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The Moroccan wheat sector: What if there is no more tariff protection?

Roberto Telleria Juárez[a*] and Boubaker Dhehibi[b]
[a] IPC Policy and Investment Officer; IPC Global Support Unit (IPC GSU), Food and Agriculture Organization of the United Nations (FAO). *Roberto.TelleriaJuarez@fao.org (corresponding author email address)*
[b] Agricultural Resource Economist, International Centre for Agricultural Research in the Dry Areas (ICARDA) Abdoun, Khaled Abu Dalbouh Street, Buildings No. 15 Amman – Jordan

Corresponding author

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ABSTRACT

This paper focusses on testing how a hypothetical elimination of tariffs to imported wheat coupled with changes in productivity would impact on the domestic wheat supply, prices and factor use in Morocco. Having one of the highest per capita wheat consumption in the world, the government is determined to increase domestic wheat production to become self-sufficient. To this end, wheat imports have been subject to high tariffs, but Morocco's trade agreements with the EU and the USA have been pushing import tariffs on wheat to be complete eliminated. Using a methodology based on the GTAP model, our simulation results indicate that domestic wheat production would augment as result of improvements in capital and unskilled labor productivity, and would reduce as result of elimination of tariff protection to imported wheat. The future of wheat production in Morocco will depend on the tradeoffs between the potential cost savings from the substitution of domestic production of wheat with imports, and the contribution of wheat to GDP and employment opportunities generated in the cereal sector.

Contribution/ Originality
The current paper is a timely contribution to the ongoing discussion among Moroccan policy makers that are concerned on the implications that eliminating tariffs would have on wheat production, employment and other domestic indicators.

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1. INTRODUCTION

Overtime the government of Morocco has provided significant support to the agricultural sector, and in particular to wheat production (ADB, 2016). As result ordinary people in Morocco has been paying as low as 0.2 dollars per loaf of bread (about 500 gr). Wheat support has overtime driven patterns of consumption to be intensively based on cereal consumption (CIHEAM, 2006). Wheat supply, essentially in the form of soft and durum wheat flours[1], in average accounted for 247 kg/per capita (or 660 gr/day) in 2001-2013 (FAOSTAT, 2017), placing Morocco among the top wheat consumers in the world (Arrisueño *et al.*, 2016). Yet the country is a net-wheat importing country (Agriculture and Agri-Food Canada, 2017) with low and stagnant wheat yields (Mrabet *et al.*, 2012).

Morocco, as World Trade Organization (WTO) member has to start with liberalizing its wheat market by eliminating wheat import tariffs (United States Trade Representative, 2014). However, in May 2017 the Government announced the increase of the import duty on "soft" wheat from 30 to 135% (FAO, 2017). As per the Green Morocco Plan (GMP), that is country's 2008-2020 national development plan for modernizing and integrating agriculture into the world market, improving human development, and enhancing sustainable growth (GMP, 2009), Morocco has been investing resources to improve labor and capital productivity aiming at enhancing domestic wheat productivity (GMP, 2014).

Previous research (Radouane and Ghoufrane, 2016; and Aziz and Hertel, 2007) has sought to understand the possible scenarios out of full liberalization of import tariffs, but changes in productivity of wheat reflecting the government's intention to increase domestic wheat production have not being sufficiently specified. In this context, the purpose of this paper is to analyze macroeconomic implications for the wheat sector that would emerge out of both liberalizing the wheat market (for both soft and durum wheat), and increasing labor and capital productivity used in wheat production.

Results from our simulations focus on changes in production, imports, prices, overall welfare, terms of trade, and production factors, which are variables of outmost importance to assess changes in the Moroccan wheat sector. To analyze effects on the wheat sector out of wheat tariff liberalization, we simulated changes in tariff protection. To analyze effects on the wheat sector out of labor and capital productivity, we simulated technological changes improving labor and capital productivity.

This paper is organized as follows: Following this introduction, the second part presents the model, database aggregation and simulation scenarios used to estimate changes in protection tariffs and productivity of production factors. The third part presents results of the simulation scenarios, focusing on import liberalization effects and changes in wheat production, including changes in macro indicators such as GDP, welfare, imports, terms of trade, and shares of domestic production. The fourth section discusses feasibility of results, focusing on historical wheat production, level of dependence of the country to imported cereals, wheat relevance in Moroccan diet, and wheat water consumption as compared to other commodities. By introducing water consumption in the discussion, we seek to understand (from a macro perspective) restrictions that limited water resources could impose in the overall framework of commodities that are produced in the country. Finally, section five presents conclusions emerging from this study.

[1] Used to make a wide range of foods including bread, crumpets, muffins, noodles, pasta, cakes, pastries, cereal bars, sweet and savoury snack foods, crisp-breads, sauces and confectionery.

2. MODEL, DATABASE AGGREGATION, AND SIMULATION SCENARIOS

Growth and development of the wheat sector is important for food security in Morocco (GMP, 2014; Yigezu *et al.*, 2013). The extent to which tariff protection and subsidies contribute to improved performance of the wheat sector is analyzed here using the GTAP model (Hertel, 1997). In this paper, the GTAP database version 8.0 (129 regions or countries and 57 sectors or commodity groups – latest available) was used, which represents a snapshot of the world economy in the year 2007. This database contains all trade agreements Morocco has singed so far (latest one with the US in July 2005).

As the GTAP model has been widely discussed and described in many economic policy articles, here we just point out its general characteristics. GTAP it is a standard, static, multi-region, multi-sector computable general equilibrium (CGE) model. It is basically expressed in equations contained in the code of the model, which represents the fundamental theory behind the GTAP model (Telleria, 2010). GTAP includes explicit 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. It also assumes a fixed factor endowment and full factor use. Model results for all variables are expressed as relative changes from the original GTAP database. That is, scenario results are percentage changes from the base case scenario.

The GTAP database is huge containing input-outputs matrices for 129 regions (countries or groups of countries) and 57 sectors (commodity groups), which are available in Version 8.0. Given this size, the amount of computational resources needed to compute the data is usually unbearable and, 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 criterion for regional aggregation consisted of choosing countries that are important trade partners for Morocco, while that of commodity groups consisted of sectors that are important contributors to Moroccan GDP (see Table 1).

