Political Economy of the Wheat Sector in Morocco: Seed Systems, Varietal Adoption, and Impacts

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Institut National de la Recherche Agronomique

ICARDA

Science for resilient livelihoods in dry areas

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Preface

In Morocco, wheat is an important cereal crop that significantly contributes to the livelihoods of farming communities and the national economy. On average for the period 2010–2016, the country produced 5.7 million tonnes of wheat grain on about 3.2 million ha of land. In 2013, total cereal production accounted for 47% of the agricultural value added. Wheat production alone was worth about USD 850 million, making it the second most important crop after olives.

In the 1960s, Morocco was largely self-sufficient, producing more than 80% of the wheat for domestic consumption. This declined over the years and by the turn of the century, on average, only 60% of the total domestic demand for wheat was met. Despite the doubling of its population during the same period, the per capita supply of wheat increased impressively from 138 kg/person in the 1960s to an average of 255 kg/person in the period 2001–2016. Considering the population increase and changing food habits, wheat, and particularly bread, consumption became an even bigger component of food security.

With the introduction of improved wheat varieties in the 1980s, significant increases in yields were observed, though the yield levels were far below both the global average of over 3 t/ha and the African average of 2.3 t/ha. Consequently, Morocco continued to import large volumes, making wheat the most important (in both volume and value terms) of all agricultural imports. Despite the high dependency on imports, wheat remains one of the most important food staples in the Moroccan diet. The Green Morocco Plan (GMP) (the official government strategy to achieve food security), for the sustainable management of natural resources and agricultural competitiveness, considers the cereal seed system as a fundamental component to enhance the agricultural sector and to achieve wider economic development.

The use of high-yielding varieties and the associated crop management practices have been the major drivers for the significant changes in wheat production and productivity. One of the most important results from public investment in agricultural research is the development of new crop varieties and their associated technologies. The Government of Morocco and its

international research and development partners have made substantial investments in agricultural innovation. However, developing new crop varieties is not enough. To have a real impact, crop development should be coupled with an efficient and effective seed-delivery system that will push technologies out to farmers' fields. Within this context, there are several actors in the Moroccan seed sector. These include the national agricultural research system, public and private seed companies with networks of seed dealers, associations of seed growers and seed traders, and regulatory agencies whose individual or collective strengths and weaknesses influence the country's ability to achieve meaningful impacts.

This book, *Political Economy of the Wheat Sector in Morocco: Seed Systems, Varietal Adoption, and Impacts,* documents the studies conducted on the wheat sector in general. It also documents the wheat seed system, its adoption and impacts in Morocco, through support provided by the CGIAR Research Program (CRP) on Wheat and the European Union-International Fund for Agricultural Development (EU-IFAD) Project. Chapter 1 highlights the cereal seed sector, including the policy and regulatory frameworks. Chapter 2 presents the development of improved wheat varieties, their registration and release, including variety protection and licensing for commercialization. Chapter 3 summarizes the early generation seed (breeder, pre-basic, and basic) multiplication by the National Agricultural Research System (NARS), and large-scale certified seed production by the public and private sectors. Chapter 4 elaborates on seed quality assurance and certification. Chapter 5 describes the adoption and impacts of improved varieties and seed demand analysis. Chapter 6 presents perspectives on the wheat seed sector. Chapter 7 synthesizes the overall findings on the wheat seed sector, focusing on delivery systems, variety adoption, and impacts in Morocco.

The experiences documented in this book are expected to inform stakeholders – including policy makers, researchers, farmers, private and public commercial farms, and development partners – about the status, challenges, and opportunities in the wheat sector in Morocco. Additionally, it paves the way for the development of more efficient intervention options for the future.

Editors
February 2019

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The views and opinions expressed in this book are purely those of the authors and do not necessarily reflect the views of their employers.

Abbreviations

AMMS	Association Marocaine des Multiplicateurs de Semences (Moroccan Seed Growers' Association)
AMSP	Association Marocaine des Semences et Plants (Moroccan Seed Trade Association)
CAP	Common Agricultural Policy
CCPOV	Commission Consultative de la Protection des Obtention Végétale
CIHEAM	Centre International de Hautes Etudes Agronomiques Méditerranéennes
CIMMYT	International Maize and Wheat Improvement Center
CNSSP	Comité National de la Sélection des Semences et des Plants
COMADER	Confédération Marocaine de l'Agriculture et du Développement Rural
CRP	CGIAR Research Program
DCSP	Division de Contrôle des Semences et Plants
DDFP	Direction de Développement des Filières de Production
DPA	Direction Provinciale d'Agriculture
DPVCTRF	Direction de la Protection des Végétaux, des Contrôles Techniques et de la Répression des Fraudes
DRA	Direction Régionale d'Agriculture
DSS	Directorate of Strategies and Statistics
DUS	Distinctness, uniformity and stability
EU	European Union
FDA	Fonds de Développement Agricole (Agricultural Development Fund)

FMCA	Fédération Marocaine des Chambres de Agriculture
FNIS	Fédération Nationale Interprofessionnelle des Semences et Plants
GDP	Gross domestic product
GIS	Geographic Information System
GMP (LMV)	Green Morocco Plan (Le Maroc Vert)
GPS	Global positioning system
GTAP	Global Trade Analysis Project
IARC	International Agricultural Research Center
ICARDA	International Center for Agricultural Research in the Dry Areas
IFAD	International Fund for Agricultural Development
INRA	Institut National de la Recherche Agronomique (National Agricultural Research Institute)
ISTA	International Seed Testing Association
MAAR	Ministry of Agriculture and Agrarian Reform
MAD	Moroccan Dirham (USD 1 = MAD 8.62 in 2012 and 8.5 in 2014)
MAPM	Ministère de l'Agriculture et de la Pêche Maritime (Ministry of Agriculture and Maritime Fisheries)
MENA	Middle East and North Africa
MHH	Men heads of households
MoA	Ministry of Agriculture
MoAF	Ministry of Agricuture and Fisheries
MoF	Ministry of Finance
NARS	National Agricultural Research System
OECD	Organisation for Economic Co-operation and Development
ONCA	Office National du Conseil Agricole
ONSSA	Office National de Sécurité Sanitaire des Produits Alimentaires (National Office for the Safety of Agricultural Products)

ORMVA	Office Régional de Mise en Valeur Agricole
PSM	Propensity score matching
PVP	Plant Varieties Protection
SODEA	Société de Développement Agricole (Farm Development Corporation)
SOGETA	Société de Gestion des Terres Agricoles (Agricultural Land Management Corporation)
SONACOS	Société Nationale de Commercialisation des Semences (National Seed Commercialization Company)
UNESCO	United Nations Educational, Scientific and Cultural Organization
UPOV	International Union for the Protection of New Varieties of Plants
USDA	United States Department of Agriculture
VCU	Value for cultivation and use
WHH	Women heads of households
WTO	World Trade Organization

List of tables

Chapter 6: Wheat sector perspectives

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6 Wheat sector perspectives

6.1 Executive summary

With a consumption of more than 250 kg of wheat per person per year, Morocco has one of the highest per capita wheat consumptions in the world. Such a high consumption is in part the result of the subsidies that Morocco has been providing to the wheat sector to make wheat byproducts (bread, pasta, etc.) affordable. Keeping wheat prices low has traditionally been a popular policy in Morocco. Yet, following independence, the total supply of wheat has become more reliant on imported wheat, and less on domestically produced wheat. While this is not necessarily bad, the Moroccan government has been determined to increase domestic wheat production to become fundamentally self-sufficient. To this end, since the 1980s, wheat imports have been subject to high tariffs (even more than 100% ad valorem). This has provided protection to domestic wheat producers. Yet, Morocco's trade agreements with the EU, the USA, and other countries have been pushing and will eventually achieve complete elimination of the import tariffs. Aware of this situation, the Moroccan government has been allocating resources to improve wheat productivity, to make the sector more competitive. This section focuses on understanding how a hypothetical elimination of tariffs on imported wheat will affect domestic wheat supply. This simulation was complemented with a productivity shock that simulated technological improvement leading to a productivity increase in the Moroccan wheat sector.

The methodology used the Global Trade Analysis Project (GTAP) model to rigorously estimate possible outcomes emerging from technological changes and the elimination of import tariff protection. The results indicate that domestic wheat production would increase because of improvements in capital and unskilled labor productivity and would decrease as result of the elimination of tariff protection for domestic wheat. Results suggest that the Moroccan wheat sector strongly depends on import tariffs to keep the wheat

sector protected from more competitive wheat produced abroad. The results also suggest that increased wheat productivity and production will not be enough to reduce wheat imports. Morocco has been and will continue to be a net wheat-importing country. Yet, Morocco does not need to be self-sufficient to increase the per capita supply of wheat. Importing wheat from countries well-endowed with water can be an interesting option to Morocco, allowing it to specialize in the agricultural production of commodities that are less water intensive.

6.2 Introduction

Over time the Government of Morocco has provided significant subsidies to the agricultural sector, in particular for wheat production. As a result of the subsidies, ordinary people in Morocco pay as low as USD 0.2 per loaf of bread (about 500 g). Over time, the wheat subsidy has driven patterns of consumption to be intensively based on cereal consumption, to the point that Morocco has become one of the highest wheat-consuming countries in the world (more than 250 kg/year/per capita). Decades of subsidies and investments to improve wheat productivity, coupled with high import tariffs to protect domestic wheat production from more competitive imports, have not prevented the relative decline in total domestic wheat production in comparison to wheat imports.

