADstat, 2024). A combination of domestic policies and international trade agreements has significantly influenced Morocco's agricultural development. The 1996 EU trade agreement, implemented in 2000, has been a major booster. Today, the EU is Morocco's primary trading partner, accounting for 49% of its total trade (European Commission, 2023). Notably, 66% of Morocco's food exports are destined for the EU market, positioning the country as the first Extra-EU supplier of tomatoes and canned olives and the second Extra-EU supplier of olive oil (MAPMDREF, 2023). Other relevant free trade agreements were signed with Turkey and the United States in 2004 and implemented in 2006.

Morocco's agricultural sector has also been influenced by domestic policies, such as the "Green Morocco Plan" (GMP), launched in 2008. The GMP aimed to modernize agriculture and boost its contribution to the economy through the implementation of high-added-value projects and solidarity projects. Ten years after its launch, the GMP has led to an increase in agricultural GDP from 6.8 billion USD to 13 billion USD, and the creation of 342,000 additional jobs (MAPMDREF, 2023). However, it has also drawn criticism for its potential negative environmental impacts, including water resource depletion (Benabderrazik *et al.*, 2021). The second major policy was the "Halieutis Plan", launched in 2009. It aimed to enhance the fishery sector's sustainability, competitiveness and contribution to the national economy. Ten years after the program's launch, a modernization of the fleet was observed and Morocco doubled its GDP from fishing and fish industry, reaching 1.9 billion USD in 2020. However, the implementation of the program was hampered by budgetary issues and planning deficiencies.

Although Morocco realized great progress in agricultural productivity, it continues to face various burdens of malnutrition. Figure 1 depicts the trends between 2000 and 2021 for some key health indicators (Christian *et al.*, 2022). Undernourishment has been steadily decreasing over time until 2018, but then started to increase again to rates equalling those of 20 years ago. The rate of undernourished people was 7% in 2021, corresponding to 2.1 million Moroccans. Progress in reducing stunting was more favourable, with the share of stunted children dropping from 25% in 2001 to 13% in 2021. Also, anaemia in women, which is caused by iron deficiencies, decreased over time, which is caused by iron deficiencies. While progress was realized from 35% in 2001 to 30% in 2015, rates have stalled since then and have not decreased further. On the other hand, obesity rates have doubled from 10% in 2000 to 20% in 2021. This showcases the complex linkages between various aspects of malnutrition, which can be linked back to under- or overconsumption of certain nutrients.

3.2 Data

We used data from the Food Balance Sheets (FBS) provided by FAOSTAT, which offer standardized national-level estimates on food production and trade. The FBS data are a widely

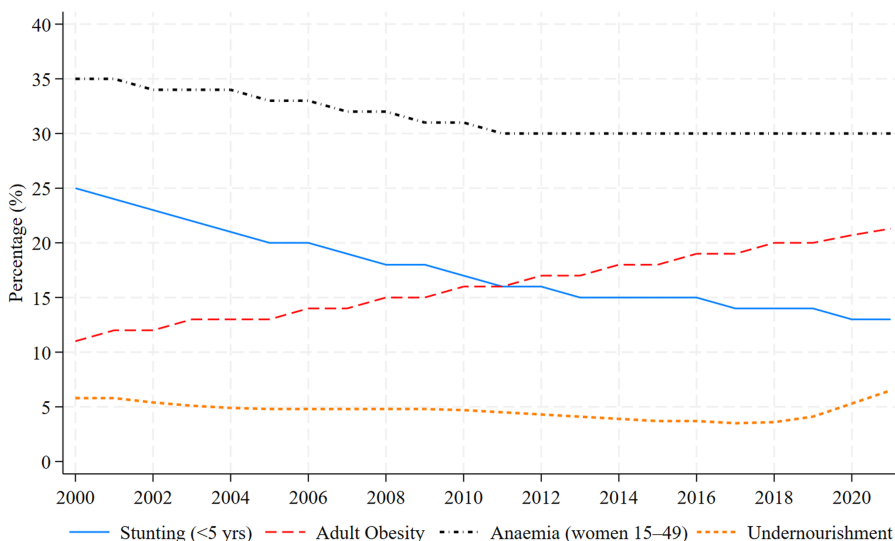


Figure 1. Key health indicators between 2000 and 2021 for Morocco. Source: Authors' own work based on FAOSTAT data

used source in agriculture, nutrition and health research ([Hoffmann et al., 2021](#); [Macdiarmid et al., 2018](#)). The data are collected from governmental organizations and standardized across countries, with unavailable data or missing values being extrapolated based on country regional surveys. The dataset includes annual information on four key trade elements: (1) production (quantities produced within Morocco), (2) imports (quantities brought in from the rest of the world), (3) exports (quantities sent abroad) and (4) domestic supply, calculated as $Production + Imports - Exports$, accounting for the part destined for human consumption (so excluding, e.g. feed, seed and losses). The analysis covers 94 major food items, with the quantities expressed in 1,000 tons. The time horizon covers the period between 1991 and 2021, which is the latest year available at the time of the analysis. We chose 1991 as starting point, since Morocco has experienced three major agricultural trade and development policies since then: massive privatizations of Moroccan institutions and economy openness in the early 1990s, the free trade agreement signed with the EU in 1996 that entered into force in 2000, and the “Green Morocco plan” launched in 2008.