Table 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.
4	SE Asia	South East Asia: Cambodia, Indonesia, Lao People's Democratic Republic, Malaysia, Philippines, Singapore, Thailand, Viet Nam.
5	South Asia	South Asia: Bangladesh, India, Nepal, Pakistan, Sri Lanka.
6	N America	North America: United States, Canada, Mexico.
7	Latin America	Latin America: Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Paraguay, Peru, Uruguay, Venezuela, Costa Rica, Guatemala, Honduras, Nicaragua, Panama, El Salvador, Caribbean, Rest of LAC.
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 MENA.
10	SSA	Sub-Sahara Africa: Cameroon, Cote d'Ivoire, Ghana, Nigeria, Senegal, Ethiopia, Kenya, Madagascar, Malawi, Mauritius, Mozambique, Tanzania, Uganda, Zambia, Zimbabwe, Botswana, Namibia, South Africa, rest of Africa.
11	ROW	Rest of the World.

No.	Sector	Description
1	Wheat	Wheat.
2	Cereal grain	Cereal grains nec.
3	Grain crops	Paddy rice, Vegetables, fruit, nuts, Oil seeds, Sugar cane, sugar beet, Plant-based fibers, Crops nec, Processed rice.
4	Meat livestock	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	Processed food	Vegetable oils and fats, Dairy products, Sugar, Food products nec, Beverages and tobacco products.
7	Textile	Textiles, Wearing apparel.
8	Light manufacture	Leather products, Wood products, Paper products, publishing, Metal products, Motor vehicles and parts, Transport equipment nec, Manufactures nec.
9	Heavy manufacture	Petroleum, coal products, Chemical, rubber, plastic products, Mineral products nec, Ferrous metals, Metals nec, Electronic equipment, Machinery and equipment nec.
10	Util. Constr.	Electricity, Gas manufacture, distribution, Water, Construction.
11	Trans. Comm.	Trade, Transport nec, Water transport, Air transport, Communication.
12	Other services	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

To set simulation scenarios, we used historical yield data for Morocco and wheat production goals as established by the GMP. That is, as part of its twelve-year agenda, the GMP 2008–2020 highlights wheat as an strategic crop for enhancing the ability of the agricultural sector to make progress toward productivity-led growth (GMP, 2014). Table 2 shows wheat yields achieved in Morocco before and after implementation of the GMP. The country increased wheat yields from 1,388 kg/ha in average for the period 2001-2007 to 1,747kg/ha in average for the period 2008-2014 (in 2008 the GMP was launched). This translates into an implicit annual growth rate of 25.86%. To analyze how productivity change might impact wheat production, imports, exports, and the economy as a whole, we imposed this annual growth rate (rounded to a more conservative 20%) onto the GTAP model as an annual change in capital and labor factor productivity.

Table 2: Wheat yield 2001–2014 (kilograms per ha), implicit annual growth rate

Year	Yield	Year	Yield
2001	1,228	2008	1,319
2002	1,279	2009	2,140
2003	1,722	2010	1,709
2004	1,808	2011	1,949
2005	1,026	2012	1,234
2006	2,036	2013	2,164
2007	615	2014	1,713
Growth (%)		25.86	

Source: Own elaboration based on FAOSTAT, 2017
Note: Yield data for 2014 is the latest data available at FAOSTAT

As we used the GTAP static model, productivity increases and tariff changes take place in a single period. This single period can be one year, three or five years. It is not defined in the GTAP model, but it is understood that the single period corresponds to the time needed for all agents in the

model (e.g. consumers and producers) to make their "optimal" decisions. Productivity and tariff variables are naturally exogenous in the GTAP model. That is, the national productivity and tariff levels are given in the baseline scenario, and become shocks when exogenously modifying them through changing their levels from the initial calibration year (2007) to current time. In the GTAP model, simulated changes in productivity and tariff levels induce variations in relative prices and a structural adjustment for the entire world economic system. To assess liberalization of the domestic wheat market and technological changes affecting wheat productivity, we defined the following three scenarios:

- 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 to wheat imported into Morocco.

The first scenario tests impacts on wheat production in Morocco emerging from improved technology in the form of 20% more productive capital (e.g. improved mechanization and improved irrigation) utilized in wheat production. The second scenario adds productivity shock in the form of 20% more productive unskilled labor. Unskilled labor improvement refers to workers earning better skills and knowledge in agricultural management practices such as more effective timing for pesticide application, better irrigation management and/or improved application of organic/inorganic fertilizers, all leading to improvements in labor productivity used in wheat production. We hit unskilled labor because most of the manpower used in wheat production in Morocco is non-specialized labor. The third scenario adds a hypothetical liberalization in the wheat market by simulating 100% elimination in wheat tariffs. This last scenario weights increases in productivity vis-à-vis elimination in wheat import tariffs.

3. RESULTS

As per the purpose of this paper, presentation and discussion of results concentrate on the impacts that the different scenarios would produce over the Moroccan economy only (i.e. no results for Moroccan trade partners –such as the EU or the USA– are provided). Results focus on the most important variables relevant to evaluate how technological (improving factor productivity) and trade reform changes affect the wheat sector in Morocco. Presentation of results starts with macroeconomic changes in terms of GDP, welfare, and terms of trade. Then, results are reported in terms of changes of demand of production factors, changes in wheat production, changes in domestic prices, and changes in international trade of wheat.

3.1. Aggregate welfare outcomes

The Moroccan GDP would increase by 0.09% and 0.49% under Scenarios 1 and 2 respectively, and decrease by 0.83% per year under Scenario 3 (Table 3). Although these numbers at first sight look very small, in fact they are annual changes in GDP values. GTAP computes these percentages in terms welfare. The first scenario (S1) would represent for Morocco a net positive welfare gain of US$ 130 million per year. The second scenario (S2), which adds increased productivity in unskilled labor, results in welfare increases of US$ 429 million per year. The last scenario (S3), which adds unilateral trade liberalization on wheat, yields a net welfare gain of US$ 495 million per year.

