THE ASSESSMENT OF THE ECONOMIC IMPORTANCE OF AZOLES IN EUROPEAN AGRICULTURE: WHEAT CASE STUDY

Nomisma

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Founded in 1981 and located in Bologna, Nomisma is an economic research institute with more than 80 shareholders, including industrial groups, insurance companies, and Italian and foreign banks. "Nomisma" is an ancient Greek word that signifies "the real value of things": it is in this spirit that Nomisma operates as an observatory on the main trends in the real economy and contemporary society. Nomisma engages in research at international, national and local levels focused on production factors, on the economics of sectors and businesses, on development problems and – in general – on the trends that affect the structure, the behaviour and outcomes of contemporary economics.

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EXECUTIVE SUMMARY

The objective of this study is to make an assessment of the socio-economic importance in European agriculture of azoles active substances. In order to evaluate the actual relevance of this class of compounds, the economic impact of a withdrawal from use of azoles has been estimated, considering the specific case study of wheat.

The evaluation of the impact has been carried out by taking into account the future trends of the main variables, which are yield, area, production, trade balance, consumption and self-sufficiency. The time frames of the analysis consider a short term impact analysis (2013) and a long term one (2020).

In the short term evaluation, rates of yield reduction have been used to estimate the drop in production linked to the increased diseases occurrence and to related effects that could arise from the withdrawal from use of azole fungicides. In the long term analysis, the development of resistance for the remaining fungicides has been considered along with the yield reduction effect: specifically, in a long term horizon the increasing selection pressure for the remaining fungicides would result in a lack of protection regarding diseases and would cause difficulties in managing them.

The impact analysis carried out by Nomisma has outlined some very clear results.

- The projections have shown that, with azoles still in use, wheat yield and cultivated areas would continue to increase in the next few years, resulting in an overall growth of wheat production that has been estimated at +5.0% in 2013 and +13.4% in 2020. According to these trends, the European Union would remain a net exporter of wheat and would continue to produce more wheat than what is being consumed.

- The yield of wheat would decrease in the hypothesis that the use of azoles ceased resulting in a loss of production (leaving all other variables constant) of 9.8 millions of tons in 2013 (from 141.1 to 131.3) and 18,6 millions of tons in 2020 (from 152.4 to 133.8). This decreasing production would not only mean a loss of value of 2.4 billion euros in 2013 and 4.6 billion euros in 2020. It would also mean that the European Union would be unable to satisfy its internal demand and maintain a 100% self-sufficiency rate.

- An analysis has also been made of key variables (namely imports, exports, stocks and cultivated area) that would need to adjust to compensate for the reduction of the yield and to guarantee a 100% demand satisfaction rate and a 100% self-sufficiency rate. While there would be substantial changes in all variables, it is particularly significant (and unrealistic) that the cultivated area would need to increase by 7.5% in the short term scenario and by 13.9% in the long term scenario.

- The role of azoles is highlighted in maintaining the European Union's position as a net exporter. The sensitivity of the world price to changes in the EU are also highlighted given that it is a primary player in term of production (it accounts for 21% of total wheat production), productivity (European yield is 5.3 t/ha while the global average is 2.9 t/ha) and trade (it contributes to 16.8% of world wheat trade flows).

- In conclusion, the study shows that the economic relevance of azoles in the European Union is considerable, as their hypothetical loss would have significant relapses on both the domestic market and international markets. On the internal market, we estimate that without azoles there would be a drop in domestic production, leading to a deterioration of the demand satisfaction rate and to higher prices. This could in turn imply that the European Union could cease to be a net exporter at world level, bringing into question the possibility of the other big wheat supplier (North and South America, Australia, Russia, etc.) to be able to satisfy the global demand. This would increase the current uncertainty concerning global food security, bringing further consequences – which have been prominently emerging over the last years - such as drop in stocks, increase of prices and price volatility upsurge.

PART I
IMPACT IN THE EUROPEAN UNION

1. MAIN RESULTS OF THE PART I OF THE STUDY

The objective of this study is to make an assessment of the socio-economic importance in European agriculture of azoles active substances. In order to evaluate the actual relevance of this class of compounds, the economic impact of a withdrawal from use of azoles has been estimated, considering the specific case study of wheat.

The starting point of the study will be an assessment of the contribution of azoles to wheat crop, with focus on total wheat. The analysis has been conducted at European level (EU 27).