The (FBS) methodology changed over time, with the old version covering data up to 2013 and the revised version from 2010 onward. The main differences concern the treatment of imbalances previously absorbed into a single element, now proportionally distributed using improved imputation modules and updated UN population data (2019 vs. earlier versions). To assess potential effects on our results, we compare overlapping years (2010–2013) using both versions ([Appendices 1–3](#)). Findings remain consistent; therefore, we use the old version for 1991–2009 and the revised version for 2010–2021.

3.3 Conversion into food groups

The first part of the analysis examines production and trade patterns across food groups. We aggregate FBS items into 12 food groups based on the EAT-Lancet Commission classification ([Willett et al., 2019](#)). Each food item is assigned to one group (see [Appendix 4](#) for detailed explanation and mapping). We retain the edible portion instead of the total weight ([Macdiarmid et al., 2018](#)). This means that for fruits, vegetables and nuts, we exclude inedible parts, like kernels, peels and shells, while for animal products, we convert the whole carcass weight into meat without bones ([Aleid et al., 2014](#); [Ferrão et al., 2021](#); [Sen et al., 2004](#)) (see [Appendix 5](#) for more details).

To compare domestic food supply in Morocco with the EAT-Lancet Commission’s recommendations for a healthy and nutritious diet, we express all values in grams per day per capita. We divide the total quantities (in tons) for each food group by the number of days in the year and the population for each year, with population data from FAOSTAT.

3.4 Conversion into macro- and micronutrients

The second part of the analysis focuses on the production and trade patterns of macro- and micronutrients. We follow the same approach as for the food groups, focusing on the edible portion of each item, but now we convert each of the 84 food items into their nutritional content. We calculate calories, proteins, carbohydrates and fats as macronutrients, and iron, magnesium and vitamin A as key micronutrients. We do so by matching the edible portion of each FBS food item with the data from the updated Moroccan food composition tables ([Khalis et al., 2020](#)). For certain items, we utilize the nutritional composition of their end-use applications. For example, the item ‘Wheat and wheat products’ is represented by a weighted average of various wheat derivatives, including pasta and bread in their different forms. [Appendix 6](#) describes in detail the conversion of each food item into their nutritional content.

For each macro- and micronutrient, we present the recommended intake as well. To account for different nutritional needs across sex and age, we assign weights to each sex and age category based on population demographics and calculate the weighted average nutritional needs of the entire population ([Macdiarmid et al., 2018](#)). To test the robustness of the adequacy assessment, we apply alternative demographic weightings and reference intake standards. The

results confirm that deviations from recommended intake remain broadly unchanged. Detailed findings are reported in [Appendix 7](#).

A schematic overview of these conversions is provided in [Appendix 8](#) to enhance transparency and guide the reader through the main analytical steps.

3.5 Econometric specification and diagnostic tests

To examine the relationship between trade and nutrient availability, we estimate a system of seven nutrient equations using seemingly unrelated regressions (SUR). This approach accounts for contemporaneous correlation across equations, as shocks to Morocco's food system may simultaneously affect multiple nutrient outcomes. Each equation is specified as an autoregressive model in log levels, with a lagged dependent variable, trade and production covariates, and a deterministic time trend [Equation 1](#). Augmented Dickey–Fuller (ADF) tests support modelling the series in levels with trend. The Breusch–Pagan test rejects the null of cross-equation independence ($\chi^2(21) = 107.731, p = 0.000$), confirming the efficiency gains from SUR relative to separate OLS estimations. Residual diagnostics show no evidence of first-order serial correlation. Full diagnostic results are reported in [Appendix 9](#).

$$\ln(N_{k,t}) = \alpha_k + \rho_k \ln(N_{k,t-1}) + \beta_{1k} \ln(\text{Imports}_t) + \beta_{2k} \ln(\text{Exports}_t) + \beta_{3k} \ln(\text{Production}_t) + \delta_k \text{Trend}_t + \varepsilon_{k,t} \quad (\text{Equation 1})$$

$$k \in \{\text{Calories, Proteins, Fats, Carbohydrates, Iron, Vit A, Magnesium}\}.$$

4. Results

4.1 Production and trade patterns of food groups

[Figure 2](#) presents a comparative analysis of the different production and trade patterns (domestic supply, production, imports and exports) for each of the twelve food groups, all measured in g/day/capita. We observe different trends across food groups and across the production and trade patterns. We first describe domestic supply, which represents the food availability for human consumption. Over time, cereals have remained consistently the largest component of domestic supply, followed by vegetables. The domestic supply of cereals was stable over time, while the vegetable supply peaked in the mid-2000s before declining in the past decade. For animal products, the domestic supply of poultry and fish peaked between 2015 and 2019 at 39 g/day/capita and 46 g/day/capita, respectively, before slightly declining. Red meat supply saw a modest increase of 23%, reaching 27 g/day/capita by 2021. Egg and dairy supply also grew significantly, with dairy supply doubling over the years, suggesting a substantial increase in dairy consumption among Moroccans. Domestic supply of legumes and nuts has tripled over time, but remains relatively low compared to the other food groups.