Table 3: Aggregated welfare changes for Morocco (percentage changes)

Economic Variable	S1: 20% productivity increase capital	S2: S1 + 20% productivity increase in unskilled labor	S3: S2 + 100% liberalization of the wheat sector
Value GDP	0.09	0.49	-0.83
Welfare (millions of US$)	130	429	495
Terms of trade	0.04	0.26	-0.64

Source: Own elaboration based on results from GTAP 8.0 simulations

Understanding welfare changes is one of the most important results in the GTAP model as 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 relative prices of exports and imports), and d) more (or less) investments. All these factors together provide decomposition of welfare changes (Table 4). Allocative efficiency is negative in S1 and S2 indicating loses to the economy due to less efficient allocation of production resources between sectors. Allocative efficiency under S3 was projected to be positive (US$ 209 million), which is explained by the removal of the import tariff. That is, when a commodity is subject to a protection tariff, it implies that this commodity is under-using resources compared to what it would use under free market conditions (conversely, subsidies lead to overuse of resources, which in turn leads to over-production relative to free market conditions). Technical change effect is positive in all three scenarios, which is just due to the improved productivity of capital and unskilled labor.

Table 4: Welfare decomposition for Morocco (million US$)

Sources of welfare	S1: 20% productivity increase capital	S2: S1 + 20% productivity increase in unskilled labor	S3: S2 + 100% liberalization of the wheat sector
1) Allocative efficiency effect	-51	-125	209
2) Technical change effect	167	463	463
3) Terms of trade effect (TOT)	9	60	-149
4) Investment savings effect	5	31	-27
Total	130	429	495

Source: Own elaboration based on results from GTAP 8.0 simulations

In S1 and S2 the terms of trade – TOT (expressed in millions of US$) increased in relation to the baseline, while in the third scenario it decreased. From Morocco's perspective, changes in TOT measures 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 commodities, determining that Moroccan exports became more competitive abroad (appreciation of the TOT). Negative TOT as in S3 indicates that price index of imported commodities grew faster due to elimination of import tariffs to wheat, resulting in depreciation of TOT. Positive values of investment savings effect reflect increases in national savings due to improved productivity of capital and labor, while the negative value of investment saving effect under S3 denotes a reduction in national savings due to trade policy changes. Thus, welfare changes in Morocco came predominantly from the technical change effect.

3.2. Aggregated production

This section addresses changes in aggregated production in Morocco, which would increase in some commodity sectors and decrease in others (Table 5). 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 – less than one percent in cereal grains, meats and livestock and other commodities. Under the S3, wheat production would decrease, while the production of cereal grains, grain crops, processed foods and textiles would increase in the range of 0.1 - 4.5%. The most noticeable result is observed in the domestic production of wheat that would increase by 16.37% under S2 and would decrease by 13.72% under S3.

Table 5: Moroccan production of tradable commodities (percentage changes)

No.	Commodity	Production in Moroccan sectors		
		S1: 20% productivity increase capital	S2: S1 + 20% productivity increase in unskilled labor	S3: S2 + 100% liberalization of the wheat sector
1	Wheat	5.99	16.37	-13.72
2	Cereal grain	0.11	0.25	2.13
3	Grain crops	-0.23	-0.75	2.22
4	Meat livestock	0.16	0.40	1.83
5	Extraction	-0.09	-0.59	0.66
6	Processed food	0.55	1.35	4.32
7	Textile	-0.24	-1.17	3.40
8	Light manufacture	-0.13	-0.36	1.28
9	Heavy manufacture	-0.10	-0.39	1.00
10	Util. Construction	-0.17	0.39	0.16
11	Transp. Communic.	0.13	0.31	1.04

Source: Own elaboration based on results from GTAP 8.0 simulations

These results are explained by the way in which GTAP computes changes in aggregate output. That is, changes in output are captured by production function (*QVA*) that assembles inputs or endowments (*QFE*), which are quantities of endowments *e* used in sector *p* (Equation 1). 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.

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

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 factors. Increase in wheat production in S2 and reduction under S3 denote relatively high substitutability in inputs. Hence, as result of the shocks (i.e. changes in tariffs and changes in productivity of unskilled labor and capital), aggregate output changes resulting in changes in domestic sales, changes in exportable production, and a slack variable in the market clearing condition, which 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. Decomposing changes on wheat, Table 6 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, while in S3 wheat domestic production decreased mainly due to lowered demand for domestically produced wheat. Despite increased capital and unskilled labor

productivity, in the third scenario demand switches in favor to imported wheat. That is, the effect of the liberalization 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) wheat purchased from abroad.

Table 6: Moroccan wheat production (percentage changes)

Aggregated wheat production	S1: 20% productivity increase capital	S2: S1 + 20% productivity increase in unskilled labor	S3: S2 + 100% liberalization of the wheat sector
Domestic sales	5.63	15.41	-15.08
Export sales	0.35	0.96	1.36
Slack variable	0	0	0
Total	5.99	16.37	-13.72

Source: Own elaboration based on results from GTAP 8.0 simulations

In the GTAP model changes in production are explained by changes in the demand of factors of production. Table 7 shows that under S1 and S2 there is an overall increase in the demand for production factors which drive to an increase in wheat production in Morocco, while under S3 the model projected an overall reduction in the demand for production factors, which drive to a reduction in the production of wheat in Morocco. Under S1, the demand for land, unskilled labor and skilled labor used in the production of wheat would increase in percentages that vary from 2.91 and 4.56%. Changes in demand for natural resources used in wheat production are almost zero across all simulation scenarios. This result is because the GTAP model considers natural resources (such as land, mines, forests, and natural gas) as sluggish production factors, meaning that the amount of natural resources is almost fixed, and therefore its supply curve is almost perfectly inelastic leaving very little room to mobility among sectors. Under S2 the demand for land and skilled labor used in wheat production would increase in the range of 7.96 and 12.39%, while the demand of unskilled labor and capital would decrease by about 2.5%, which is due the direct effect of the productivity simulation (that consists of increasing productivity by 20% that lowers the demand for capital and unskilled labor used in the Moroccan wheat production - GTAP's general equilibrium closure). Under S3 the demand for all production factors used in wheat production would reduce by from -33.85 to -12.88%. These reductions are explained by lowered demand of domestically produced wheat, which is the direct effect of the wheat tariff elimination. Productivity changes (*AFE* in Table 7) are zero meaning 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 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 wheat Moroccan sector by -20%.