The evaluation of the impact has been carried out considering a dynamic assessment: this means that it takes into account the overall future trends of the main variables (considered as "standard drivers") which are yield, area, production, trade balance, consumption and self-sufficiency. The time frame of the analysis is dual: it has been considered a short term impact analysis (2013 – T_1) and a long term one (2020 – T_2) based on forecasts[1].

The assessment of the impact on wheat production from losing all azoles has been carried out using a "scenario analysis" and basing the whole analysis on the outcomes of ADAS and Horta studies[2].

In the short term evaluation (T_1 - 2013), rates of yield reduction have been used to estimate the drop in production linked to the increased diseases occurrence and to related effects that could arise from the withdrawal from use of azole fungicides. The EU index (table 1.1) has been obtained by means of a weighted average of the indices calculated by ADAS and Horta (through four countries-case studies – Denmark, France, Italy and United Kingdom).

Table 1.1 – EU27: yield loss index in the hypothesis of a loss of azoles (2013 and 2020)

Yield reference scenario (t/ha)	Short term T_1 (2013)		Long term T_2 (2020)	
	5.37		5.63	
Yield "No azoles" scenarios	Impact of loss of azoles		Impact of loss of azoles + resistance effect	
	Loss index	Yield (t/ha)	Loss index	Yield (t/ha)
"No azoles" scenario (A)	7.0%	5.00	12.2%	4.94
"No azoles" best scenario (A-20%)	5.6%	5.07	9.7%	5.08
"No azoles" worst scenario (A+20%)	8.4%	4.92	14.6%	4.81

Source: Nomisma elaborations on Blake J. et al. (2011) and Salinari F. et al. (2011) data.

In the long term analysis (T_2- 2020) the development of resistances for the remaining fungicides has been considered along with the yield reduction effect: specifically, in a long term horizon the increasing selection pressure for the remaining fungicides would result in a large lack of protection regarding diseases and would cause difficulties in managing them. Therefore, the long term yield reduction index (directly related to the efficacy of the remaining active substances) has been

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[1] The specific methodology of the forecast and the construction of estimates will be developed throughout the report.

[2] References: "Evaluation of the benefits provided by the azole class of compounds in wheat, and the effect of losing all azoles on wheat and potato production in Denmark, France and the UK", made from ADAS (Blake J. et al., 2011); "Evaluation of the benefits provided by and of the effect of losing the azole class of compounds on durum and common wheat production in Italy", made by Horta Srl and Università Cattolica del Sacro Cuore (Salinari F. et al., 2011).

combined with the impact on yield reduction resulting from the resistance development (comprehensive index is shown in table 1.1).

Additionally, an uncertainty assessment has been included to improve the reliability of the estimates of the economic impact: it has been decided to consider a possible deviation from the calculated indices (expressed by a range of variability of plus/minus 20%) aimed at identifying a confidence interval of the assessment – and at validating the consistency of the estimates.

The impact analysis carried out by Nomisma has outlined some very clear results.

Firstly, our projections have shown that, with azoles still in use, wheat yield and cultivated areas would continue to increase in the next few years, resulting in an overall growth of wheat production that has been estimated at +5.0% in 2013 and +13.4% in 2020. According to these trends, the European Union would remain a net exporter of wheat and would continue to produce more wheat than what is being consumed.

However, Nomisma has estimated that the yield of wheat crops would decrease in the hypothesis that the azoles were ceased to be used, resulting in a loss of production of 9.9 millions of tons in 2013 (from 141.1 to 131.3) and 18,6 millions of tons in 2020 (from 152.4 to 133.8). In turn, this decreasing production would not only mean a loss of value of 2.4 billion euros in 2013 and 4.6 billion euros in 2020, but it would also make the European Union unable to satisfy its internal demand and to maintain a 100% self-sufficiency rate.

One of the main accomplishments of the analysis, in fact, has been to calculate the demand satisfaction rate and the self-sufficiency degree under the different scenarios. As it has been done for the estimates of the economic impact indices a range of variability of about plus/minus 20% of the outcomes has been considered, thus creating a sensitivity analysis.

These indices represent a measure of the effect of an hypothetical loss of azoles. As figure 1.1 shows, the two ratios decline both in the short term and in the long term: as a result, the European Union would be unable to satisfy its internal demand, and its internal production will no longer be greater than the domestic demand.