Domestic supply is mainly determined by production in Morocco, but production patterns tend to be much more erratic. This is especially the case for cereal production, which fluctuated a lot over time. Cereal production in Morocco between 1991 and 2021 has not followed a consistent upwards or downwards trend but has instead shown significant volatility. While there were years of strong output, such as 1996, 1994 and 2015, other years, particularly during droughts ([Treguer et al., 2018](#)) like 2000, 2016 and 2020, saw production levels fall sharply. In contrast, vegetable production saw a significant surge from the early 1990s to the mid-2000s, reaching over 498 grams per day per capita, but later stabilized and declined slightly, averaging around 386 grams per day per capita in recent years. Similarly, fruit production also grew, with average levels in the most recent five years about 40% higher than in the early 1990s, reaching 333 g/day/capita by 2021. Animal product production, particularly poultry and fish, saw a

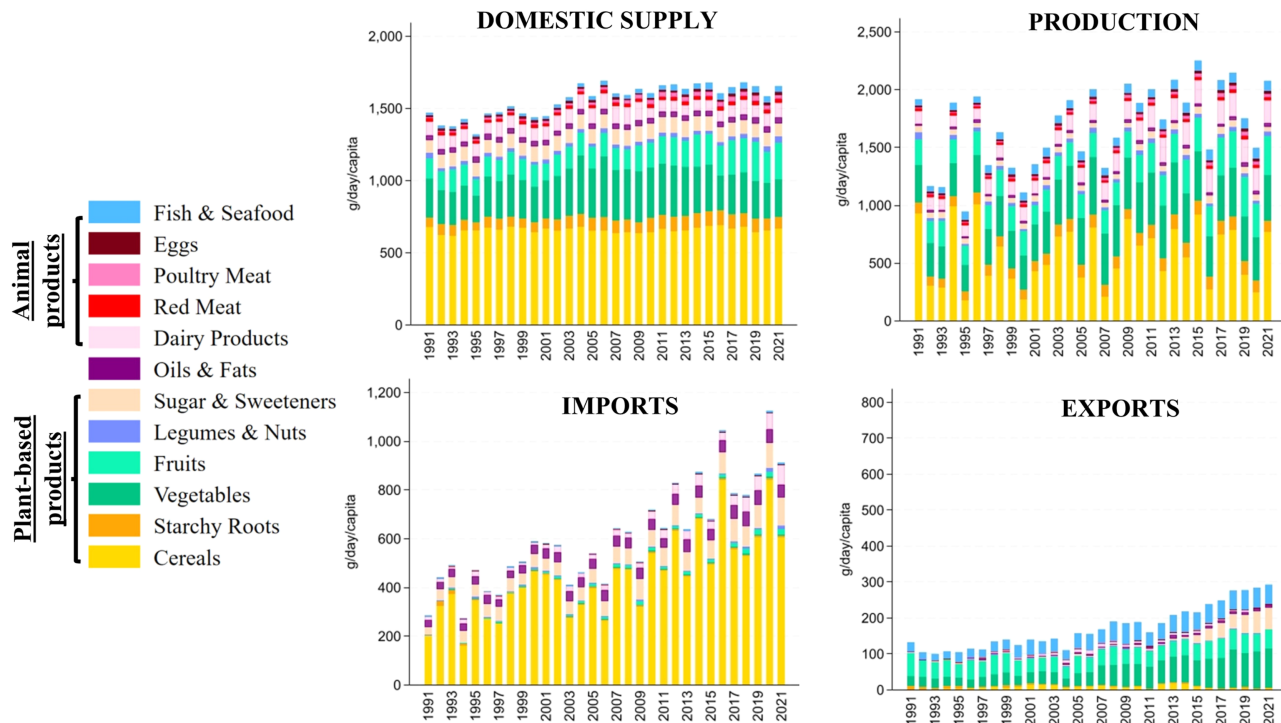


Figure 2. Domestic supply, production, imports and exports for each of the twelve food groups destined for human consumption in Morocco from 1991 to 2021. Source: Authors' own work

dramatic increase, surging by 200 and 50%, respectively, while dairy production approximately doubled. Meanwhile, legume and nut production remained relatively stable throughout the period, with limited variation over time. The volatility in production is compensated through imports, particularly for cereals. Cereal imports increased from approximately 282 g/day/capita in the early 1990s to 628 g/day/capita in recent years, a 120% growth. This value is higher than domestic cereal production, which was 590 g/day/capita in the five recent years, indicating that Morocco depends now more on imports than on its own production for cereals (see [Appendix 10](#) for more details). While vegetable imports remain negligible, fruit imports have increased significantly, reaching 22 g/day/capita in 2021. Dairy imports rose from 42 g/day/capita in 2017 to 83 g/day/capita in 2021. Legume and nut imports also increased, from 3 g/day/capita in the early 1990s to 11 g/day/capita in recent years, as stagnant production failed to keep up with population growth. Morocco's imports of oils and fats rose by 86%; similarly, sugar imports have increased in recent years.