Table 7: Changes in demand of factors of production, and changes in production of wheat in Morocco

Production factor	S1: 20% productivity increase capital				S2: S1 + 20% productivity increase in unskilled labor				S3: S2 + 100% liberalization of the wheat sector			
	AFE	QVA	ESUBVA	Total	AFE	QVA	ESUBVA	Total	AFE	QVA	ESUBVA	Total
1 Land	0		-3.08	2.91	0		-8.41	7.96	0		0.84	-12.88
2 UnSk Lab	0		-1.46	4.53	-20		1.08	-2.55	-20		-0.04	-33.76
3 Sk Lab	0	5.99	-1.42	4.56	0	16.37	-3.98	12.39	0	-13.72	-5.3	-19.03
4 Capital	-20		3.66	-10.36	-20		1.06	-2.57	-20		-0.13	-33.85
5 Nat Res	0		-5.97	0.02	0		-16.32	0.05	0		13.65	-0.08

Source: Own elaboration based on results from GTAP 8.0 simulations

These results are explained by the way in which the GTAP model computes production factor demand. That is, in the left-hand side of Equation 2 an increase in capital productivity (*AFE*) 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 (analogous is the case of productivity in labor). Then, when productivity of capital (*AFE*) increases, three effects are generated: i) if capital becomes more productive, then less capital is used for a given amount of output and constant prices; ii) 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); and iii) more productive capital also lowers the cost of production, facilitating output expansion. The price ratio is raised to a negative value of the elasticity of substitution (*ESUBVA*). 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*) is determined by the sum of share weighted prices of endowments.

$$QFE_{e,p}.AFE_{e,p} = QVA_p.SVA_{e,p}.[\frac{PFE_{e,p}}{PVA_p.AFE_{e,p}}]^{-ESUBVA_p} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Hence, GTAP captures the changes in demand of production factors through changes in productivity, in prices of production factors and in the elasticity of substitution among production factors. In Equation 2, productivity changes in capital and in unskilled labor are reflected through the variable *AFE*, which has a negative sign meaning that if technical change makes capital and unskilled labor more productive, 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 prices of production factors. When capital and unskilled labor become more productive, the retributions to 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 production factors.

In terms of commodity prices, GTAP assumes that changes in supplier prices are transmitted to consumers as function of production costs reflected in prices and taxes. As expected wheat prices in all scenarios would decrease (Table 8). In S1 the price of domestic wheat suppliers would decrease by 3.94%, while in S2 prices would lower by 10.78%. The largest wheat price reduction is projected in S3 (-15.08%) which occurs because of import tariff elimination.

Table 8: Changes in Moroccan domestic prices (percentage changes)

Commodity group	S1: 20% productivity increase capital	S2: S1 + 20% productivity increase in unskilled labor	S3: S2 + 100% liberalization of the wheat sector
Wheat	-3.94	-10.78	-15.08
Cereal grain	0.36	1.1	-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
Textile	0.06	0.27	-0.58
Light manufacture	0.08	0.32	-0.32
Heavy manufacture	0.04	0.26	-0.22
Util. Construction	0.05	0.37	-0.28
Transp. Communic.	0.1	0.44	-0.36

Source: Own elaboration based on results from GTAP 8.0 simulations

These results are explained by the way GTAP computes changes in commodity prices. That is, commodity prices in the model are assumed to change as function of tariffs on imports (*tm*), which is a source-generic change in tax on imports of commodity *i* into country *s*, plus supplier import tariffs (*tms*), that is a bilateral import protection measure, and plus the Cost, Insurance and Freight (*CIF*) world price of commodity *i* supplied from country *r* to country *s* (*pcif*):

$$pms(i,r,s) = tm(i,s) + tms(i,r,s) + pcif(i,r,s) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Under S1, the price of wheat would reduce because overall wheat supply in the country (domestic and imported) would increase due to more domestic production. In S2, wheat domestic price would further decline due to more domestic wheat production. In the scenario of wheat trade liberalization (S3), the price of wheat decreases the most (-15.08%), which is concomitant to import tariff reduction and technological change improvement in capital and unskilled labor productivity. As expected, changes in prices of other commodities were very small (most of them less than one percent), indicating that as a result of the shocks the model produced relatively small reallocation of production factors among sectors, and therefore the production level in each one would not change significantly.

3.3. CHANGES IN IMPORTS

Morocco has historically been a net importing wheat country (Figure 2, below). This situation does not change in the three scenarios simulated, meaning that Morocco would not become self-sufficient or a net wheat exporter country. Under the first two scenarios, the first point of impact emerging from increase in Moroccan productivity of capital and unskilled labor is 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 9). In S3, wheat imports substantially increase by 44.29%, because eliminating wheat import tariffs makes more attractive to import wheat rather than producing it domestically. In this scenario imported wheat displaces domestically produced wheat. As discussed in the next section, such a large increase in wheat imports is mainly explained by the much lower production cost of wheat in other countries supplying Morocco.

Table 9: Changes in Moroccan imports (percentage changes)

Commodity group	S1: 20% productivity increase capital	S2: S1 + 20% productivity increase in unskilled labor	S3: S2 + 100% liberalization of the wheat sector
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
Textile	0.07	0.18	1.02
Light manufacture	0.11	0.87	0.04
Heavy manufacture	0.09	0.87	0.11
Util. Construction	0.24	1.17	0.22
Transp. Communic.	0.34	1.32	0.27

Source: Own elaboration based on results from GTAP 8.0 simulations

Thus, the model projected the effect of tariff elimination overcomes improvements in productivity, suggesting that if an objective is to hold substantive domestic wheat production in Morocco, then

tariff protection measures are needed. In the first two scenarios Moroccan importers (firms, households and government) would find more supply of domestic wheat sold at competitive price, which would lead to a reduction in Moroccan imports of wheat. In the third scenario, Moroccan dealers find imported wheat cheaper (due to the tariff elimination) which displaces domestic production provoking an increase in wheat imports.

4. DISCUSSION

How feasible are these results - i.e. how feasible is it that wheat production in Morocco would increase under productivity change scenarios, and would decrease under liberalization scenario? How feasible is that imports of wheat would decrease in Morocco under the two first scenarios and would increase in 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 arguable that many variables have to be considered, such as production costs, commodity demand, import tariffs, labor market and others. It could also be argued that 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, economic cycles), environmental and physical variables among others.

In this paper, 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 turns difficult to achieve a full assessment of the model, especially if the system being modeled includes informal markets like in case of the Moroccan wheat sector. We chose to analyze feasibility of results based on outputs of the model, and to this end secondary data was collected from national and international sources. Discussion elements focused on analysis of historical production value data of wheat and other commodities, domestic and imported supply of wheat, water consumption in Morocco, and expansion of the Moroccan export sector relative to the world market.