Figure 1.1– Impact of withdrawal from use of azoles: demand satisfaction rate and self-sufficiency rate degree in the short and long term
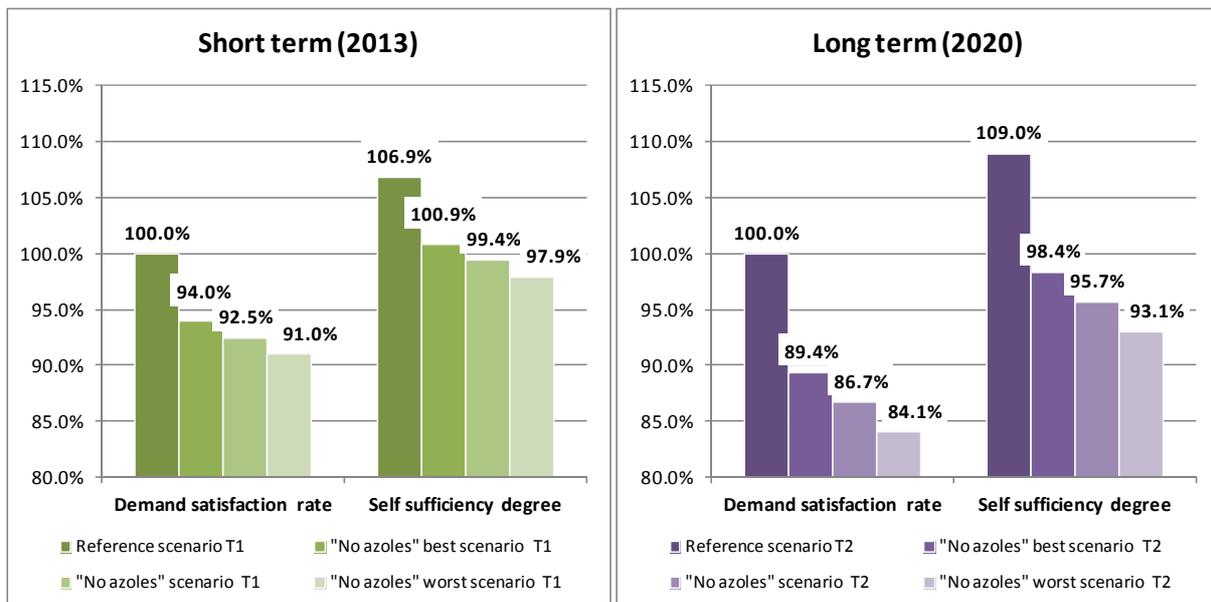
Source: Nomisma elaborations.

A second step of the analysis has been to estimate how the other variables determining the production and the availability of wheat (namely imports, exports, stocks and cultivated area) should adjust to compensate for the reduction of the yield and to guarantee a 100% demand satisfaction rate and a 100% self-sufficiency rate. The results clearly show that most of the adjustments seem at best very difficult to meet, as they would require drastic cuts of the stocks or of the exports of wheat, or alternatively a very sharp increase of imports or of cultivated area.

Table 1.2 illustrates the single adjustments required to maintain a 100% demand satisfaction rate. The unlikelihood of these adjustments is evident if we look at the cultivated area, which should increase by 7.5% in the short term scenario and by 13.9% in the long term scenario. As for the trade component, the adjustments would make the EU dependable from the external production or would subtract considerable amounts of wheat to external buyers. The option of cutting the stocks appears even more unfeasible, since it would mean to exhaust the entire reserve of wheat in just a few years in the short term and in just one year in the long term.

**Table 1.2– Single variable adjustments required
to maintain a 100% demand satisfaction rate in the short and long term**

	Short term 2013			Long term 2020		
	"No azoles" best scenario T_1	"No azoles" scenario T_1	"No azoles" worst scenario T_1	"No azoles" best scenario T_2	"No azoles" scenario T_2	"No azoles" worst scenario T_2
Variation production (,000 t)	-7.9	-9.9	-11.9	-14.8	-18.5	-22.3
Variation area (%)	5.9%	7.5%	9.2%	10.8%	13.9%	17.1%
Variation export (%)	-50.3%	-62.9%	-75.5%	-82.1%	-102.6%	-123.2%
Variation import (%)	119.6%	149.5%	179.4%	269.3%	336.7%	404.0%
Variation stock (%)	-39.5%	-49.4%	-59.3%	-74.2%	-92.7%	-111.3%

Source: Nomisma elaborations.

Since price variations may negatively affect both economic agents along the supply chain and final consumers, the impact of the withdrawal of azoles on wheat prices has been considered as well.

The assessment has been carried out by means of a combination of a systematic review of economic literature and own estimations, based on data sets supplied by international statistical and research institutions (Eurostat, FAO, FAPRI). The reviewed literature pointed out a general trend toward high commodity price levels along with greater volatility in the future, due to increasingly inelastic demand and anticipated low stock levels as compared to consumption. This tendency is expected to last at least for forthcoming years, as it is driven by a mix of both short and long-term factors.