Overall, export volumes are smaller than imports, indicating a positive agri-food trade balance. While cereal exports are negligible, vegetable exports have steadily increased, growing about fourfold from 26 g/day/capita in 1991 to 100 g/day/capita in 2021. The proportion of domestically produced vegetables allocated for export rose from 8% in the early 1990s to 27% in 2021, explaining why Morocco is now one of the key vegetable exporters from Africa. Fruit exports have remained relatively stable over time. Meanwhile, Morocco has become a key exporter of oil and fats, particularly olive oil and refined soybean oil. Sugar and sweetener exports have also increased.

4.2 Comparison with the EAT-Lancet recommended diet

[Table 1](#) compares Morocco's daily food supply with EAT–Lancet recommendations and assesses trends over 1991–2021 using the Mann–Kendall test and Sen slope. Cereals and added sugars show no significant long-term trends but remain far above recommended levels in 2021 (+188% and +187%, respectively). Vegetables display no significant trend and remain 13% below recommendations.

Fruits and dairy products exhibit significant upwards trends; fruits exceed recommended intake in 2021 (+28%), while dairy remains 18% below the benchmark. Among protein sources, red meat, poultry, eggs, and fish show significant increases, with red meat exceeding recommendations by 89% in 2021. Despite a positive trend, legumes and nuts remain 45% below the recommended intake.

We complement these findings by reporting mean percentage deviations from recommended intake across sub-periods (1991–2000, 2001–2010 and 2011–2021) with 95% confidence intervals ([Appendix 11](#)). The appendix results confirm the persistence of large and statistically significant excesses in cereals and sugars across all sub-periods. Similarly, substantial deficits in legumes and dairy products remain statistically significant throughout the 3 decades. Vegetables exhibit a more nuanced pattern: while deviations narrow over time and briefly approach adequacy in the middle sub-period, supply remains at or below recommended levels in most years, indicating that improvements have not fully closed the dietary gap. While some categories, such as fruits, poultry and fish, shift from deficits in earlier periods to excess in the most recent sub-period, the deviations from EAT–Lancet benchmarks remain statistically significant in most cases, pointing to enduring structural imbalances over time.

4.3 Production and trade patterns of macro- and micronutrients

[Figure 3](#) illustrates the evolution between 1991 and 2021 of production, imports, exports, and domestic supply for calories, proteins, carbohydrates and fats. Domestic supply for calories, proteins and fats has increased since 2000. This is attributed to rising imports for calories and increased production and imports for proteins. In contrast, carbohydrate domestic supply remained stagnant, as the decline in production was offset by increased imports. In general,

Table 1. Trends in Moroccan domestic food supply and deviation from Eat-Lancet dietary recommendations (1991–2021)

Food Groups	Moroccan Domestic Supply grams per day				Comparison with the Eat-Lancet target	
	1991	2021	Mann-Kendall Test (Sen Slope)	Time Evolution (1991-2021)	Recommended Lancet intake grams per day (possible range)	2021 deviation supply from recommended intake (%)
Cereals						
Rice, wheat, corn and other	678	668	0.084 (0.086)		232	188%
Tubers or starchy vegetables						
Potatoes, cassava and others	67	80	0.531*** (0.565)		50 (0–100)	60%
Vegetables						
All vegetables	268	260	0.187 (0.066)		300 (200–600)	–13%
Fruits						
All fruits	140	256	0.716*** (0.205)		200 (100–300)	28%
Dairy foods						
Whole milk or equivalents	92	204	0.867*** (0.212)		250 (0–500)	–18%
Protein sources						
Red meat	22	27	0.609*** (2.896)		14 (0–28)	89%
Chicken and other poultry	11	30	0.867*** (0.948)		29 (0–58)	2%
Eggs	13	20	0.320** (1.750)		13 (0–25)	54%
Fish	16	41	0.759*** (0.800)		28 (0–100)	47%
Legumes + Nuts	41	42	0.355*** (1.244)		125 (0–175)	– 45%
Added fats						
Unsaturated oils	29	35	0.372*** (2.564)		40 (20–80)	–13%
Saturated oils	6	6	–0.015 (–1.541)		11.8 (0–11.8)	– 49%
Added sugars						
All sugars	85	89	0.196 (0.631)		31 (0–31)	187%

imports play an important role in attenuating the volatility of domestic production for all macronutrients. The dynamism of Morocco’s agri-food sector is evident in the increased exports of calories, proteins and fats since 2000, and of carbohydrates after 2012. When comparing these values with the daily needs, we find that the domestic supply of all macronutrients has consistently been larger than population requirements, except for fats, where adequate supply was achieved from 2000 onwards. Morocco is still reliant on imports to meet the population requirements for calories and fats, with imports accounting for around half of the total supply, while domestic production largely covers proteins and carbohydrates.

Figure 4 shows the production, imports, exports and domestic supply of three key micronutrients (iron, vitamin A and magnesium) between 1991 and 2021. The total supply of these micronutrients generally met Moroccan population requirements, and in most years, domestic production alone sufficed without relying on imports. Regarding iron, domestic production stabilized starting from 2000 and consistently remained above the requirement line. During this period, both imports and exports increased, leading to a 23% rise in domestic supply of iron. A significant increase in vitamin A levels was observed post-2000, coinciding with the implementation of the EU-Morocco Free Trade Agreement. This surge is directly linked to expanded production of fruits and vegetables rich in vitamin A. Magnesium supply was largely met through domestic production.