A key finding related to the first two scenarios is that as response to productivity change, wheat production in Morocco would increase by 5.99% in S1 and by 16.37% in S2. These results are feasible considering several measures the government has been taking in recent years. Since the launch of the GMP, Morocco increased its investments in labor training and physical capital accumulation reaching figures between 5.4 and 6% of GDP (World Bank, 2010; UNESCO, 2014), which is almost twice (3.8%) the average for Middle East and North African countries (AMCML, 2014). These investments have been mainly given in the form of subsidies to the wheat sector. For example, in 2016 the government has set seed subsidies for durum wheat, common wheat, and for barley, which covered 40 to 60% of the seed costs (USDA, 2017). In calendar year 2017 the volume of subsidized common wheat flour, known as "National Flour", is 650,000 MT (USDA, 2017) given by the government in an effort to support low-income consumers. Stocks held by licensed agents (such grain merchants, cooperatives, processors and government managed port silos) also receive storage premium subsidies. In 2012 the government allocated 28 million dollars to lower the price of wheat certified seeds (USDA, 2013). This subsidy targeted 70% soft wheat, 29% durum wheat, and 1% barley (USDA, 2013). Other subsidies to foster wheat production and productivity included 30% to 70% subsidy in the purchase of capital (modern machinery and irrigation facilities) and training of farmers. 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 to production of cereals. This insurance program targeted 500,000 ha representing about 10% of Morocco's cereal planted areas (USDA, 2013). The purpose of the program was to absorb between 50% and 90% of the financial loses if farmers experience unfavorable conditions. Hence, the Moroccan cereal policy has supported domestic

wheat production to the point that wheat became by far the most important crop in the country (Figure 1) in terms of quantities produced (more than five million tons produced in 2014), and the second more important in terms of net production value (445 million dollars in 2014).[2]

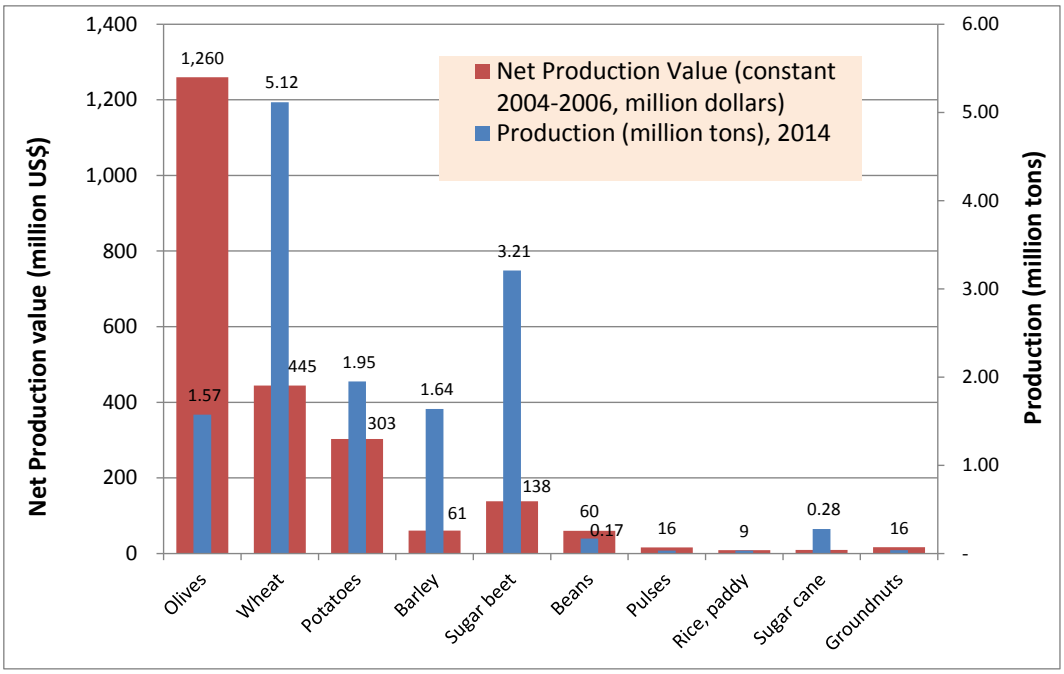

Figure 1: Top ten commodities in Moroccan agriculture, production and value, 2014

Source: Own elaboration based on production and value data extracted from online FAOSTAT, 2017
Note: Yield data for 2014 is the latest data available at FAOSTAT

Despite years of support, the country has been unable to be self-sufficient in wheat production. In fact, Morocco has overtime become more and more dependent on wheat imports. In the 1960s, with an average population of 13 million inhabitants, Morocco used to be largely self-sufficient by producing 81% of total wheat supply (Figure 2). By 1970s the domestic wheat production dropped to 62%, while imports increased from 20% in 1960s to 38% in the 1970s. The trend in supplying with smaller share of domestically produced wheat continued over 1980s and 1990s, while in parallel the imports of wheat were increasing. By 2001-2013 Morocco used to produce 60% of domestic supply, while 40% was imported mainly from the France, United States, Canada and Ukraine. Meanwhile, Moroccan population more than doubled from the 1960s, reaching 34.5 million in 2015, and along with population growth wheat per capita supply increased from 138 kg/person in the 1960s up to 247 kg/person as average for the period 2001-2013.

[2] Other important crops in Moroccan agriculture are sugar beet, potatoes, barley and olives (in that order of importance) that have been produced in levels that exceeded one million tons in 2014. For Morocco, the value of olive production is the commodity that yielded more income to the economy in 2014 (more than 1.2 billion dollar), followed by wheat and potatoes (445 and 303 million dollar respectively), and sugar beet, barley and beans (between 60 and 138 million dollar).