The quantitative assessment of price responses is based on the data on drop in production, which has been estimated in the previous phase of the study and by means of elasticity estimates, provided by economic literature and research institutions (FAPRI). In order to restrain uncertainties, the time period considered is limited to the short term (2013).

As a first step of the analysis, EU27 price variations at T_1 have been calculated, under the hypothesis of the "No azoles" scenario developed in the previous part of the study, distinguishing between total, food and feed use. Then, as it has been done in the previous analysis, the "No azoles" best scenario and the "No azoles" worst scenario have been computed as well.

In the "No azoles" scenario (figure 1.2), the estimated prices response to the loss of azoles amounts to +23% for total wheat. Wheat prices for human consumption are expected to show a slightly larger variation (+25%), while prices of wheat for feed use are estimated to vary a little less (+21%).

When we consider the other two scenarios, we observe that prices are subjected to significant variations. In fact, due to the loss of azoles, by 2013 wheat prices volatility in the EU27 could increase from 17% (wheat price for feed use, in the "No azoles" best scenario) up to 30% (wheat price for food use, in the "No azoles" worst scenario). In general, it has been noticed that the most price-responsive product category is wheat for human consumption, while price variations of wheat used for animal feed are the smallest.

Figure 1.2 - EU27 wheat price variations estimated in the hypothesis of loss of azoles (2013)
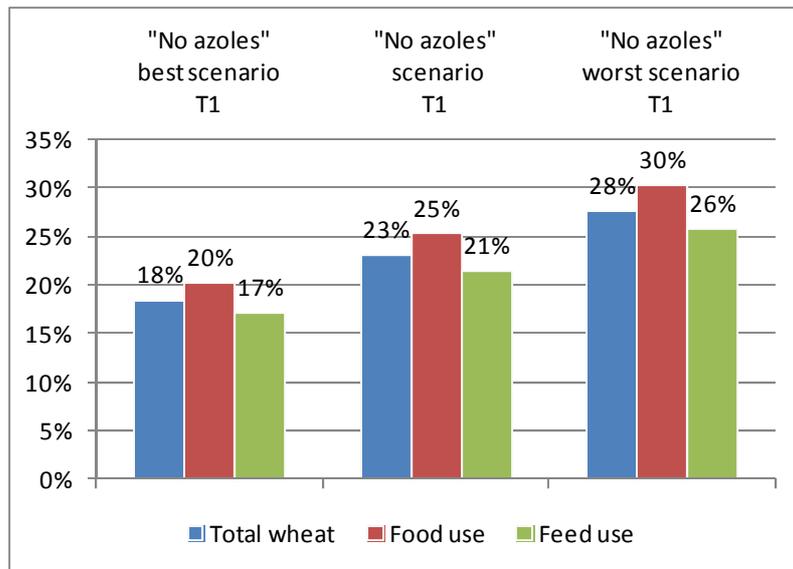
Source: Nomisma elaborations on FAO (production) and FAPRI (elasticity) data.

Figure 1.3 shows the trend of the EU27 wheat price index from 2000 to 2013. There the estimates for 2013 in the reference scenario, outlined by the DG AGRI (European Commission, 2010), are compared to price index estimates in the "No azoles" scenario we forecast, both in the best and worst hypotheses.

While the European Commission anticipates a moderate increase in wheat price for 2013 as compared with the current year, Nomisma calculations show that the withdrawal of azoles would entail a steep rise, possibly even higher than the ones occurred in 2008 and in 2010. In fact, in 2013 wheat price index is projected to reach a minimum of 124 and a maximum of 133.

Since wheat production is mostly concentrated in few Member States, a differentiated impact on prices between the two areas is expected. More precisely, since EU15 Member States produce the large majority of wheat output (about 77% of total EU27) comparing price variations estimated for EU15 with those estimated for total EU27 we do not detect significant differences, except a slightly larger impact on prices of wheat for food use (+1.8% in the "No azoles" scenario). On the opposite, some differences are noticeable when comparing EU12 with EU27 and lower price variations have been estimated with respect to both total wheat (-1.7% in the "No azoles" scenario) and especially wheat for human consumption (- 4.6% in the "No azoles" scenario).