In the frame of the WTO negotiations, countries have been encouraged to eliminate import tariffs to experience welfare gains from international trade. What if Morocco decides to liberalize its wheat market? Will per capita consumption of wheat decrease? Will the domestic wheat supply increase? Will improvements in wheat productivity be enough to compensate for a reduction in or elimination of import tariffs? Shedding light on these questions can provide policy makers with key information to analyze the trade-offs that emerge from protecting the wheat sector in the context of subsidies that sustain a large production.

To analyze the implications emerging from wheat liberalization, we simulated changes in tariff protection. To test the effect of policies designed to improve productivity, we simulated technological changes that improve wheat productivity. By analyzing policies for trade liberalization of wheat, we assessed the dependence of domestic wheat production on tariff protection. By testing policies for improved factor productivity, we analyzed the effect in terms of production, imports, self-sufficiency, changes in prices, and overall welfare.

The next part of this chapter presents the methodology used to estimate changes in productivity and the protection tariffs for the wheat sector. This part briefly presents the theory behind the GTAP model that has been used to estimate the macro-effects of increased capital and unskilled labor productivity and import tariff elimination on the overall domestic wheat supply. Then, the results of the simulation scenarios are presented. The effects of increased wheat productivity (resulting from technological change) and import liberalization on the development of the wheat sector, including macro-indicators, such as gross domestic product (GDP), welfare, imports, terms of trade, and shares of domestic production are discussed. How feasible the results obtained might be is the next part discussed. This discussion analyzes the wheat sector in Morocco, focusing on production, imports, and value from the 1960s onwards. It includes reference to the importance of wheat in the Moroccan diet as well as the level of dependence of the country on imported cereals. Water productivity was compared, considering that it is not only cereals that compete for water resources, but other commodity groups, such as vegetables, fruits, and pulses. The purpose of this comparison was to understand from a macro-perspective the trend in agricultural production, not only from an economic viewpoint, but also considering the restrictions that limited water resources can impose in the overall aggregate of commodities that are produced in the country. Finally, conclusions emerging from this study are presented.

6.3 Methodology

Growth and development of the wheat sector is important for food security in Morocco. The extent to which subsidies and tariff protection contribute to improved performance in this sector is analyzed here using the GTAP model (Hertel 1997). This model, widely discussed and described in many economic policy articles, is a standard, static, multi-region, multi-sector computable general equilibrium (CGE) model. It explicitly includes the treatment of international trade and transport margins, global savings and investment, and price and income responsiveness across countries. It assumes perfect competition, constant returns to scale, and an Armington specification for bilateral trade flows that differentiates trade by origin.[1] It also assumes fixed factor endowment and full factor use.

[1] The GTAP model adopts Armington's (1969) treatment for commodity substitution. That is, even in regions producing the same commodity, the elasticity of substitution between the two regions is not infinite, meaning that the "low of one price" does not hold.

In this exercise, the GTAP database Version 8.0 (addressing 129 regions or countries and 57 sectors or commodity groups) was used. It represents a snapshot of the world economy for 2007. The results of this model for all variables are expressed as relative changes from the original GTAP database. That is, the scenario results are percentage changes from the base case scenario. The GTAP model is basically expressed in equations contained in the code of the model, which represents the fundamental theory behind the GTAP model. Given the large number of components included in this code, this simulation focuses on the behavioral equations needed to understand the effects of changes in technology and in tariff protection. It describes the interactions of the various agents of the model, the way goods and services are exchanged, the distribution of production factors, and the way prices are built-up as a result of the shocks.

The GTAP model assumes that agents (e.g. farmers) combine five endowment inputs (land, skilled labor, unskilled labor, capital, and natural resources) with intermediate inputs (fertilizers, seeds, pesticides, or any other input that has already been subject to some level of transformation process) to produce agricultural commodities for final consumption. Farmers' behavior is modelled through the 'production tree' (Figure 6.1). At the top of this figure is the percentage change in the final output (*qo*), which is produced from the percentage change in value added[2] (*qva*) and from the percentage changes in intermediate inputs (*qf*). Also, at the top level, there is a constant elasticity of substitution (*ESUBT*), indicating that if it is non-zero it is possible to substitute value added by intermediate inputs and vice-versa. For example, if *ESUBT* is a positive number, then intermediate inputs could be substituted by employing more labor, land, or capital if the prices of intermediate inputs increase. The farms' production functions use nested constant elasticities of substitution (CES) functions that represent the form in which farms demand endowment and intermediate inputs. At the bottom of the tree, farms purchase the endowment inputs (*qfe*) as well as some domestic (*qfd*) goods.

There is also an elasticity of substitution among the components of value added, namely *ESUBVA* that is also a constant in the model (i.e. *ESUBVA* is a CES function). The *ESUBVA* indicates the degree to which it is possible to increase output by using one or more inputs. For example, agricultural output on a given amount of land can be increased by employing more labor and capital.

[2] In GTAP lexicon, changes in value added refer to changes in production factors – skilled labor, unskilled labor, capital, land, and natural resources.

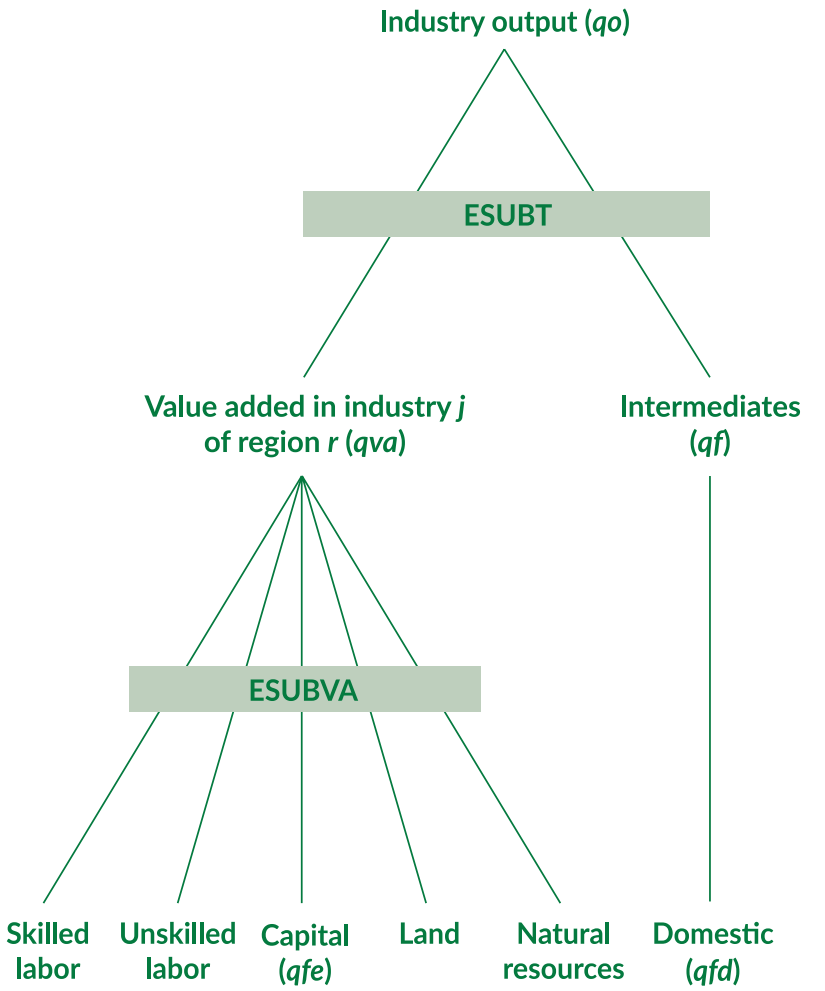

Figure 6.1: Farmer behavior in the "production tree"

Source: Hertel and Tsigas 1997.

The key assumption in the production tree is the separability of the primary factors from the intermediate inputs. Separability permits the nesting of value-added primary factors together (Hertel 1997). The separability assumption of the primary factors from intermediate inputs has two implications:

- The optimal mix of land, labor, and capital (value-added primary factors) is invariant to the price of intermediates

- The elasticity of substitution between any primary factor and intermediates is the same.[3]

The mathematical form of the CES function focuses on the value-added nest. The value-added production function (*QVA*) is produced by assembling inputs or endowments (*QFE*) which, formally, is the amount of endowment *e* used in sector *p* (Equation 1).[4] These endowments are weighted by a distributive parameter (δ) indicating its relative importance in production and raised to a power (σ) that governs the elasticity of substitution between endowments.

$$QVA_p = \left\{ \left(\sum_e \delta_{e,p} QFE_{e,p} \right)^{\frac{\sigma_p - 1}{\sigma_p}} \right\}^{\frac{\sigma_p}{\sigma_p - 1}} \quad (1)$$

On the one hand, if there is a high degree of substitutability among inputs (i.e. high σ), the reduction in one input can be offset by increasing other inputs. On the other hand, if σ is very small (zero in the limit), then a case of the Leontief production function appears, where factors of production are used in fixed proportions as there is no substitutability between them. The implication is that an increase in any production factor will lead to no increase in output. The derived demand equation for inputs that follows this production function is shown as the derived demand for endowment (*QFE*) *e* in sector *p* (Equation 2). This is a function of the overall level of production of value added (*QVA*), the share of input *e* in total value added in sector *p* (*SVA*), and the relative prices of endowments and value added.

$$QFE_{e,p} = QVA_p . SVA_{e,p} . \left\{ \frac{PFE_{e,p}}{PVA_p} \right\}^{-\sigma_p} \quad (2)$$

[3] Hertel (1997) recognizes that the separability assumption might be restrictive for certain applications (e.g. the energy-labor substitution is not equal to energy-capital substitution); however, he claims that this assumption can be relaxed in the GTAP standard model if a full matrix of substitution elasticities is known.