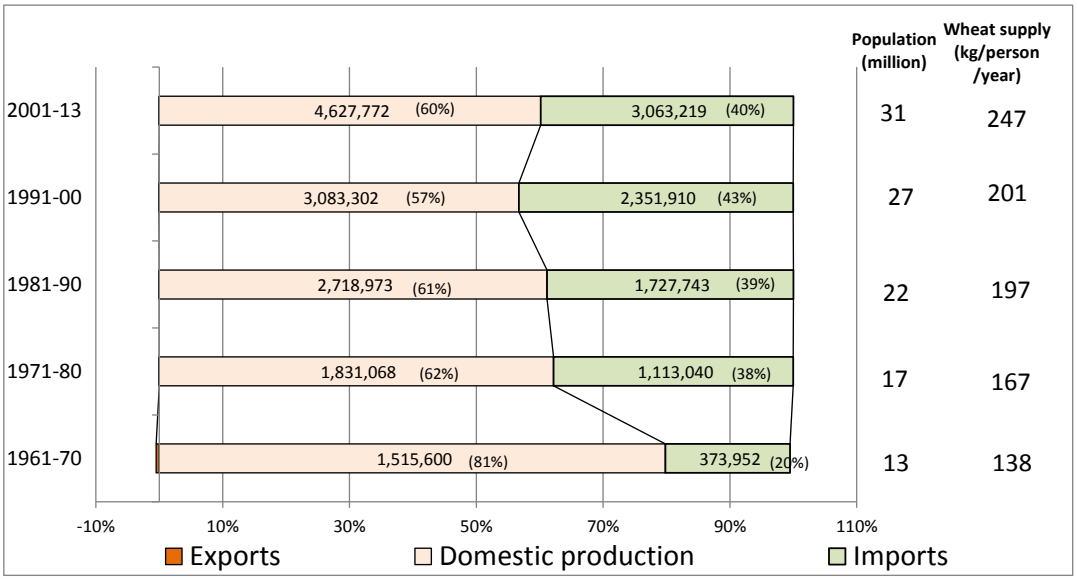

Figure 2: Morocco: Total domestic wheat supply (1,000 tons)

Source: Own elaboration based on data extracted from FAOSTAT online database, 2017
Note: International trade data for 2013 is the latest data available at FAOSTAT

This historical trend shows that as population increased wheat demand also increased along with wheat imports that overtime became progressively more important to satisfy domestic wheat consumption. The projections of the GTAP model seem to be acceptable under the first two scenarios. That is, production would increase as result of technological changes, but those increases would not be enough to completely get rid of 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, that eliminated wheat import tariffs, forecasted an increase on imports of wheat and a reduction of domestic wheat production. These results were due to lowered imported wheat prices that displaced some of the domestic wheat production. The tariff protection that Morocco applies to imported wheat is complex and varies according to the source (Table 10). In 2015 durum wheat imports were subject to 75% ad-valorem tariff when imported from US, and 170% when coming from the EU, while 30 to 70% and 30% were applied in the case of soft wheat imported from the US and the EU respectively (WTO, 2017; USDA, 2017). In 2015 the Moroccan import tariff for cereal products ranked from 59.4% to 195% in 2014 (WTO, ITC and UNCTAD, 2016). Such tariffs suggest high protection to 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 also a trade agreement with, such as the United Arab Emirates, Mauritania, Algeria, Iraq or Libya, are all zero (Table 10). However, these countries (likewise Morocco) are net wheat importers and therefore no wheat trade takes place among them.

Table 10: Tariff structure applied to wheat, by region specific, 2015

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	Soft wheat
FTA-DR for the Arab League Member Countries	HS02	100190	100	0.0	Soft wheat
FTA-DR for Mauritania	HS02	100190	100	0.0	Soft wheat
FTA-DR for United States of America	HS02	100190	0	30-70	Soft wheat
FTA-DR for Arab Mediterranean Countries (Agadir)	HS02	100190	100	0.0	Soft wheat
FTA-DR for the European Communities	HS02	100190	0	30.0	Soft wheat
FTA-DR for Algeria	HS02	100190	100	0.0	Soft wheat
FTA-DR for Iraq	HS02	100190	100	0.0	Soft wheat
FTA-DR for Libya	HS02	100190	100	0.0	Soft wheat

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.
Note: Morocco applies Most Favored Nation (MFN) clause to countries with no preferential agreement. As per the Uruguay Round multilateral trade negotiation (1995), Morocco has converted all its import tariffs into ad-valorem rates

If Morocco eliminates wheat import tariffs to the US and EU countries, Moroccan farmers would face challenging competition from foreign producers. Saubanov *et al*. (2014) estimated that wheat production costs in France (US$ 266,7/ton), Germany (US$ 245,3/ton), United States (US$ 238/ton) and Argentina (334 US$/ton), which are wheat suppliers to Morocco, are significantly lower to the average wheat production in Morocco estimated in 580 US$/ton (Bentaleb, 2012). These estimates suggest that producing one ton of wheat in Morocco would cost between 74 and 144% more as compared to France, Germany, United States and Argentina.

Competitiveness of US, France, Germany and others is not only about having lower production costs, but it depends on other factors too. A significant one is the substantive domestic support developed economies provide to their cereal farmers. For example, the United States, through the US Farm Bill, uses different forms of subsidies that directly affect farmers' income. These include (in order of financial importance): yield and revenue protection insurance, conservation subsidies, direct payments, agricultural research services, disaster aid payments, countercyclical payments, and marketing loans (Rupp, 2014). The structure of European subsidies, provided through the Common Agricultural Policy (CAP), to its farmers is similar to that of the US Farm Bill, except that the generally the CAP does not subsidize crop insurance programs.[3]

Schnepf (2014) estimated that the US average farmer income was US$ 108,844 in 2013, which was about 53% higher than the average income of an ordinary US household. IFPRI (2014) estimates the average principal farm operator income for 2008-2012 was 127% of average US household income. Matthews (2012) estimated that in average the total subsidy that a typical French farmer received in 2012 was Euro 32,204, while it was Euro 33,974 and 44,824 for German and British farmers respectively. For Morocco, ACLIMAS (2014) estimated that farmers producing wheat in rainfed areas made in average US$ 5,160 in 2013, while wheat producers from irrigated areas made US$ 8,940 in 2013.

Additionally, the US and European countries have invested in large cereal storage capabilities to undertake extensive storage, thereby giving these countries market power. Research and subsequent use of improved wheat varieties and advanced agronomic practices have for years position European countries (New Zealand, Ireland, Belgium, Netherlands, Germany, United Kingdom, Denmark and France) in the top of world's highest wheat yields ranging from 7.3 to 10 ton/ha in 2014 (FAOSTAT, 2017). While the United States (3 ton/ha) and Argentina (2.7 ton/ha) achieved lower yields than European countries, they still attained higher wheat yields as compared to Morocco (1.7 ton/ha in average in 2014) (FAOSTAT, 2017). For Morocco eliminating wheat import tariffs would imply competing with heavily supported wheat production in developed economies. Stiglitz (2011) claims that subsidized agriculture in developed countries tends to drive downwards agricultural domestic prices in developing countries, which in turn frequently causes lesser domestic production (just as predicted by the GTAP model). Lower prices and smaller production can drive farmers, particularly small ones, out of the business or expose them to substantial income reductions (Stiglitz, 2011).