Figure 1.3 – Wheat price trend and estimates in the short term (index 2012=100)
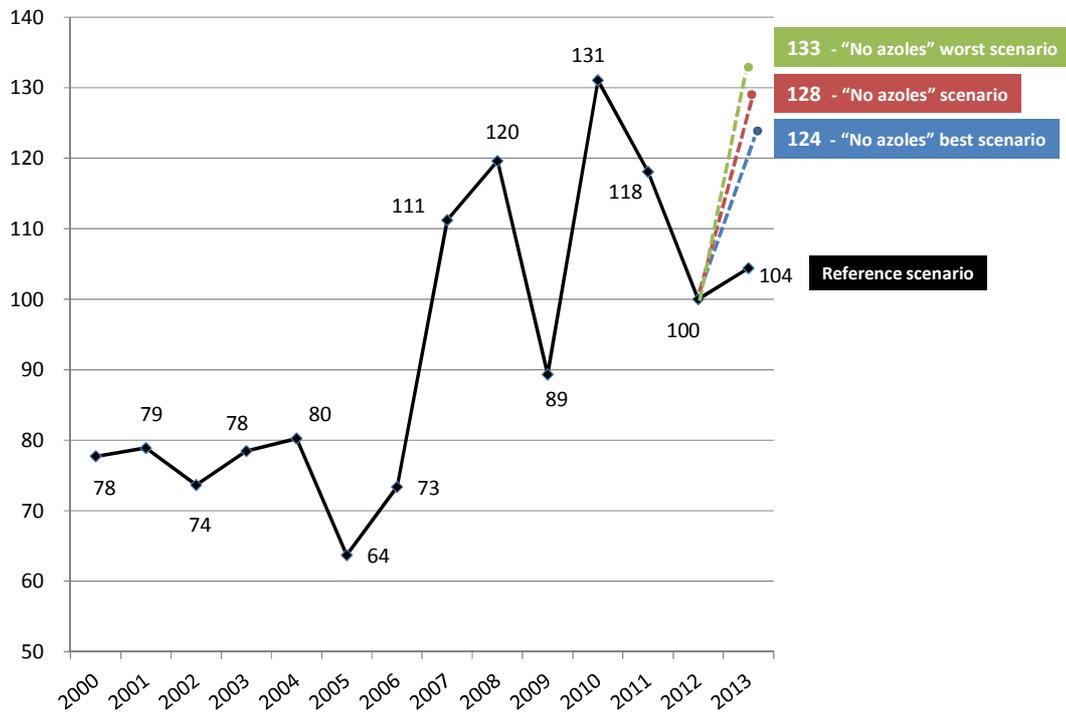
Source: Nomisma elaborations on OECD-FAO Agricultural Outlook 2011-2020 data (wheat producer price).

The role of maintenance the European production levels related to azoles production inputs is significant, because of the long-term fallouts that could lead the European Union to switch from the position of net exporter to net importer: this sensitivity is due to the large interdependence of the international wheat market.

The European Union, in fact, is a primary player in term of production (it accounts for 21% of total wheat production), productivity (European yield is 5.3 t/ha while the global average is 2.9 t/ha) and trade (it contributes to 16.8% of world wheat trade flows).

The global scenario is therefore based on several aspects. The world food commodities demand is significantly increasing both in the medium and long term, driven by per capita income growth and population increase, especially in developing countries that actually cannot satisfy the national demand with their internal production. Additionally, the biofuel market is expected to continue being an important source of demand for cereals (ethanol in the case of wheat).

The strengthening of the supply can be related to a wider utilization of natural resources, but it has to be considered that the expansion potential is restricted and concentrated in limited areas (Sub-Saharan Africa or Latin America), which are already facing a pressing growth of commodities internal demand. Moreover, the productive performances are influenced by climate change, which in Europe has mainly adverse effects.

The technological endowment is widespread in developed countries and it represents an essential driver to boost crops productivity: a larger utilization of agricultural inputs could occur only in developing countries or emerging countries but this seems to be not feasible in the short term. With regard to innovation within this area of interest, it has to be said that investments in R&D constitute

a very essential element, even if the growth rates of this kind of investments are more reduced than in the past.

To assess the global interdependence of the wheat production and trade, international policies and regulations have been considered. Despite the world market openness ruled by WTO, which point towards a steady growth of global trade and the possibility for countries with limited supply to import from countries with surplus, during crisis times the individual interest prevails against the general interest: export restrictions are not unusual, even if the WTO normally sanctions them. Additionally, in the new CAP 2014-2020 the support to the competitiveness of the European agricultural sector has been combined with new objectives (food security, price volatility, environmental sustainability). The pursuing of these objectives is bounded to the financial funding, which is progressively sinking.