[4] The GTAP model uses linearized equations for general equilibrium. When the intermediate demand shown in Equation 1 is linearized, changes in the value-added production function (*QVA*) become a percentage change in value added (*qva*). It is a function of the percentage change in output (*qo*) and of the relative prices weighted by the elasticity of substitution amongst the intermediates in value added – *ESUBT* (which determines the substitution effect among intermediate inputs and the value-added primary factors).

$qva_j = qo_j - ESUBT_j * [pva_j - ps_j]$ as per the GTAP convention; lower case variables represent percentage changes.

For example, if *QVA* goes up by 1%, then *QFE* also increases by 1% – assuming that relative prices do not change. Underlying this is the assumption of constant returns to scale. Notice that this price ratio is raised to a negative value of the elasticity of substitution (σ). This means that if the price of a given input (*PFE*) rises relative to the average price or cost of all inputs (*PVA*), then the demand for that particular input (*QFE*) will fall given that the relative prices are raised to a negative value of elasticity of substitution. The price index of value added (*PVA*), in the right-hand side in Equation 2, is determined by the sum of the share-weighted prices of the endowments.

In the GTAP model, technological change refers to the variations farms might experience as a result of the technology improvements used in the production of agricultural commodities. In this study, the focus is on technological changes occurring when primary factors (i.e. capital and unskilled labor) augment wheat production in Morocco. To analyze how these technological changes work in the model, let us assume that if technological change in capital (*AFE*) increases, three effects are generated:

- If capital becomes more productive, then less capital is used for a given amount of output and constant prices
- If capital becomes more productive and returns to capital do not change, then the effective price of capital is reduced, encouraging the substitution of other inputs for capital (i.e. more capital demanded)
- More productive capital also lowers the cost of production, facilitating output expansion.

These effects are explained in Equation 3, which is equivalent to Equation 2, but expressed in GTAP code notation. On the left-hand side, an increase in *AFE* (e.g. higher capital productivity) for a constant level of output of value added (*QVA*) and constant relative prices (*PFE* and *PVA*), implies that less capital is needed (*QFE*). On the right-hand side, an increase in capital productivity (*AFE*) lowers the effective price of capital (*PFE*), thus encouraging substitution of capital for other inputs.

$$QFE_{e,p}.\,AFE_{e,p} = QVA_{p}.SVA_{e,p}.\left[\frac{PFE_{e,p}}{PVA_{p}.\,AFE_{e,p}}\right]^{-ESUBVA_{p}} \quad (3)$$

In the CES price equation, an increase in capital productivity (*AFE*) lowers cost, and with a lower price of capital, encourages expansion in the output of the sector (Equation 4):

$$PVA_p = \left\{ \sum_e SVA_{e,p} \cdot \left[\frac{PFE_{e,p}}{AFE_{e,p}} \right]^{1-ESUBVA_p} \right\}^{\frac{1}{1-ESUBVA_p}} \quad (4)$$

Commodity prices in the model are assumed to change as a function of the tariffs on imports (*tm*). These are a source-generic change in tax on imports of the commodity *i* into country *s*, plus supplier import tariffs (*tms*), that is a bilateral import protection measure, and plus the cost, insurance, and freight world price of commodity *i* supplied from country *r* to country *s* (*pcif*). This commodity price formation process in linearized form is shown in Equation 5:

$$pms(i,r,s) = tm(i,s) + tms(i,r,s) + pcif(i,r,s) \quad (5)$$

6.3.1 Sectoral and regional aggregation

The GTAP database is huge, containing input-outputs matrices for 129 regions (countries or groups of countries) and 57 sectors (commodity groups). These are available in Version 8.0. Given this size, the amount of computational resources needed to calculate the data is usually unbearable. Therefore, for the simulations to be solvable, data aggregation is needed (Hertel et al. 2004). Thus, this database was aggregated into 11 regions and 12 sectors, where the criterion for regional aggregation consisted of choosing countries that are important trade partners for Morocco. The criteria for the commodity groups consisted of sectors that are important contributors to Moroccan GDP (Table 6.1).

6.3.2 Simulation scenarios

To assess the technological changes improving wheat productivity and the liberalization of the domestic wheat market, the following three scenarios were defined:

- **Scenario 1**: 20% productivity increase in capital used in wheat production in Morocco
- **Scenario 2**: Scenario 1 plus 20% productivity increase in unskilled labor used in wheat production in Morocco
- **Scenario 3**: Scenario 2 plus full liberalization of import tariffs on wheat imported into Morocco.

Table 6.1: Regional and sectoral aggregation based on GTAP database, Version 8.0

No	Region	Description
1	Mar	Morocco
2	Oceania	Oceania: Australia, New Zealand, rest of Oceania
3	East Asia	East Asia: China, Hong Kong, Japan, Korea, Mongolia, Taiwan, rest of the East Asian countries
4	SEAsia	South East Asia: Cambodia, Indonesia, Lao People's Democratic Republic, Malaysia, Philippines, Singapore, Thailand, Viet Nam
5	SouthAsia	South Asia: Bangladesh, India, Nepal, Pakistan, Sri Lanka
6	N. America	North America: United States, Canada, Mexico
7	LatinAmer	Latin America: Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Paraguay, Peru, Uruguay, Venezuela, Costa Rica, Guatemala, Honduras, Nicaragua, Panama, El Salvador, Caribbean, rest of the Latin American and Caribbean countries
8	EU25	European Union 25: Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, and UK
9	MENA	Middle East and North Africa: Egypt, Tunisia, rest of the MENA countries
10	SSA	Sub-Sahara Africa: Cameroon, Côte d'Ivoire, Ghana, Nigeria, Senegal, Ethiopia, Kenya, Madagascar, Malawi, Mauritius, Mozambique, Tanzania, Uganda, Zambia, Zimbabwe, Botswana, Namibia, South Africa, rest of the African countries
11	ROW	Rest of the world
No	**Sector**	**Description**
1	Wheat	Wheat
2	Cerealgran	Cereal grains not elsewhere classified (nec)
3	GrainCrops	Paddy rice, vegetables, fruit, nuts, oil seeds, sugar cane, sugar beet, plant-based fibers, crops nec, processed rice
4	MeatLstk	Bovine cattle, sheep and goats, horses, animal products nec, raw milk, wool, silk-worm cocoons, bovine meat products, meat products nec
5	Extraction	Forestry, fishing, coal, oil, gas, minerals nec
6	ProcFood	Vegetable oils and fats, dairy products, sugar, food products nec, beverages, tobacco products
7	TextWapp	Textiles, wearing apparel
8	LightMnfc	Leather products, wood products, paper products, publishing, metal products, motor vehicles and parts, transport equipment nec, manufactures nec
9	HeavyMnfc	Petroleum, coal products, chemical, rubber, plastic products, mineral products nec, ferrous metals, metals nec, electronic equipment, machinery and equipment nec
10	Util_Cons	Electricity, gas manufacture, distribution, water, construction
11	TransComm	Trade, transport nec, water transport, air transport, communication
12	OthServices	Financial services nec, insurance, business services nec, recreational and other services, public administration, defense, education, health, dwellings

Source: Own classification based on GTAP 8.0 Database.

These scenarios test the effects on wheat production in Morocco if improved technology, in the form of more productive capital (improved mechanization, improved irrigation, seeds, fertilizers, etc.), is used in the production processes applied to wheat (Scenario 1). Also, wheat production could be changed if it is assumed that unskilled labor becomes more productive through training and capacity building (Scenario 2). Finally, using the previous scenarios, we tested how unilateral elimination of import tariffs on imported wheat affects domestic wheat production (Scenario 3).

6.4 Results

The results presented in this section focus on the most important variables relevant to evaluating how technological (improving factor productivity) and trade reforms affect the wheat sector in Morocco. Presentation of the results starts with macro-economic changes in terms of GDP, welfare, and terms of trade. Then the results are reported in terms of changes in demand for production factors, changes in wheat production, changes in domestic prices, and changes in the international trade in wheat.

6.4.1 Aggregate welfare outcomes

Moroccan GDP would marginally increase by 0.09% per year under Scenario 1 and 0.49% per year under Scenario 2 and would decrease by 0.83% per year under Scenario 3. These minor results in terms of GDP change were expected, given that wheat is a relatively minor sector in comparison with the whole Moroccan economy (Table 6.2).