The government of Morocco is aware of the importance of tariffs to protect domestic wheat production, which contributes to create agricultural and agro-industrial employment, and provides livelihoods for thousands of families along the wheat commodity chain (i.e. variety development, seed improvement, certification, multiplication, planting, transformation and marketing to end-users). In the country there are around 1,300 wheat seed growers spread out across different production regions (ICARDA, 2014). They use about 70,000 ha to produce 1.5 million quintals of cereals, mainly wheat (AMMS, 2014 personal communication - Mohamed Bouanani). Cereals (soft and durum wheat, and barley) covered over five million hectares in 2013, representing most

[3] The CAP provides some crop insurance payments for few crops and under certain events related to damages caused by hail or freeze

of the agricultural lands in Morocco (GMP, 2014). About 72% of the total cereal production corresponds to wheat, and the remaining to barley (FAOSTAT, 2017). The latest agricultural census in Morocco (1996) is outdated, but still provides an indication the number of farmers that that directly depend on cereals for their income. This census estimated that 1.45 million Moroccan farmers were engaged into cereal production in 1996 (MADR, 1996).

Despite of such a large wheat production areas and the amount of manpower dedicated to produce cereals, wheat imports in Morocco are the most important (in both quantitative and value terms) among all agricultural imports (Figure 3). In 2013 Morocco imported more than 2,700 million tons of wheat, which was valued in almost one billion dollars (at an average cost of 359 US$/ton). Moroccan dependency on cereals is high, and wheat is one of the most important foodstuffs in Moroccan diet. USDA (2013) estimated that in 2013 per capita consumption of wheat was 258 kg per year, which is about 700 grams per day per person. Our estimations suggested that in the period 2001-2013 average per capita wheat consumption was 247 kg per year (Figure 2). Taking either of these two estimations, Morocco is a high per-capita wheat consumer country in the world.

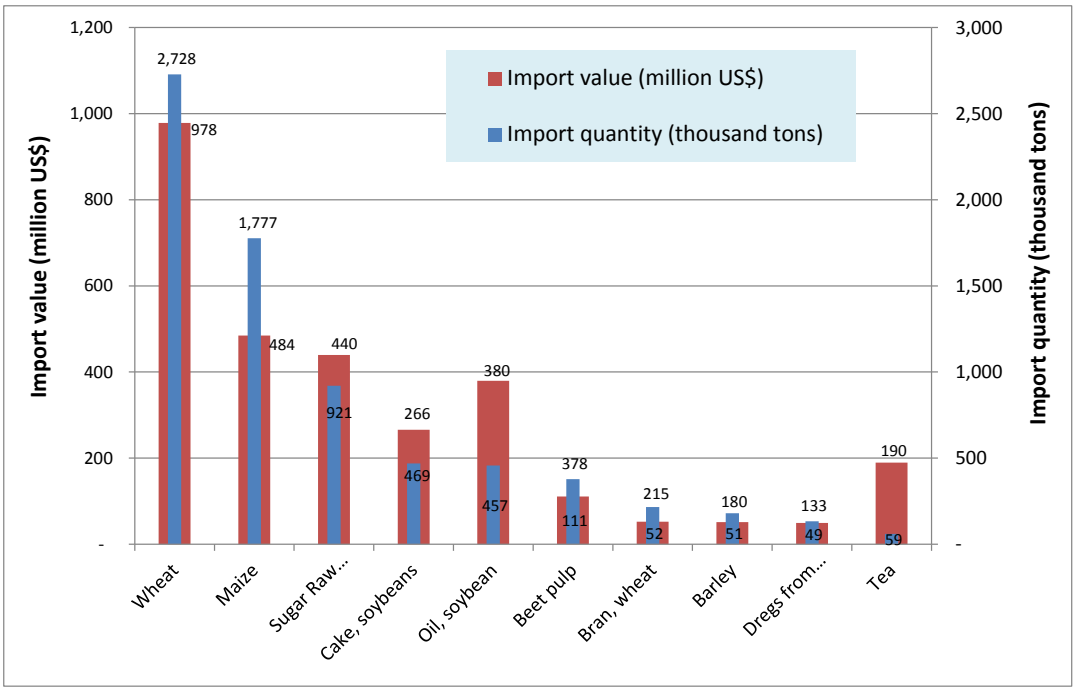

Figure 3: Top 10 imported commodities in Morocco, 2013

Source: Own elaboration based on import data extracted from online FAOSTAT, 2017

High consumption of cereals is explained by government policy to keep bread prices at affordable levels to all segments of the population. Politically and socially keeping low prices for bread has traditionally 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 wheat, as basic foodstuff, should be available to every household in the country. Even in countries like Jordan, that only produces about 3% of the total wheat that consumes (the rest is imported), the price per kilogram of bread can be as low as 0.2 dollars/kg. Similarly in Egypt or Syria (before the conflict), the prices of bread products responded to government policies that kept them to less than one quarter of dollar per kilogram. The Moroccan government has only subsidized imports of soft wheat suitable for bread production, and has managed to keep domestic bread price at about 0.2 cents of dollar per loaf (Morocco has not been subsidizing imports of durum wheat). Low

prices of bread in net-importing wheat countries contrast with high prices in net-exporting wheat countries such as Argentina where bread products can cost as much as two dollars per kilogram.

Removing import tariffs to wheat would be a very challenging trade policy measure for many reasons. According to GMP (2014) all cereal production in 2013 contributed to 47% of the agricultural added value (no estimation for wheat only was found). In turn, agricultural GDP in 2016 represented 13% of the total Moroccan GDP (WDI, 2017). GMP (2014) estimated that 75% of the rural employment is generated by the cereal sector. These figures suggest that the main contribution of cereal production is not in terms of GDP, but it is massive generator of employment in the country. Liberalizing fully the Moroccan wheat market could negatively affect thousands of jobs that directly depend on wheat for livelihoods.

Yet, liberalizing the wheat market could provide market signals for Moroccan farmers to further diversify production. Relatively less production of domestic wheat might not necessarily harmful to the Moroccan society as a whole. As shown in Figure 2, wheat supply per capita showed a significant increase since the 1960s onwards. This suggests that Morocco does not necessarily need be self-sufficient in production to increase wheat supply per person, even in the face of rapid population growth. Large cereal producers such as the United States, Russia, France, Canada, Germany, Australia, Ukraine and Argentina supply significant volumes of wheat at cheaper price that would cost to domestically produce them.