In conclusion, the study showed that the economic relevance of azoles in the European Union is considerable, as their hypothetical loss would have significant relapses on both the domestic market and international markets. On the internal market, we estimate that without azoles there would be a drop in domestic production, leading to a deterioration of the demand satisfaction rate and to higher prices. This could in turn imply that the European Union could cease to be a net exporter at world level, bringing into question the possibility of the other big wheat supplier (North and South America, Australia, Russia, etc.) to be able to satisfy the global demand. This would increase the current uncertainty concerning global food security, bringing further consequences – which have been prominently emerging over the last years - such as drop in stocks, increase of prices and price volatility upsurge.

2. THE ROLE OF AZOLES IN WHEAT CROP

Loss of all azoles: evaluation of agronomic impact on wheat

This study is aimed at evaluating the importance of the azoles in European agriculture. Even if defining the significant role of the azole in agriculture could be straightforward, there is a lack of accurate data and information on the economic relevance of azoles on specific cultivations. . To This work fills this gap by estimating the relevance of azoles in terms of the economic impact of a potential loss of all azoles on wheat production in the European Union. Specifically, four European countries have been used as case studies: Denmark, France, Italy and the United Kingdom.

To assess the potential agronomic impact of losing the use of all azole active substances on wheat, the two following studies have been taken as references:

- "Evaluation of the benefits provided by the azole class of compounds in wheat, and the effect of losing all azoles on wheat and potato production in Denmark, France and the UK", made by ADAS (Blake J. *et al.*, 2011);
- "Evaluation of the benefits provided by and of the effect of losing the azole class of compounds on durum and common wheat production in Italy", made by Horta Srl and Università Cattolica del Sacro Cuore (Salinari F. *et al.,* 2011).

These studies have estimated the impact on wheat crop of the yield loss resulting from the withdrawal of azole fungicides and all fungicides from use.

The assessment of the impact of losing all azoles on wheat production has been carried out following the approach set up by ADAS, thus using a "scenario analysis" (Blake *et al.*, 2011). As mentioned above, the scenario analysis has been applied to four specific countries-case studies.With regard to the Italian case study, the analysis has been conducted both on durum wheat and on common wheat, while in the other countries only the common wheat has been analysed – basically due to the reduced importance of durum wheat on total wheat production in the other case studies[3].

To evaluate the impact on yields the following scenarios have been assessed:

- all fungicides remain available (scenario 1);
- all classes of fungicides are withdrawn from use (scenario 2);
- all azole fungicides are withdrawn from use (scenario 3).

The "scenario 1" and "scenario 2" have been used as "reference" scenarios to estimate the consequences of a possible withdrawal from use of all azole fungicides ("scenario 3"). In other words, the impact related to "scenario 3" is estimated to lie between the outcomes issuing from "scenario 1" and "scenario 2".

The analysis of "scenario 3" accounted for the extent to which control might be maintained by the use of alternative active substances (assuming that all other relevant fungicides remain available for use).

The assessment of the impact of withdrawing all fungicides (scenario 2) and all azoles (scenario 3) for the four different case studies has been built considering each country distinctive characteristics. This means that all assumptions have been based on the country specific production performances (wheat yield, crop areas and production), on key diseases that affect wheat crops and the interested

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[3] For what concerns France, for example, the durum wheat production represents just the 10% of total wheat production in 2010.

area- also considering that the broad spectrum of azole activity has contributed substantially to the control of septoria, rusts, mildew, eyespot and fusarium[4] - and on the disease susceptibility of the major wheat varieties of each case study - assuming that the yield response and disease profile of the ten most widely grown varieties could be representative of all the varieties grown in each country.

The agronomic analysis has been developed in a long term perspective (ten years - from 2001 to 2010), considering the yearly variability of diseases occurrence and pressure.

The two mentioned studies defined the proportion of yield response attributable to the control of each single disease and estimated the ratio of each disease control resulting from azoles. Each estimate of yield responses has been determined by teams of country experts using trial data that compared untreated controls areas with those that had received standard fungicide regimes[5].

The scale of the benefits deriving from fungicides use differs for each country and strongly depends on their specificity, such as the extent of cropped area, the severity of different diseases and the degree of reliance on specific active substances. Specifically, for the Italian case study the indices have been calculated taking into account that at present the fungicides treated area represents 21% of the total cropped surface for durum wheat and 41% for common wheat (2006-2010 average data), whilst Horta study has estimated that in 2020 the entire wheat cropped area will be treated with fungicides.