In terms of welfare, Scenario 1 would represent a net positive welfare gain of USD 130 million/year for Morocco. Scenario 2, which adds increased productivity in unskilled labor, results in welfare increases of USD 429 million/year. Scenario 3, which adds the unilateral trade liberalization on wheat, augments net welfare by USD 495 million/year. Understanding welfare changes is one of the most important results in the GTAP model as it provides a general overview of changes emerging from policy adjustments. In the GTAP model, such changes come from four main sources: a) improved (or deteriorated) efficiency, b) improved (or deteriorated) technology, c) improved (or deteriorated) terms of trade (which refers to changes in the relative prices of exports and imports), and d) more (or less) investment. All these factors together provide decomposition of welfare changes as shown in Table 6.3.

Table 6.2: Aggregated welfare changes for Morocco

Economic variable	Scenario 1	Scenario 2 (Scenario 1 + 20%)	Scenario 3 (Scenario 2 + full tariff liberalization)
Value GDP (%)	0.09	0.49	–0.83
Welfare (USD million/year)	130	429	495
Terms of trade (%)	0.04	0.26	–0.64

Source: Own elaboration based on results from GTAP Version 8.0 simulations.

Table 6.3: Welfare decomposition for Morocco (USD million)

Sources of welfare	Scenario 1	Scenario 2 (Scenario 1 + 20%)	Scenario 3 (Scenario 2 + full tariff liberalization)
Allocative efficiency effect	–51	–125	209
Technical change effect	167	463	463
Terms of trade effect	9	60	–149
Investment savings effect	5	31	–27
Total	**130**	**429**	**496**

Source: Own elaboration based on results from GTAP Version 8.0 simulations.

Allocative efficiency is negative under Scenarios 1 and 2 indicating losses to the economy as a result of a less efficient allocation of production resources between sectors. Allocative efficiency under Scenario 3 was projected to be positive (USD 209 million). This is explained by the removal of the import tariff. That is, when a commodity is subject to a protective tariff, it implies that this commodity is under-using resources compared to what it would use under free market conditions (conversely, subsidies lead to the over-use of resources, which in turn leads to over-production relative to free market conditions). The technical change effect is positive in all three scenarios, which is just because of the simulations. In all, it is simulated that the productivity of capital and unskilled labor is improved.

Under Scenarios 1 and 2 the terms of trade (ToT) (expressed in USD million) increased, while under Scenario 3 it decreased. From Morocco's perspective, changes in ToT measure the price of products exported from Morocco relative to the price of products imported into Morocco. ToT increased under the first

two scenarios because the price index of exported commodities increased faster than the price index of imported ones. This means that Moroccan exports became more competitive abroad (appreciation of the ToT). Negative ToT, as in Scenario 3, indicates that the price index of imported commodities grew faster because the elimination of import tariffs on wheat resulted in depreciation of the ToT. The positive values of the investment savings effect reflect increases in national savings arising from the improved productivity of capital and labor. The negative value of the investment saving effect under Scenario 3 denotes a reduction in national savings resulting from trade policy changes. Thus, welfare changes in Morocco came predominantly from the technical change effect.

6.4.2 Aggregated production

This section addresses changes in aggregated production in Morocco. Changes in production are captured by the production function (Equation 1). Aggregated production would increase in some commodity sectors and decrease in others (Table 6.4). Under Scenarios 1 and 2, the model projected that the production of wheat would increase, while the production of other commodities (which includes domestically consumed and exported goods) would experience minor changes. These would be less than 1% in cereal grains, meats and livestock, and other commodities. Under Scenario 3, wheat production would decrease, while the production of cereal grains, grain crops, processed foods, and textiles would increase in the range 0.1–4.5%. The most noticeable result is observed in the domestic production of wheat, which would increase by 16.37% under Scenario 2 and would decrease by 13.72% under Scenario 3. These results are explained by the way in which the GTAP models change in aggregate output. That is, as a result of the shocks, aggregate output changes as a result of changes in domestic sales, changes in exportable production, and a slack variable in the market clearing condition. This is exogenous to the model and, therefore, is zero as no changes are produced in this variable.

Changes in production are an important result in terms of understanding the general equilibrium demand response (Equation 1). Decomposing changes in wheat (Table 6.5) shows that under Scenarios 1 and 2 the driving force behind the increases in total domestic wheat production was increased demand for domestically produced wheat. In Scenario 3 domestic wheat production decreased mainly because of lowered demand for domestically produced wheat. Despite increased capital and unskilled labor productivity, in Scenario 3 demand switches to imported wheat. In other words, the effect of liberalization

Table 6.4: Changes in the Moroccan production of tradable commodities (%)

Commodity	Production in Moroccan sectors		
	Scenario 1	Scenario 2 (Scenario 1 + 20%)	Scenario 3 (Scenario 2 + full tariff liberalization)
Wheat	5.99	16.37	–13.72
Cereal grain	0.11	0.25	2.13
Grain crops	–0.23	–0.75	2.22
Meat livestock	0.16	0.40	1.83
Extraction	–0.09	–0.59	0.66
Processed food	0.55	1.35	4.32
Textiles, wearing apparel	–0.24	–1.17	3.40
Light manufacturing	–0.13	–0.36	1.28
Heavy manufacturing	–0.1	–0.39	1.00
Utilities, construction	–0.17	0.39	0.16
Transport, communication	0.13	0.31	1.04

Source: Own elaboration based on results from GTAP Version 8.0 simulations.

Table 6.5: Changes in Moroccan wheat production (%)

Aggregated wheat production	Scenario 1	Scenario 2 (Scenario 1 + 20%)	Scenario 3 (Scenario 2 + full tariff liberalization)
Domestic sales	5.63	15.41	–15.08
Export sales	0.35	0.96	1.36
Slack variables	0	0	0
Total	**5.98**	**16.37**	**–13.72**

Source: Own elaboration based on results from GTAP Version 8.0 simulations.

in the wheat sector overcomes the increases in factor productivity, suggesting that the Moroccan wheat sector strongly depends on import tariffs to keep the wheat sector protected from more competitive (i.e. cheaper and possible higher quality) wheat produced abroad.

When wheat production changes, there are also changes in the demand for the factors of production. Changes in the demand for these factors are given by Equations 2 and 3, which in a linearized form is expressed as:

$$qfe(i,j,r) = -afe(i,j,r) + qva(j,r) - ESUBVA(j) * [pfe(i,j,r) - afe(i,j,r) - pva(j,r)]$$

GTAP captures the changes in the demand for production factors through changes in productivity, in the prices of production factors, and in the elasticity of substitution among production factors. The above equation shows technical change in capital and unskilled labor are reflected through the variable *afe*. This has a negative sign meaning that if technical change makes capital and unskilled labor more productive (as in Scenarios 1, 2, and 3), then agricultural farms would need less labor and less capital if production remains unchanged. Yet, *afe* also appears within the last bracket, which refers to the prices of the production factors. When capital and unskilled labor become more productive, the retributions of those production factors increase. Farmers have an incentive to substitute capital and unskilled labor for other inputs that are comparatively less productive. The level of replacement depends on the elasticity of substitution (*ESUBVA*) among the production factors. Quantifying Equation 3, the variable *afe* represents the technical change, and its values are zero. This means that it is an exogenous variable that has not been shocked in the model, except in the cases of capital and unskilled labor that were shocked by the 20% increased productivity. GTAP uses general equilibrium closure and, as a result, the direct effect of the productivity simulation is to lower the demand for capital and unskilled labor used in the Moroccan wheat sector by 20% (Table 6.6).

The value of *qva* is constant across production factors meaning that the wheat sector in Morocco would expand by 5.99% under Scenario 1 and 16.37% under Scenario 2 as a result of productivity increases. Under Scenario 3 it would shrink by 13.72% as result of full liberalization in the wheat sector. In general, under Scenarios 1 and 2 there is an overall increase in the demand for the production factors, which leads to an increase in wheat production in Morocco. Under Scenario 3 the model projected an overall reduction in the demand for production factors, which leads to a reduction in the production of wheat in Morocco.

Under Scenario 1, the demand for land, unskilled labor, and skilled labor used in the production of wheat would increase in percentages that vary from 2.91% to 4.56% (Table 6.6). Changes in demand for the natural resources used in wheat production are almost zero across all simulation scenarios. This result arises because the GTAP model considers natural resources (such as mines, aquifers, forests, and natural gas) as sluggish production factors, meaning that the amounts of natural resources are almost fixed, and, therefore, the supply

Table 6.6: Changes in demand for the factors of production and the associated changes in the production of wheat in Morocco (%)

Production factor	Scenario 1				Scenario 2 (Scenario 1 + 20%)				Scenario 3 (Scenario 2 + full tariff liberalization)			
	afe	*qva*	*ESUBVA*	*Total*	*afe*	*qva*	*ESUBVA*	*Total*	*afe*	*qva*	*ESUBVA*	*Total*
Land	0		−3.08	2.91	0		−8.41	7.96	0		0.84	−12.43
Unskilled labor	0		−1.46	4.53	−20		1.08	−2.55	−20		−0.04	−33.31
Skilled labor	0	5.99	−1.42	4.57	0	16.37	−3.98	12.39	0	−13.27	−5.3	−18.57
Capital	−20		3.66	−10.35	−20		1.06	−2.57	−20		−0.13	−33.40
Natural resources	0		−5.97	0.02	0		−16.32	0.05	0		13.65	−0.38

Source: Own elaboration based on results from GTAP Version 8.0 simulations.

curve is almost perfectly inelastic leaving very little room for mobility among sectors.