The fact that Morocco is a net cereal-importing country can also be regarded from water efficiency and virtual water utilization viewpoints. Figure 4 shows average water consumption per ton for traditional irrigated and rainfed crops in Morocco. In general cereals (maize, barley, durum wheat, soft wheat and rice) and pulses (lentils, peas, chickpeas and soya beans) tend to consume more water per ton of crop than fruits (apples, lemon, oranges, mandarins and bananas, excepting fruit trees dates and olives) and vegetables (garlic, sugar beet, carrots, potatoes, onions, cucumber, lettuce and tomatoes).

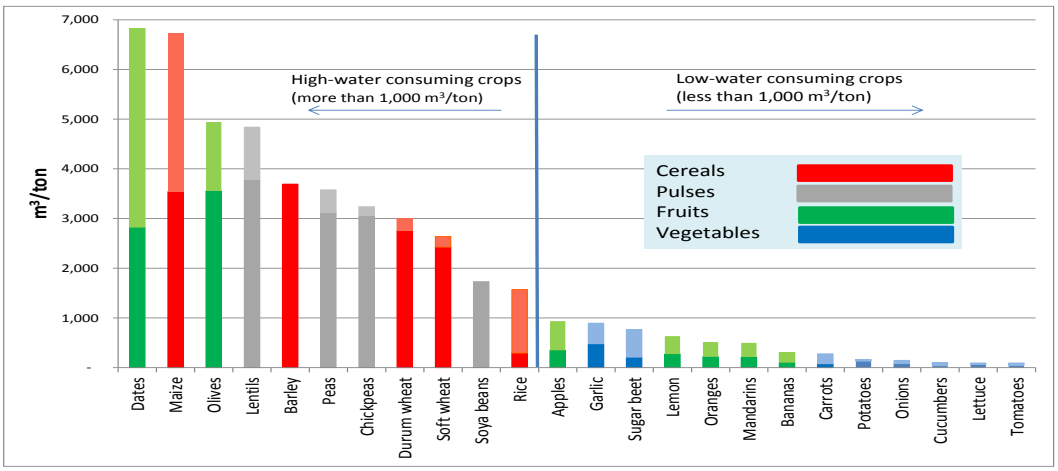

Figure 4: Water consumption for traditional crops in Morocco, 2010

Source: Own elaboration based on data from Mekonnen and Hoekstra (2010). Mekonnen
Note 1: Following Schyns and Hoekstra (2014), we estimated average water consumption per ton for irrigated and rainfed crops (in m^3/ton) by summing-up green and blue water footprint. Green water footprint is the volume of rainwater consumed during the production process of a crop. Blue water footprint refers to the volume of surface (irrigation) and groundwater consumed (evaporated) as a result of the production of a crop.
Note 2: Strong color denotes green water footprint (rainfed crop), while light color denotes blue water footprint (irrigated crop).

Cereals utilize between 1,570 and 6,700 m^3/ton, which is substantially more water if compared with vegetables or fruits (except dates and olives) that consume between 100 and less than 1,000 m^3/ton. Pulses, fruit trees olives and dates also consume higher quantities of water (more than 1,730 m^3/ton) as compared to vegetables and fruits. In average, durum and soft wheat consume 3,003 and 2,642 m^3/ton respectively. Green water (rain) is mainly used for wheat and barley, while maize and rice use 47% and 81% respectively of blue water (surface irrigation). Green water consumption is predominant for pulses. Vegetables and fruits use mix of green and blue water (i.e. rainfed and surface irrigation).

Water resources in Morocco have been shrinking due to lower levels of precipitation, over-abstraction of groundwater, population growth and an increasing demand for water (Sadler and Magnan, 2011). It is estimated that due to climate change water for agriculture will reduce 16% by 2030 and 34% by 2050 (Boughlala, 2013). Hence, from a virtual water utilization perspective, it seems that importing wheat from well-endowed water countries would bring much-needed savings in water that can be utilized in other cultivars that are less water-intensive, but still well-priced and counting with steady domestic and international demand. Figures 3 and 5 back-up trend of Moroccan farmers that since the 1960s have relatively been reducing wheat cultivars that use more water, while intensifying their farming systems with fruit and vegetable that use relatively less water.

5. CONCLUSION

This research had the motivation of improving understanding of the macro implications that would emerge should Morocco decides to liberalize its wheat market. 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. In this context, we simulated improvements in factor (capital and labor) productivity and elimination in wheat import tariffs, and estimated their effects on domestic wheat supply, per-capita wheat consumption, and wheat prices. Shedding light on these issues provide policy makers with key information to analyze trade-offs emerging from keeping protected the wheat sector or liberalizing in light of trade agreements and current trends. One of the main results suggest that wheat production under scenarios S1 and S2 would increase by 5.99% and 16.37% respectively, while it would decrease by 13.72% under S3. Our simulations and analysis of Morocco's historical trend in wheat production lead us to conclude that Morocco has been and it is likely to continue to be a net wheat importing country.

Discussion of results suggests that the import tariffs that Morocco applies to imported wheat are very important to keep substantial domestic wheat production. Import tariffs provide a framework to produce domestic wheat in a way that competes with cheaper wheat produced in other counties (such as France, United States, and Germany), which use high-yielding varieties and are comprehensively supported. Removing tariffs to wheat could reinforce the historical trend that Moroccan farmers have been following since the 1960s that consisted of relatively reducing wheat cultivars that are more water-intensive, while intensifying their farming systems with fruits and vegetables that are less-water intensive. This could also lead towards increasing dependency on wheat from well-endowed water countries.

However, our analysis also shows that without these tariffs local wheat production would drop drastically. Tariffs contribute to keep a relatively large wheat sector generating significant agricultural value added and, more importantly, to maintain thousands of jobs along 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 term. The Moroccan government has a difficult duty ahead that consists of maintaining wheat-associated agricultural employment in light of shrinking water resources for agriculture, and while dealing with international pressure that is asking for liberalization of the wheat sector. The future of wheat

production in the country will therefore depend on the trade-offs between the potential cost savings from the substitution of domestic production of wheat with imports on one hand, and the contribution of wheat to GDP and employment opportunities with its social and political benefits on the other.

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