The estimated reduction of wheat production that could derive by withdrawing from use of azoles is summarized in table 2.1: this evaluation is based on production in terms of quantity.[6]

Table 2.1 - Agronomic impact:
Production quantitative loss in case of withdrawal from use of all classes of fungicides or all azole fungicides

AGRONOMIC IMPACT *Production loss in quantity (%)**	SCENARIO 2 No fungicides available	SCENARIO 3 No azoles available
United Kingdom	19.5%	6.8%
France	25.1%	8.0%
Denmark	7.3%	5.0%
Italy - common wheat (North)°	15.6%	9.1%
Italy - durum wheat (Central - South)°	28.0%	16.2%

*The assessment considers the loss in quantity. The loss expressed in term of crop value deriving from the reductions in quality has not been reckoned in this study.

°The indexes refer to the treated area. At present (2006-2010 average data) 21% and 41% of the total cropped area are treated with fungicides for durum and common Italian wheat respectively. In 2020 Horta foresees that 100% of cropped area will be treated with fungicides.

Source: Nomisma elaborations on Blake J. et al. (2011) and Salinari F. et al. (2011) data.

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[4] Septoria tritici blotch (STB), Yellow rust, Brown rust, Eyespot, Powdery mildew, Fusarium ear blight (FEB) and specifically for the Italian case study also Brown Root Rot.

[5] This information was based on untreated control plots from trials – when this practice was feasible. In cases in which the entire regions were not treated with fungicides, the losses could result to be greater than in the case of isolated untreated plots surrounded by treated crops. However, this kind of effect could not be estimated and consequently has not been accounted for in the analysis. Therefore, the estimate is conservative.

[6] The two reference studies (ADAS and Horta) included also an assessment in terms of value, which has not been considered in Nomisma evaluation order to be consistent with the coherence of the analysis settings.

Loss of all azoles: yield impact assessment in the short and long term horizons

The assessment of the socio–economic impact of a potential loss of all azole fungicides in wheat crop has been based on an index methodology: thus, rates of yield reduction have been used in the analysis to estimate the drop in production linked to the diseases occurrence and the related effects that could arise from the withdrawal from use of azole fungicides.

The geographical scope of the analysis comprehends the four mentioned case studies and the European Union (27) as a whole: therefore, to calculate the index at the European level an extent of the case studies indices has been made.

Specifically, the economic assessment has been performed at two level of analysis. First of all, a short term impact evaluation has been made, based on the effect of losing the azoles: the reference year is 2013. For what concerns the long term reference scenario (2020), the assessment has been based on the combined effect of both the loss of azoles and the fungicides resistance occurrence.

The short term assessment has taken into account only the indices of yield loss that could occur in case of withdrawal of all azoles as estimated by ADAS and Horta studies. For the 2013 yield loss index at EU level, a weighted average of the indices calculated for the four case studies has been used (figure 2.1). Again, it has to be remarked that for the Italian case study only the area treated with fungicides has been considered: thus, the index is calculated taking into account that in 2010 21% and 41% of the total cropped area was treated with fungicides for durum and common wheat respectively.

Figure 2.1 –Yield loss indices in the hypothesis of loss of azoles (short term - 2013)
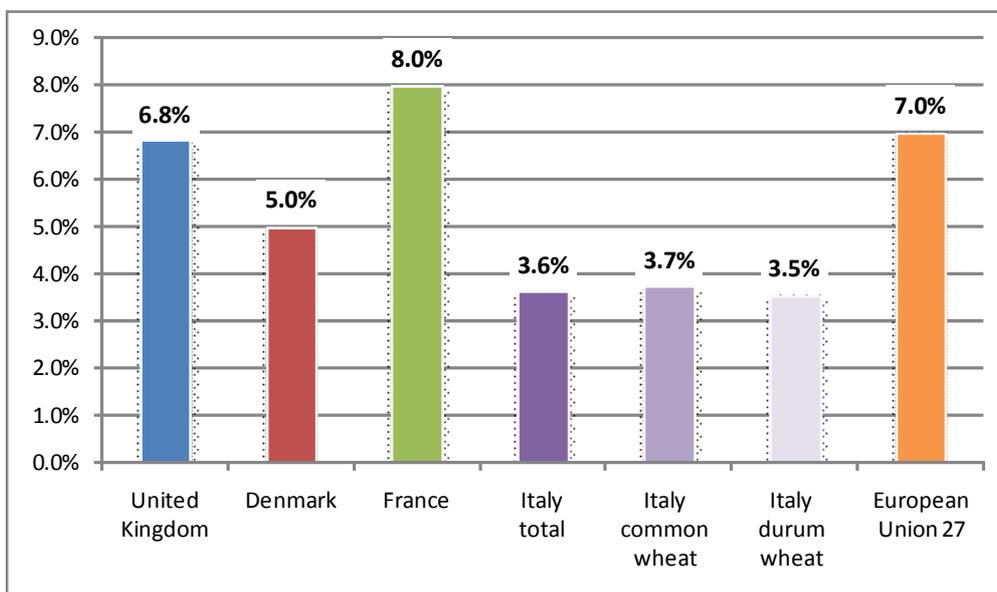
Source: Nomisma elaborations on Blake J. et al. (2011) and Salinari F. et al. (2011) data.