Under Scenario 2, the demand for land and skilled labor used in wheat production would vary between 7.96% and 12.39%. Demand for unskilled labor and capital would decrease by about 2.5%. This is a direct effect of the productivity simulation (that consists of increasing productivity by 20% which lowers the demand for capital and unskilled labor used in Moroccan wheat production – GTAP's general equilibrium closure). Under Scenario 3, the demand for all production factors used in wheat production would reduce by percentages ranging from 33.86% to 12.88%. These reductions are explained by the lower demand for domestically produced wheat, which is the direct effect of eliminating the wheat tariff.

In terms of commodity prices, GTAP assumes that changes in supplier prices are transmitted to consumers as a function of the production costs and are reflected in prices and taxes (Equation 5). As expected, wheat prices in all scenarios would decrease (Table 6.7). In Scenario 1 the price of domestic wheat supplies would decrease by 3.94%, while in Scenario 2 prices would fall by 10.78%. The largest wheat price reduction is projected in Scenario 3 (−15.08%), because of the elimination of the import tariff. Under Scenario 1, the price of wheat would fall because the overall wheat supply in the country (both domestic and imported) would increase as a result of greater domestic production. In Scenario 2, the domestic price of wheat would decline further because of the greater domestic wheat production. In Scenario 3 (wheat trade

Table 6.7: Changes in Moroccan domestic prices (%)

Commodity group	Scenario 1	Scenario 2 (Scenario 1 + 20%)	Scenario 3 (Scenario 2 +full tariff liberalization)
Wheat	–3.94	–10.78	–15.08
Cereal grain	0.36	1.01	–1.03
Grain crops	0.31	0.99	–1.04
Meat livestock	0.13	0.53	–1.22
Extraction	0.01	0.11	–0.03
Processed food	–0.35	–0.78	–3.02
Textiles, wearing apparel	0.06	0.27	–0.58
Light manufacturing	0.08	0.32	–0.32
Heavy manufacturing	0.04	0.26	–0.22
Utilities, construction	0.05	0.37	–0.28
Transport, communication	0.1	0.44	–0.36

Source: Own elaboration based on results from GTAP Version 8.0 simulations.

liberalization), the price of wheat decreases most (–15.08%). This is concomitant with the drop in import tariffs and technological change accompanying improvements in capital and unskilled labor productivity. As expected, the changes in the prices of other commodities were very small (most of them less than 1%). Almost no change occurs in the prices of other commodities (other than wheat) indicating that, as a result of the shocks, the model produced very small reallocations of the factor of production among the sectors, thus the production level in each one would not change significantly.

6.4.3 Changes in imports

Morocco has historically been a net importer of wheat. This situation does not change in the three scenarios simulated, meaning that Morocco would not become a net exporter of wheat. Under the first two scenarios, the first consequence emerging from an increase in Moroccan productivity of capital and unskilled labor is the reduced imports of wheat at the expense of increased domestic wheat production. The first two scenarios estimate a reduction in wheat imports of 11.39% and 31.14%, which would take place because Morocco would produce more wheat, and, therefore, can afford to reduce imports (Table 6.8). In Scenario 3, wheat imports substantially increase by 44.29%, because

Table 6.8: Changes in Moroccan imports (%)

Commodity group	Scenario 1	Scenario 2 (Scenario 1 + 20%)	Scenario 3 (Scenario 2 + full tariff liberalization)
Wheat	–11.39	–31.14	44.29
Cereal grain	0.52	1.56	0.32
Grain crops	0.85	2.63	–1.15
Meat livestock	0.59	2.25	–2.49
Extraction	–0.09	–0.09	0.84
Processed food	–0.37	–0.63	–3.91
Textiles, wearing apparel	0.07	0.18	1.02
Light manufacturing	0.11	0.87	0.04
Heavy manufacturing	0.09	0.87	0.11
Utilities, construction	0.24	1.17	0.22
Transport, communication	0.34	1.32	0.27

Source: Own elaboration based on results from GTAP Version 8.0 simulations.

eliminating the wheat import tariffs makes it more attractive to import wheat rather than produce it domestically. In this scenario imported wheat displaces domestically produced wheat.

According to the model, the effect of tariff elimination overcomes improvements in productivity, suggesting that to maintain domestic wheat production in Morocco protection measures are needed. In the first two scenarios, Moroccan importers (firms, households, and government) would find a greater supply of domestic wheat sold at relatively cheaper prices than imported wheat, which would lead to a reduction in Moroccan imports of wheat. In the third scenario, Moroccan dealers find imported wheat cheaper (because of tariff elimination), this displaces domestic production, provoking an increase in wheat imports.

6.5 Discussion

How feasible are these results? Or put another way, how feasible is it that wheat production in Morocco would increase under the technological change scenarios and decrease under a trade liberalization scenario? How feasible is it that imports of wheat would decrease in Morocco under the two first

scenarios and would increase under the third one? It is not straightforward to discuss the credibility of CGE projections, given the difficulty in appraising predictions. When changes in production are forecasted, it could be argued that many variables must be considered, such as production costs, commodity demand, import tariffs, labor market conditions, and others. Additionally, it could be argued that the results also depend on the type of economic model being used (e.g. partial or general equilibrium), the level of the national currency (appreciation, stability, or devaluation), the economic situation (recession/expansion and economic cycles), and environmental and physical variables, among others.

In this study, the GTAP model has been chosen to analyze the Moroccan wheat sector under three specific scenarios. The GTAP model has many components, where the most important ones are the assumptions, the inputs parameter values, and the output values. Analyzing the feasibility of prediction can target any of these components and, as a result, the analysis may focus on different parts of the model. In practice, it becomes difficult to achieve a full assessment of the model, especially if the system being modelled includes informal sectors, as is the case for the Moroccan wheat sector. In such sectors the transactions being made are neither taxed nor monitored by the government. Thus they are unlikely to be included in national accounts, such as GDP. The feasibility of the results was analyzed focusing on the outputs of the model. Broadly speaking, this analysis is a combination of expert consultation and analysis of secondary data. The discussion elements have focused on an analysis of the historical production value data of wheat and other commodities, the domestic and imported supplies of wheat, water productivity in Morocco, and the expansion of the Moroccan export sector relative to the world market.

A key finding of this study in relation to the first two scenarios is that as a response to technological change, assuming no change in the other variables, the production of wheat in Morocco would increase by 5.99% under Scenario 1 and by 16.37% under Scenario 2. These results are feasible considering several measures the government has been taking in recent years. Since the launch of the Green Morocco Plan (GMP 2014), Morocco has increased its investments in labor training and physical capital accumulation, reaching figures between 5.4% and 6% of GDP (World Bank 2010; UNESCO 2014). This is almost twice the average for Middle East and North African countries (3.8%), (AMCML 2014). These investments have been mainly given in the form of subsidies to the wheat sector. For example, in 2016 the government set seed subsidies for

durum wheat, common wheat, and barley, which covered from 40% to 60% of the seed costs (USDA 2017). In calendar year 2017 the volume of subsidized common wheat flour, known as "National Flour", was 650,000 tonnes (USDA 2017). This was given by the government to support low-income consumers. The Moroccan government in 2012 allocated about USD 28 million to lower the price of certified wheat seeds (USDA 2013). This subsidy targeted about 70% common or bread wheat, 29% durum wheat, and 1% barley (USDA 2013). Subsidies for seeds are not the only instruments the government has been using to foster wheat production and productivity. Other subsidies include a 30% to 70% subsidy for the purchase of modern machinery and irrigation facilities.

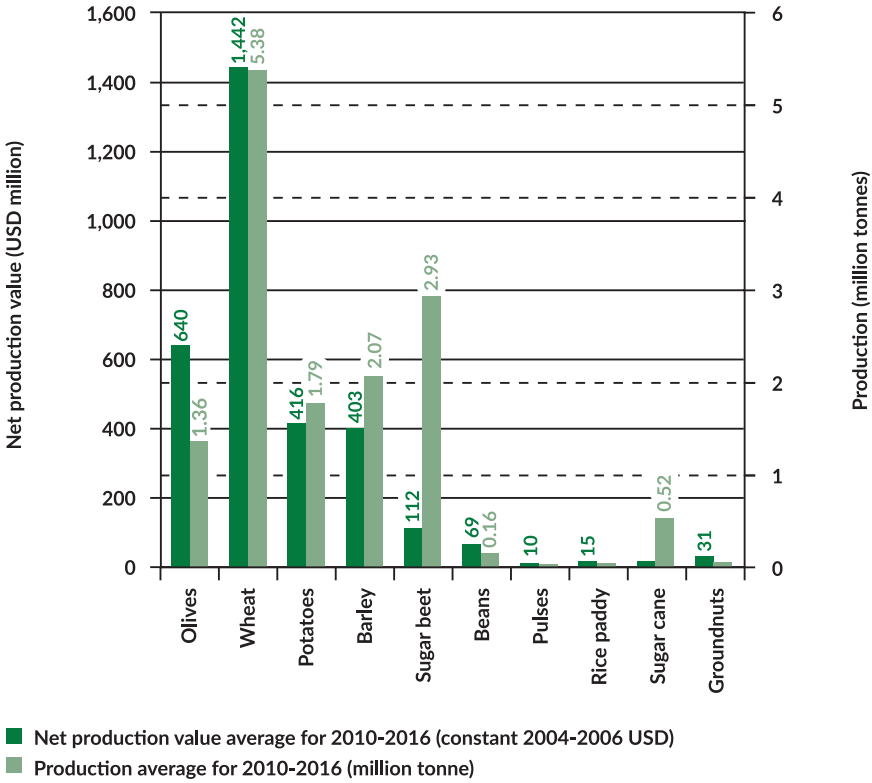

Figure 6.2: Top 10 commodities in Moroccan agriculture, in production and value, average for 2010–2016

Source: Own elaboration based on production and value data extracted from FAOSTAT online database (2018).