To assess temporal stability, we examine the mean, standard deviation and coefficient of variation (CV) of per capita nutrient supply across sub-periods (Appendix 12). Macronutrients

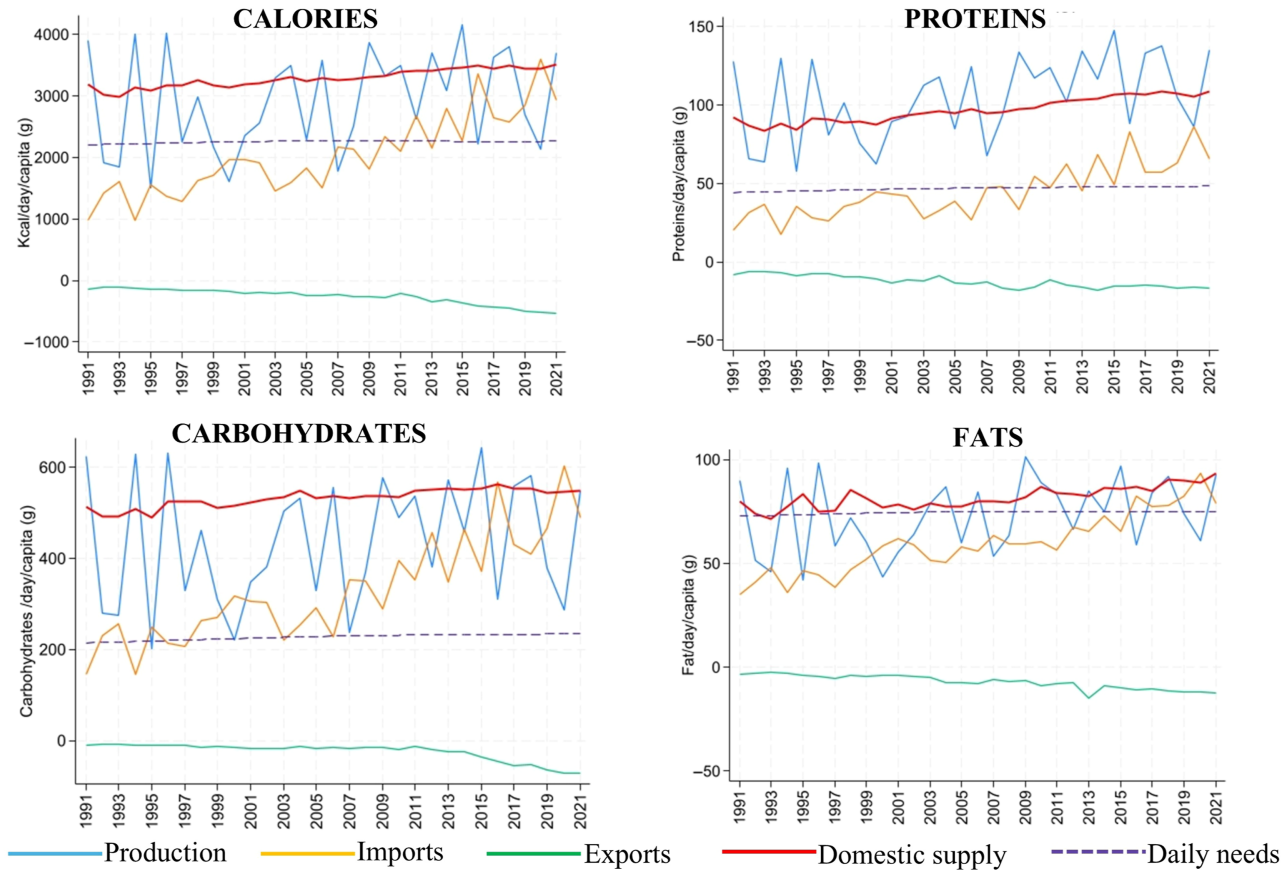


Figure 3. The evolution of macronutrients (calories, proteins, carbohydrates and fats): production, imports, exports and domestic supply between 1991 and 2021. Source: Authors' own work