In 2011, the Moroccan government implemented a crop insurance program to reduce the biotic (such as insects and pests) and abiotic (such as droughts, floods, and storms) risks associated with the production of cereals. This insurance program targeted 500,000 ha representing about 10% of the Moroccan area planted to cereal (USDA 2013). The purpose of the program was to absorb between 50% and 90% of the financial losses if farmers experienced unfavorable conditions. Thus, wheat in Morocco has become by far the main crop in terms of quantities produced (5.4 million tonnes produced, on average, in the period 2010–2016). It is also most important in terms of production value (USD 1,142 million, on average, for the same period) (Figure 6.2).

Despite years of support, the country has been unable to be self-sufficient in wheat production. In fact, Morocco has, over time, become more and more dependent on wheat imports. In the 1960s, Morocco had an average population of 13 million inhabitants and was largely self-sufficient, producing 81% of total wheat supply (Figure 6.3). By the 1970s domestic wheat production dropped to 62% of total supply, while imports increased from 19% in 1960s to 38% in the 1970s. This trend continued over the 1980s and 1990s. By 2000–2016

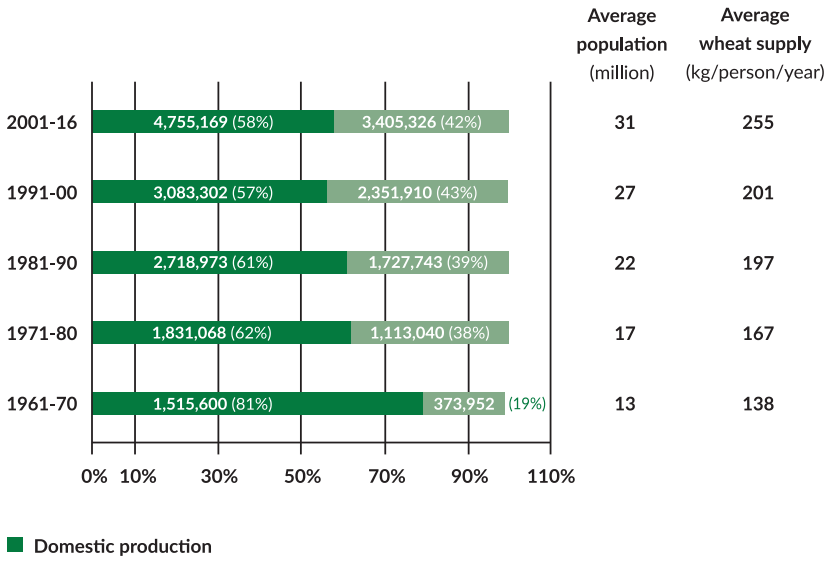

Figure 6.3: Moroccan total domestic wheat supply (000 tonnes)

Source: Own elaboration based on production, population, wheat supply, and agricultural population data extracted from FAOSTAT online database (2018).

Morocco produced 58% of domestic supply, while 42% was imported, mainly from France, Canada, Ukraine, and United States. Morocco's population more than doubled after the 1960s, reaching more than 35 million by 2016. Along with that population growth the per capita wheat supply increased from 138 kg/person in the 1960s to 255 kg/person, on average, for the period 2001–2016.

This historical trend shows that as a population increases domestic wheat demand also increases. Morocco depends on imports to satisfy this domestic demand. The projections of the GTAP model seem to be acceptable under the first two scenarios. That is, production would increase because of technological changes, but those increases would be small, and hence significant wheat imports will still be needed. Even if imports are somehow reduced, technological changes that increase productivity will not be enough to replace the wheat imports. Morocco has been and, according to its historical trend and our projections, will continue to be a net wheat-importing country.

The third scenario, eliminating wheat import tariffs, forecasts an increase in imports of wheat and a reduction in domestic wheat production. These results arise from the lowered imported wheat prices which will displace some of the domestic wheat production. The tariff protection that Morocco currently applies to imported wheat is complex and varies according to the source (Table 6.9). In 2015, durum wheat imports were subject to a 75% ad valorem tariff when imported from the United States, and 170% when coming from the European Union. In 2017 a tariff of 70% was applied to bread wheat imports from the United States and one of 30% was applied on imports from the European Union (WTO 2017; USDA 2017). In 2015, the Moroccan import tariff for cereal products ranged from 59.4% to 195% (WTO et al. 2016). Such tariffs suggest high protection for the Moroccan wheat sector. Our simulations suggested that removing them could significantly lower imported wheat prices, which in turn would increase wheat imports and displace some domestic production. Tariffs applied to other countries that Morocco has trade agreements with, such as the United Arab Emirates, Mauritania, Algeria, Iraq, and Libya, are all zero (Table 6.9). However, these countries (like Morocco) are net wheat importers and, therefore, no wheat trade takes place between them.

The Government of Morocco is aware of the importance of tariffs in protecting the domestic production of wheat. In turn, this production creates agricultural and agro-industrial employment and provides livelihoods for thousands of families in the country. Yet, despite the high wheat tariffs, which

Table 6.9: Tariff structure applied to wheat by region

Tariff Regimes Granted by Reporter (Excluding MFN)	Original Nomenclature		Duty Free TL (%)	Maximum duty (%)	HS subheading 6-digit description
	HS version	HS subhdg			
FTA-DR for United Arab Emirates	HS02	100110	100	0.0	Durum wheat
FTA-DR for the Arab League Member Countries	HS02	100110	100	0.0	Durum wheat
FTA-DR for Mauritania	HS02	100110	100	0.0	Durum wheat
FTA-DR for United States of America	HS02	100110	0	75.0	Durum wheat
FTA-DR for Arab Mediterranean Countries (Agadir)	HS02	100110	100	0.0	Durum wheat
FTA-DR for the European Communities	HS02	100110	0	170.0	Durum wheat
FTA-DR for Algeria	HS02	100110	100	0.0	Durum wheat
FTA-DR for Iraq	HS02	100110	100	0.0	Durum wheat
FTA-DR for Libya	HS02	100110	100	0.0	Durum wheat
FTA-DR for United Arab Emirates	HS02	100190	100	0.0	Bread wheat
FTA-DR for the Arab League Member Countries	HS02	100190	100	0.0	Bread wheat
FTA-DR for Mauritania	HS02	100190	100	0.0	Bread wheat
FTA-DR for United States of America	HS02	100190	0	30-70	Bread wheat
FTA-DR for Arab Mediterranean Countries (Agadir)	HS02	100190	100	0.0	Bread wheat
FTA-DR for the European Communities	HS02	100190	0	30.0	Bread wheat
FTA-DR for Algeria	HS02	100190	100	0.0	Bread wheat
FTA-DR for Iraq	HS02	100190	100	0.0	Bread wheat
FTA-DR for Libya	HS02	100190	100	0.0	Bread wheat

MFN – Most Favored Nation
HS – Harmonized System
TL – Tariff Line
FTA-DR – Free-Trade Agreement Duty Rate
Source: Own elaboration based on WTO online database 2017, Tariff Download Facility
USDA 2017. Global Agricultural Information Network. Report: MO1703.

increase imported wheat prices, wheat imports into Morocco are still the most important (in both quantitative and value terms) of all agricultural imports (Figure 6.4).

In 2016, Morocco imported almost 6.3 million tonnes of wheat, valued at USD 1.3 billion (at an average cost of USD 207/tonne). Wheat is one of the

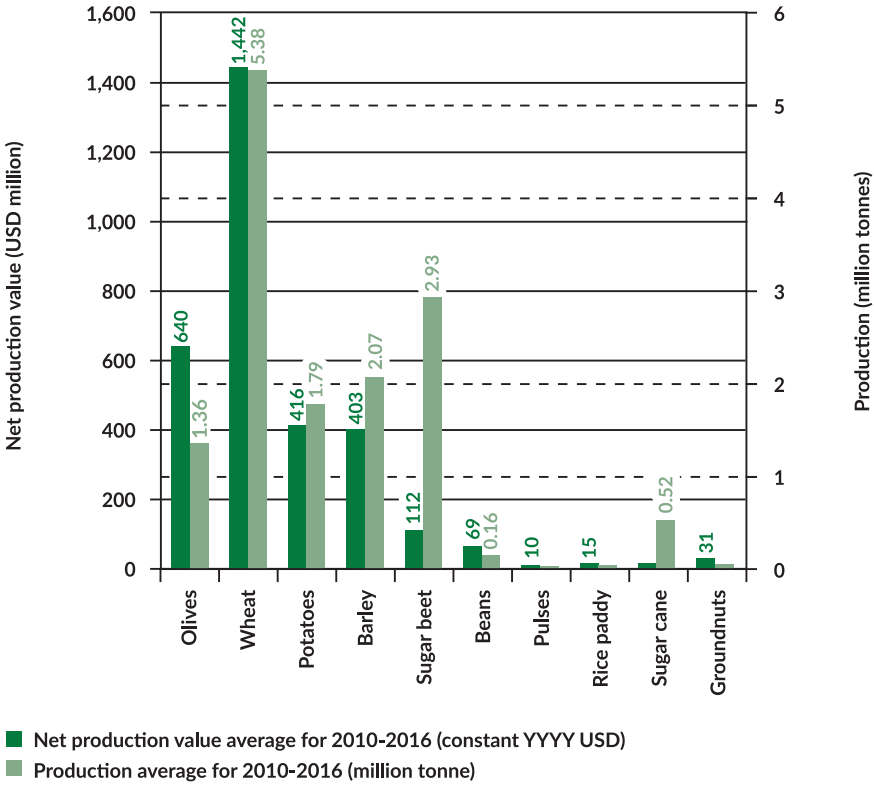

Figure 6.4: Top 10 imported commodities in Morocco, 2013

Source: Own elaboration based on import data extracted from FAOSTAT online database (2018).

most important foodstuffs in the Moroccan diet. The USDA estimated that per capita consumption of wheat in 2013 was 258 kg/year, while our estimate is 255 kg/year. Either case would place Morocco among the highest per capita wheat-consuming countries in the world. High consumption of cereals is explained by the government policy to keep bread prices at affordable levels for all segments of the population.

Keeping bread prices low has political and social benefits and has been a popular policy not only in Morocco, but also in many other Arab countries. Rapid population growth in most Arab countries has prompted governments

to make sure that a basic foodstuff will be available to every household in the country. Even in countries like Jordan, which only produces about 3% of the total wheat consumed domestically, the price of bread can be as low as USD 0.2/kg. Similarly, in Egypt or Syria (before the conflict), the price of bread products responded to government policies that kept them to less than USD 0.25/kg. The Moroccan government has only subsidized imports of bread wheat suitable for bread production and has managed to keep domestic bread prices at about USD 0.5 per loaf (Morocco has not been subsidizing imports of durum wheat). Low prices of bread in countries that are net importers of wheat contrast with the high prices in countries that are net exporters of wheat, such as Argentina, where bread products can cost as much as USD 2/kg.

Relatively less production of domestic cereals is not necessarily harmful to the Moroccan society or economy. As previously shown in Figure 6.3, wheat supply per capita has shown a significant increase since the 1960s onwards. While the average wheat supply/person/year was 138 kg in the 1960s, it increased to 167 kg/person/year in the 1970s and rose as high as 255 kg/person/year, on average, in the period 2001–2016. This suggests that a country does not need to be self-sufficient to increase the wheat supply per person, even in the face of rapid population growth. The international market has large cereal producers, such as Argentina, the United States, Canada, Ukraine, Australia, the European Union, and Russia. These countries can supply large volumes of wheat at cheaper prices than it would be possible to produce it domestically.

The fact that Morocco is a net cereal-importing country could be interpreted as efficient and rational in terms of water productivity and virtual water use. Wheat consumes more water per kg of output produced than many other cultivars. Data for Morocco (Figure 6.5) show that cereals in general (barley, maize, and durum and bread wheat) use between 2,400 and 3,600 m^3/tonne, which is substantially more water than required for vegetables or fruits. These consume between 40 and 500 m^3/tonnes. Pulses (lentils, chickpeas, and soya beans), olives, and dates consume higher quantities of water (more than 1,700 m^3/tonne) when compared with vegetables (garlic, potatoes, onions, carrots, lettuce, tomatoes, and cucumbers) and most fruits (apples, lemons, oranges, mandarins, and bananas) that use less than 500 m^3/tonne.

From a water productivity perspective, it seems that importing cereals from countries well-endowed with water, such as France, Ukraine, US, Russia, and Canada would bring savings in water that can be used for other cultivars that are

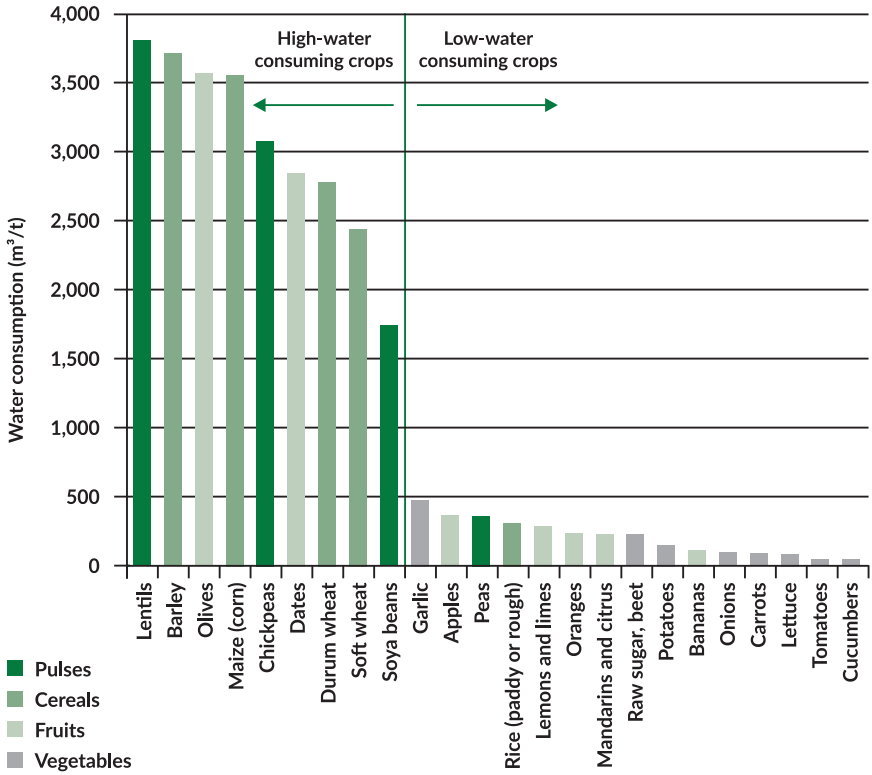

Figure 6.5: Water productivity in Morocco, 2010

Source: Own elaboration based on data from Mekonnen and Hoekstra 2010. The green, blue, and grey water footprints of crops and derived crop products. Value of Water Research Report Series No. 47. UNESCO-IHE, Delft, Netherlands. http://www.waterfootprint.org/Reports/Report47-WaterFootprintCrops-Vol1.pdf.

Note: Data in this figure corresponds to national Moroccan averages, where the "green water footprint" indicator has been used to estimate water productivity. Green water footprint is the volume of rainwater consumed during the production process. This is particularly relevant for agricultural and forestry products (products based on crops or wood), where it refers to the total rainwater evapotranspiration (from fields and plantations) plus the water incorporated into the harvested crop or wood.

less water intensive, while still having high international and domestic demand. In this context, it seems rational that since the 1960s Moroccan farmers have been reducing wheat cultivars and, instead, intensifying their farming systems with fruit and vegetable production that uses relatively less water. In fact, Morocco since the 1960s has become self-sufficient in fruit and vegetable production (Figure 6.6). It has even become a net exporter, although the share of exports in relation to total domestic production has reduced over time.

In the 1960s, Morocco used to export more than 0.5 million tonnes of fruits, which slightly increased to almost 0.57 million tonnes in 2000–07. The increase in fruit exports has not been substantial as most of the domestic production goes to satisfy the growing domestic demand, which has more than doubled from the 1960s to the period 2000–07 (1.2 million tonnes in the 1960s to 2.6 million tonnes in 2000–07). The increase in vegetable exports has almost doubled from 0.2 million tonnes in the 1960s to 0.39 million tonnes in 2000–07, and the country is completely self-sufficient in vegetables (remarkably, the supply grew from 0.8 million tonnes in the 1960s to 4.5 million tonnes in 2000–07).

Morocco's agriculture has recently consolidated the trend towards exporting vegetables and fruits. In Figure 6.7 the vertical axis measures the average growth in Moroccan exports (2008–11), while the horizontal axis measures the average annual growth of world exports (also 2008–11). This latter can be understood as the rate of world market expansion. In this figure, Morocco has gained market share in chilies and peppers, strawberries, vegetable oils, animal and vegetable oils, tangerines, tomatoes, and raw materials. All of these have increased at more than 10% per year between 2008 and 2011. The most important crop for Morocco, in terms of exports, has been olive oil, which has increased 243% per year between 2008 and 2011 (not shown in Figure 6.7 because of scale issue).

Other agricultural commodities, such as dairy products, cheese, milk, oranges, olives, coffee, tea, and prepared fruits have lost export share at a rate of between 1% and 20% per year between 2008 and 2011. As expected, wheat is not included in this figure as Morocco does not export any wheat.