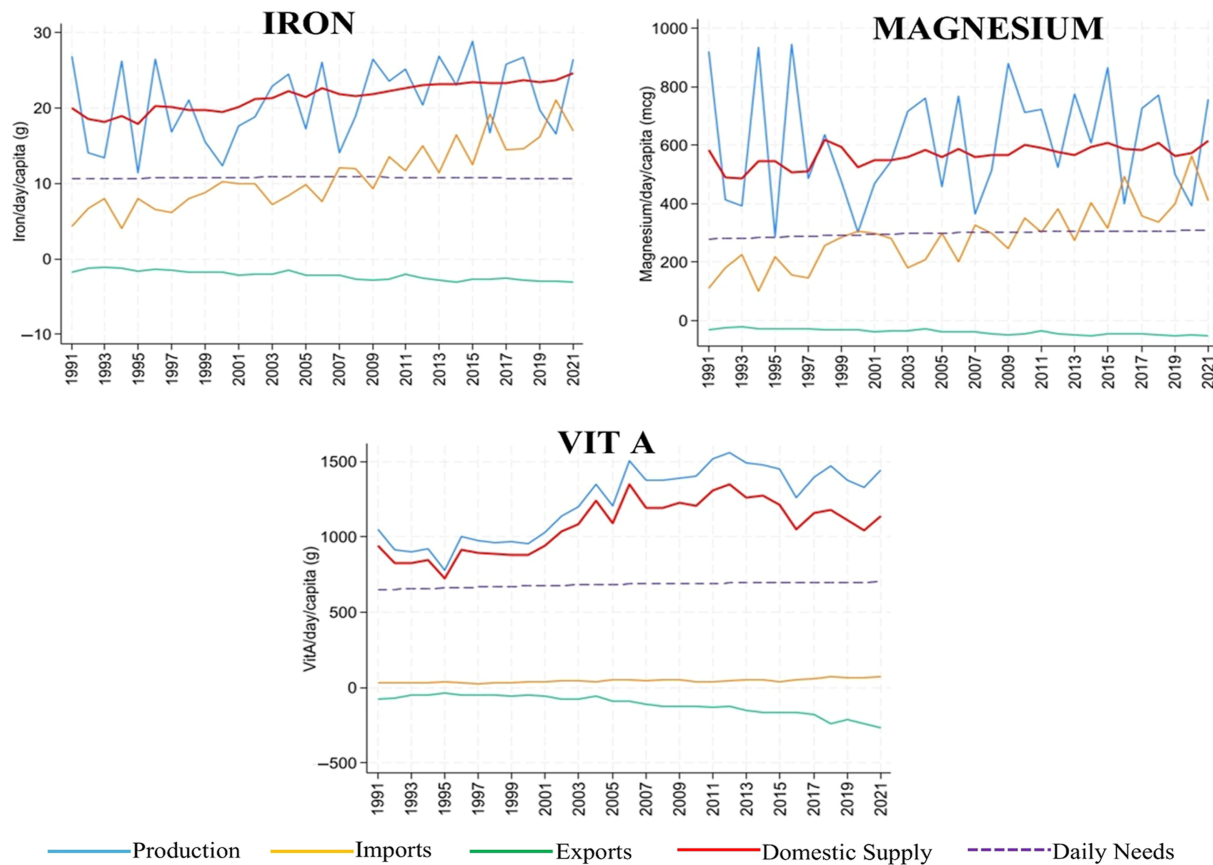


Figure 4. The evolution of micronutrients (iron, magnesium and vitamin A): production, imports, exports and domestic supply between 1991 and 2021. Source: Authors' own work

show low variability (CV generally below 5% for calories, proteins and carbohydrates, and 4–7% for fats), while iron and magnesium also remain stable over time. These low CVs suggest persistent supply patterns rather than short-term volatility. Vitamin A displays higher variability, particularly during 2001–2010, reflecting its sensitivity to domestic production dynamics (see [Figure 4](#)). Overall, nutrient supply remains broadly stable over the period 1991–2021.

4.4 Econometric results: SUR estimates

[Table 2](#) reports the main regression results examining the relationship between trade and nutrient availability. Each column corresponds to one of the seven nutrient availability, while the rows present the estimated coefficients of the explanatory variables. The lagged dependent variables are positive and highly significant in every specification, confirming the persistent nature of nutrient availability over time. The overall model fit is strong for most nutrients, with R-squared values above 0.90 in five specifications, although it is lower for fats (0.72) and magnesium (0.49).

The results indicate a positive and statistically significant association between local production and nutrient availability for most outcomes. A 1% increase in local production is associated with small increases in macronutrients (0.06% calories, 0.09% proteins and 0.07% carbohydrates) and micronutrients (0.11% iron, 0.35% vitamin A and 0.13% magnesium).

Exports are, in most cases, negatively associated with nutrient availability. This relationship is statistically significant for carbohydrates (0.08%), iron (0.09%) and vitamin A (0.37%). In contrast, exports are positively and significantly associated with fat availability (0.15%). Imports display statistically insignificant coefficients across all nutrients, indicating that imports are not associated with higher (or lower) nutrient availability, holding all other factors constant.

As a robustness check, we augment the baseline specification with log GNI per capita to control for overall economic development (see [Appendix 13](#)). The inclusion of income does not materially alter the magnitude or significance of the trade variables, and GNI itself is not statistically significant. ADF tests (see [Appendix 14](#)) show that most variables are stationary when a trend is included. Iron is the only exception. Residual-based tests confirm that the iron equation has stationary residuals ($p = 0.012$), reducing concerns about spurious regression.

5. Discussion

5.1 Domestic supply versus recommended intake levels

We first compare Morocco's domestic supply to the recommended intake levels for various food groups and macro- and micronutrients. Since the start of the measures in 1991, the country has generally met population-weighted dietary requirements for most of the food groups, except for dairy, legumes, nuts and fats. The domestic supply of many food groups even exceeds the recommended levels by far. For nearly all macro- and micronutrients, domestic supply is more than sufficient to cover the recommended intake levels. An exception is fats, which were fully covered only after 2008.