6.6 Conclusion

In view of international trade agreements already signed by Morocco, permanent trade liberalization on wheat is a reform that the Government of Morocco will have to consider undertaking. Therefore, shedding light on these issues provides policy makers with key information with which to analyze the

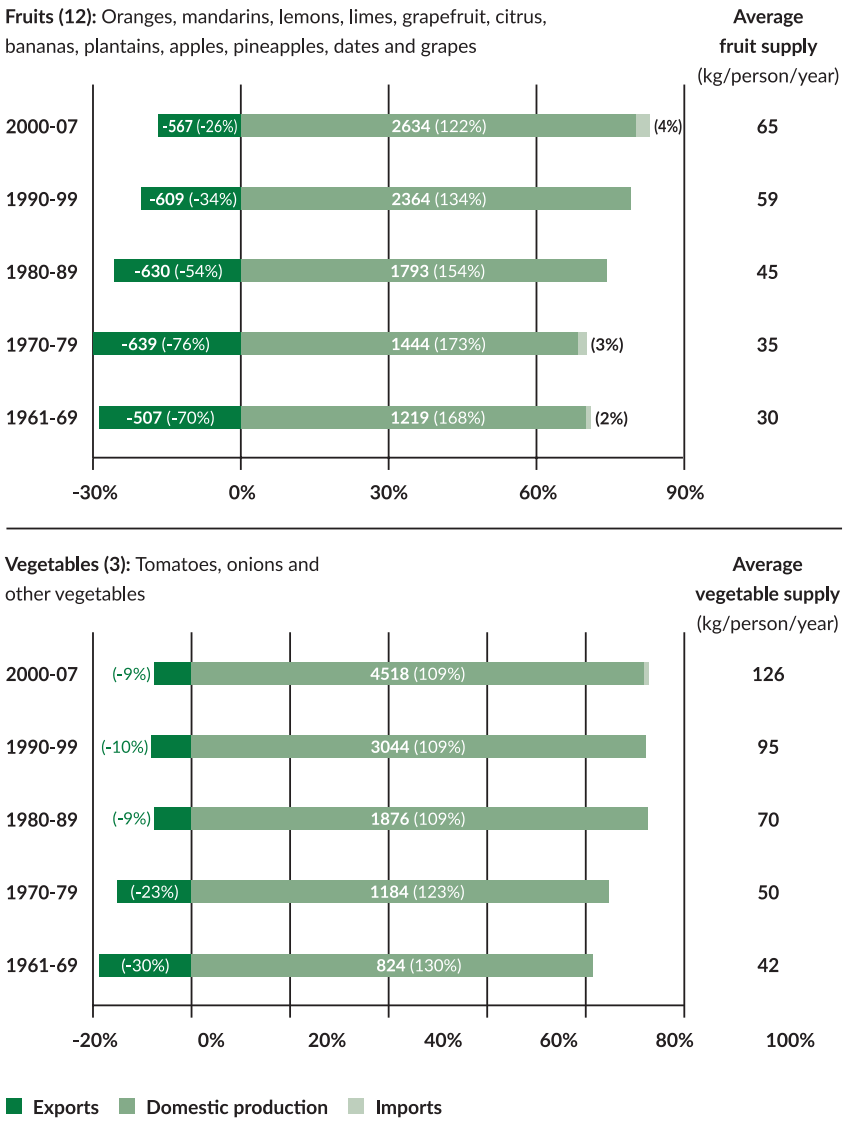

Figure 6.6: Morocco: Total domestic food supply (000 tonnes)

Source: Own elaboration based on data from the World Development Indicators (2017) online database for Prevalence of undernourished; Prevalence of underweight in children; and Poverty headcount. All other variables (production, population, cereal supply, and agricultural population) were extracted from FAOSTAT online database (2018).

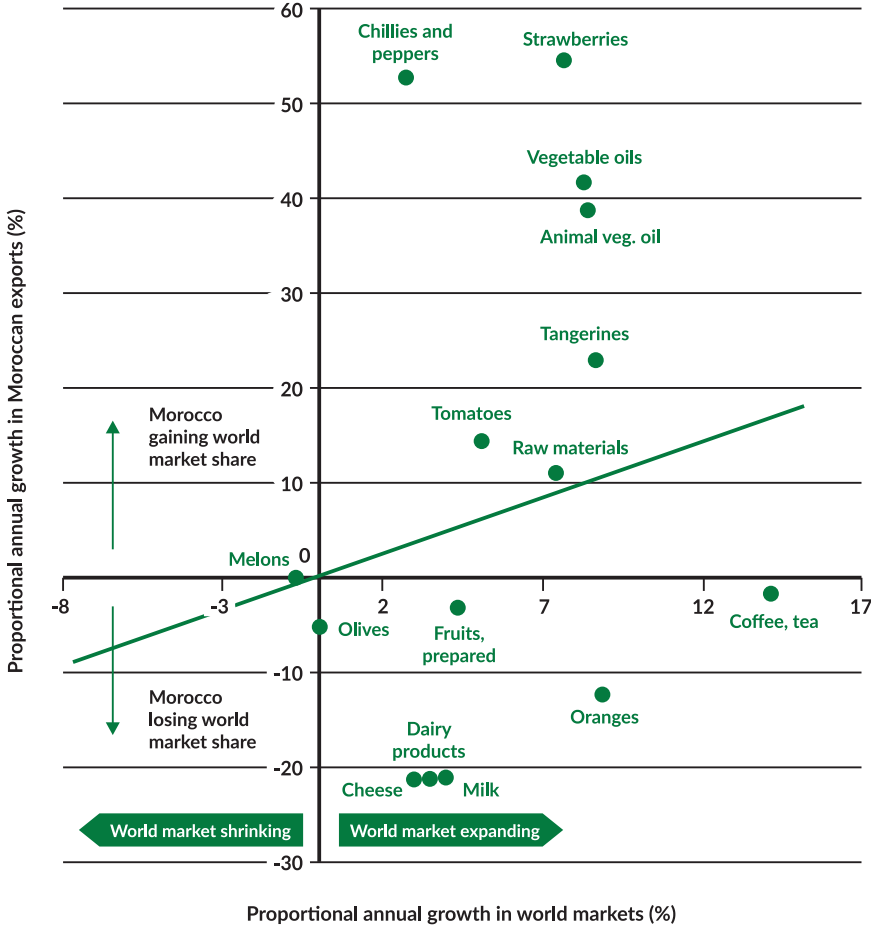

Figure 6.7: Proportional changes in export growth of the main Moroccan product lines relative to proportional changes in world market growth (average for 2008–11) (%)

Note: The percentages are averages for the period 2008–11. Data reported correspond to the most important product categories in Morocco.

Source: Own elaboration based on data extracted from FAOSTAT online database (2018); Trade, Crops and Livestock products data.

trade-offs emerging from maintaining protection of the wheat sector or liberalizing it given trade agreements and current trends.

Overall, the GTAP results show that productivity improvements in the factors of production could increase production levels in Morocco. Yet, historical data shows that such increases will not be enough to reduce wheat imports. Morocco has been and will continue to be a net wheat-importing country. Wheat production would increase because of technological changes, but those increases would be small and, hence, significant wheat imports will still be needed as projected under the first two scenarios.

Results suggest that import tariffs are important in keeping a share of domestic wheat production. That is, import tariffs provide protection to domestic wheat producers and without these tariffs national wheat production would drop drastically. In fact, both import tariffs and domestic subsidies provide a framework for the production of domestic wheat in a way that competes with cheaper wheat imports from foreign counties (mainly France, Ukraine, Canada, and the United States), which are produced using high-yielding technologies, frequently subsidized, and under rainfed conditions.

Being a net wheat-importing country is not necessarily negative. From a water use perspective, wheat consumes more water/kg of output produced than vegetables and fruits and, therefore, importing wheat from countries well-endowed with water would bring water savings. These could then be used for other cultivars that demand less water, but still have high international and domestic value.

However, our analysis also shows that without tariffs local wheat production would drop drastically. Tariffs contribute by keeping a relatively large wheat sector generating significant agricultural value added and, more importantly, to maintaining thousands of jobs in the wheat chain sector. Removing them would be a challenging trade policy as thousands of families that directly depend on wheat for their livelihoods can be affected in the short and medium terms. The Moroccan government has a difficult duty ahead. It consists of maintaining wheat-associated agricultural employment given the shrinking water resources for agriculture, while dealing with international pressures that are asking for liberalization of the wheat sector. The future of wheat production in the country will depend, therefore, on the trade-offs between the potential cost savings from the substitution of domestically produced wheat with imports, on the one hand, and the contribution of wheat to GDP and employment opportunities with their social and political benefits, on the other.

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Political Economy of the Wheat Sector in Morocco: Seed Systems, Varietal Adoption, and Impacts

Literature on the wheat sector in Morocco has been very thin on the ground. This is particularly so for national-level analysis of the country's seed system and varietal release, adoption, and impacts. By producing this book, the authors aim to address this gap in analysis.

As well as a review of existing literature on the topic, this book provides a comprehensive analysis of the seed system in Morocco, using published and unpublished secondary data collected from different sources; some of this data are not adequately documented elsewhere. The book also uses a large dataset collected from a representative sample of 1,230 wheat-growing farm households. These households reside in the 21 major wheat-growing provinces of Morocco, which constitute more than 75% of total wheat production in the country.

This book provides a thorough analysis of the historical evolution of the institutional and policy environment – in Morocco's wheat sector in general and the seed system in particular. It also provides adoption, impacts, and seed demand analysis at household, district, province, and national levels. Given the tremendous amount of data and information this book contains, I believe that it will not only provide guidance for necessary institutional, regulatory, and policy reforms, but will also be the single most important reference material regarding the wheat sector in Morocco for many years to come. The methodological background and the results reported in this book could also inspire similar work in other countries.

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