Trends in domestic food supply appear to align with improvements in health indicators shown in [Figure 1](#). In particular, the increase in calorie availability, mainly through cereals and meat, may have contributed to the observed reductions in undernourishment and stunting. However, there is no guarantee that those most in need of nutrients have access to them, as food distribution and the associated nutrients primarily depend on the purchasing power of the population ([Wood et al., 2018](#)). Undernourishment remains at 6.5% of the population, and child stunting at 13%, highlighting distributional issues within the country. In the meantime, the supply of calories and fats has even exceeded recommended intakes, contributing to suboptimal dietary patterns. This evolution, combined with a more sedentary lifestyle, has led to a sharp rise in obesity rates in Morocco, increasing from approximately 10% in 1991 to around 20% in 2021, reflecting a nutritional transition in the country ([Kaoutar et al., 2022](#)).

Table 2. Estimates from seemingly unrelated regression (SUR) framework on seven vector autoregression (VAR) models, linking production, imports and exports to nutrient availability

Variables	Log calories	Log proteins	Log fats	Log carbohydrates	Log iron	Log Vit A	Log magnesium
Log Production	0.060*** (0.020)	0.090*** (0.020)	−0.001 (0.050)	0.070*** (0.020)	0.110*** (0.030)	0.350*** (0.090)	0.130* (0.070)
Log Imports	0.010 (0.020)	0.010 (0.020)	−0.020 (0.060)	0.020 (0.020)	0.010 (0.030)	0.050 (0.090)	0.020 (0.070)
Log Exports	−0.020 (0.020)	−0.020 (0.030)	0.150** (0.080)	−0.080*** (0.030)	−0.090** (0.040)	−0.370*** (0.120)	0.040 (0.100)
Trend (Year)	0.003** (0.001)	0.005*** (0.002)	−0.000 (0.004)	0.003*** (0.001)	0.010*** (0.002)	0.010** (0.010)	−0.001 (0.004)
Log Y_{t-1}	0.340*** (0.070)	0.340*** (0.070)	0.360*** (0.080)	0.380*** (0.080)	0.350*** (0.080)	0.570*** (0.070)	0.360*** (0.110)
Constant	−0.530 (1.950)	−7.430*** (2.740)	3.110 (6.790)	−2.930 (2.380)	−14.220*** (3.870)	−23.440** (11.520)	3.960 (8.720)
Observations	30	30	30	30	30	30	30
R-squared	0.950	0.980	0.720	0.900	0.960	0.900	0.490

Note(s): Standard errors in parentheses

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$

log Y_{t-1} denotes the lagged dependent variables

Source(s): Authors' own work

Therefore, there is a need for policies that specifically target the most vulnerable segments of society to ensure equitable access to essential nutrients and improve overall nutritional outcomes. Another key link relates to the increase in proteins over time, which is mainly driven by the expanding supply of meat products. It aligns with a slight improvement in reducing anaemia among adult women in Morocco, as meat tends to be a key source of iron (Gibson and Ashwell, 2003). The growth in meat products can be attributed to increased production, which is corroborated by the regression results. Sraïri (2011) showed that this increase was driven by substantial subsidies provided to livestock producers under the “Green Morocco Plan”. However, the current supply is estimated to be more than double the population-level requirement. Given that high meat consumption is associated with high levels of greenhouse gas emissions and a higher likelihood of certain diet-related diseases (Chen *et al.*, 2013), policies might focus on lowering meat consumption (Clark *et al.*, 2020). Morocco has the potential to diversify its animal protein sources through its two extensive coastlines, stretching over 3,500 kilometres. The dynamism in the fishery sector, including the launch of the “Halieutis” program in 2009, contributed to a 156% increase in fishery production. In 2021, the estimated average annual fish domestic supply in Morocco reached 15 kg per capita, which is more than double the amount recorded at the beginning of the study period, yet it remains below the global average of 21 kg per capita (FAO, 2024a). The sector is heavily export-oriented, with around 730,000 tons exported per year, which represents more than 60% of the production. Encouraging local fish consumption through targeted policies and awareness campaigns could help balance protein sources while promoting a more sustainable and climate-friendly diet.

5.2 The role of trade: a double-edged sword

The regression results indicate that domestic production is the primary driver of nutrient availability over time, with positive (but small) elasticities for most macro- and micronutrients, particularly vitamin A, iron and proteins. This suggests that improvements in aggregate nutritional availability are more closely associated with domestic production dynamics than with trade flows *per se*, and that dietary diversity is primarily driven by domestic production rather than trade. Yet, trade flows have been important in shaping the stability and sustainability dimensions of food security.

The improvements in stability of Morocco’s domestic supply coincide with increasing imports. Relying on imports has been especially important to stabilize cereal supply, particularly since 2009, which has been crucial for the country’s economic health, social stability and national security (Bentley *et al.*, 2022). In addition, dairy supply has remained stable in the last five years due to rising imports, which have helped to offset a decline in production. Global production of food commodities is generally less volatile than production in individual countries, indicating that if global markets function well, their potential to stabilize food availability is larger than through local markets.

However, the threat of global shocks such as economic crises, trade disruptions and the long-term impacts of climate change has intensified discussions about self-sufficiency versus import dependency in meeting population needs (Macdiarmid *et al.*, 2018; Ouraich *et al.*, 2019). Morocco’s reliance on cereal imports, mainly wheat and wheat products that are a dietary staple, is a cause for concern (Appendix 10). Annual cereal imports have risen significantly from approximately 1.8 million tons to 8.2 million tons between 1991 and 2021. Domestic cereal production has struggled to keep pace with consumption, mainly due to its reliance on unpredictable rainfall (Treguer *et al.*, 2018). Moreover, production has declined over the study period, falling below import levels in the last five years. This is in line with the study by Akesbi (2011), who noted that cereal production was not a key priority of the “Green Morocco Plan”. Given increasing global shocks, mainly due to geopolitical instability, these trends raise concerns about the stability of caloric supply, a critical factor for national security and social well-being. At the same time, the current cereal supply exceeds daily requirements

by threefold, so there might be an opportunity to diversify diets in order to decrease import dependency. However, wheat remains a cultural staple in Morocco, and shifting dietary habits may face resistance and require substantial societal adjustments. Such a shift potentially necessitates subsidies or behavioural interventions to promote dietary changes.

Another major pattern over time is the significant rise in fruit and vegetable production. This can be linked to the implementation of the FTA with the EU and substantial investments under the “Green Morocco Plan”. Despite being a leading vegetable exporter, whose exports quadrupled from 1991 to 2021, Morocco’s domestic supply (260 g/day/capita) remains below the optimal intake level of 300 g/day/capita. The deviation analysis shows that, although the gap has narrowed over time and slightly above the adequacy in the 2001–2010 sub-period, vegetable supply remains at or below recommended levels in the other periods. This suggests that improvements in production and trade performance have not fully translated into sustained dietary adequacy. While trade openness has strengthened Morocco’s agricultural export sector, it may also have redirected resources towards external markets, limiting the domestic availability of vegetables that are critical sources of micronutrients. Consistent with this interpretation, exports are negatively associated with the availability of carbohydrates, iron and vitamin A in the regression results, suggesting a potential trade-off between export orientation and domestic nutrient availability. Given Morocco’s structural water scarcity, the expansion of water-intensive fruit and vegetable exports under recurrent drought conditions highlights the double-edged nature of trade ([Haddadi et al., 2025](#)): it fosters growth but may also exacerbate resource pressures and reduce system resilience. This suggests a trade-off between exports and domestic supply, which needs to be considered when balancing global and local supply chains, especially in imperfect markets ([Feyaerts et al., 2020](#)).

5.3 Research limitations

We need to acknowledge some research limitations, mainly linked to the data source. While the FBS data are widely used and the most comprehensive database available to analyse domestic supply, production, exports and imports of different food items, they entail some limitations. First, the data quality of the nutritional composition is sometimes contested. However, we found minimal discrepancies between the FBS data and the values from Morocco’s food composition table. These minor differences are likely attributable to variations in the food composition data used, suggesting that the nutritional data provided by the FBS is credible. Second, the FBS does not provide information on the distribution of nutrients within a country at the individual level. As food security not only depends on supply at the national level, but also on access, utilization and stability at the household/individual level, this is a major caveat to keep in mind when interpreting the FBS data. For example, our results show that Moroccans, in aggregate, consume the recommended amounts of fish. However, questions arise regarding the distribution of this consumption across different social classes in Morocco, as prices are often higher than the average consumer’s purchasing power, particularly for white fish ([FAO, 2003](#)). Third, FBS data measure availability rather than actual consumption and may overestimate nutrient intake due to losses along the supply chain. They also do not fully capture informal markets or cross-border trade, potentially introducing measurement bias. Therefore, FBS data should be interpreted as indicators of potential supply rather than precise measures of dietary intake.

6. Conclusion

This study highlights the evolving relationship between international agri-food trade and nutrition in Morocco. While trade openness has helped stabilize food supply, particularly for cereals and fats, it has also deepened Morocco’s reliance on imports for essential energy sources. The increase in domestic production of high-value agricultural products, particularly fruits, vegetables and animal-based proteins, has been a positive development. However,

competition between exports and domestic supply, especially for vegetables and fish, raises concerns about equitable access to nutritious foods.

Morocco's nutritional transition, marked by rising obesity alongside persistent undernourishment, calls for nutrition-sensitive trade and agricultural production policies. This entails that investments in production should be prioritized for the local market, as these will have larger effects on macro- and micronutrient availability than importing more food. Imports should rather serve to stabilizing shocks in local production. Policy implications for exports are more nuanced. Although exports are associated with reduced availability of some nutrients, the government should be cautious by implementing export reductions on nutritious-dense foods, as these also lead to substantial increases in trade revenues. A possible way to reduce this trade-off would be to use these revenues to strengthen local production or construct social protection programs that focus on improving nutritious food access among the most vulnerable. On the demand side, promoting dietary shifts away from excessive calorie, fat, and red meat consumption, through tools such as labelling, awareness campaigns and targeted taxation, can better align diets with nutritional recommendations and reduce reliance on energy-dense imports.

Future research should focus on assessing the affordability and distribution of nutrient-rich foods within Morocco, as well as the environmental implications of the country's trade model. Given the increasing risks posed by climate change and global market fluctuations, a balanced approach that strengthens both domestic food resilience and strategic trade partnerships will be crucial to ensuring long-term food security and nutritional adequacy in Morocco.

Supplementary material

The supplementary material for this article can be found online.

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