As mentioned, in the long term analysis the development of resistances for the remaining fungicides has been considered along with the yield reduction effect: specifically, in a long term horizon (2020) the loss of azole fungicides would cause difficulties in managing the diseases with active substances other than azoles. This occurrence has to be related to the increasing selection pressure for the remaining fungicides, which will result in a large lack of protection regarding diseases.

Therefore, the long term yield reduction indices (directly related to the efficacy of the remaining active substances) have to be associated with the impact on yield reduction resulting from the resistance development: thus, the long term evaluation has been estimated considering this

combined effect and has resulted in an increase of the yield loss as for the short term impact estimate.

ADAS and Horta studies use the current estimates of the efficacy of the remaining active substances: therefore, the long term adverse impact on yield results greater in Nomisma's evaluation than that in the above mentioned studies, because the effect deriving from a more difficult disease management in wheat due to the resistance development has been taken into account.

Furthermore, other aspects have to be considered to foreseen the effects on wheat crop that could result in further yield drops.

First of all, the changes in agricultural practices that could occur as a consequence of the reduced availability of active substances are not single-handedly able to provide a suitable solution to the development of resistances whilst not altering yields: breeding modifications, such as change of cultivars, lessening of fertilization and the later sowing of wheat don't seem to have a positive and definite impact in diminishing the risk of diseases occurrence and – specifically the last two – could result in negative impacts on yield.

Additionally, it has to be considered that the remaining active substances could face a potential "regulatory risk": in other words, there could be some restriction regarding these products, which will result in an increased risk of vulnerability and loss of control of the diseases due to resistance development.

The methodology chosen to calculate the index of the impact of the loss of azoles combined with the resistance occurrence effect is based on the indices of ADAS and Horta studies, referring to the long term horizon (2020).

With regard to the Italian case study, a more conservative assumption of the long term horizon ratio of fungicides treated area has been applied: whilst in Horta evaluation the assumption is that in 2020 the entire wheat cropped area will be treated with fungicides, Nomisma has considered more prudential to suppose that only 70% of wheat cropped area will be treated with fungicides. Therefore, the long term assessment has been based on this assumption.

To calculate the resistance effect in the four case studies, we have subtracted the yield loss index resulting from the loss of azoles (A -"No azoles") from the comprehensive index related to the loss of all fungicides (B -"no fungicides"): thus, the effect of all fungicides other than azoles has been isolated. Subsequently, the impact on yield due to the resistance effect (D -"resistance effect") has been estimated to be a ratio of this difference - specifically one third (33%) - thus to have a conservative assessment of the analysis. Finally, the "resistance effect" index has been added to the "No azoles" index, thus obtaining the yield loss index that combines the two mentioned effects (E - "No azoles+resistance effect"): table 2.2 illustrates the resulting yield loss indices.

Table 2.2 - Yield loss index (2020): loss of azoles and fungicide resistance combined effect

	No azoles (A)	No fungicides (B)	(B-A)	Resistance effect (D)=33%(B-A)	No azoles + Resistance effect E=(A+D)
United Kingdom	6.8%	19.5%	12.7%	4.2%	11.0%
Denmark	5.0%	7.3%	2.3%	0.8%	5.8%
France	8.0%	25.1%	17.1%	5.6%	13.6%
Italy (total)	9.5%	15.9%	6.4%	2.1%	11.6%
Italy common wheat	6.4%	10.9%	4.6%	1.5%	7.9%
Italy durum wheat	11.8%	19.6%	7.8%	2.6%	14.4%
European Union 27	7.6%	21.4%	13.7%	4.5%	12.2%

Source: Nomisma elaborations on Blake J. et al. (2011) and Salinari F. et al. (2011) data.

For what concerns the European Union (27) level, the construction of the index has been made using the weighted average of the indices of the four case studies. The weights are represented by the average wheat production volume of Denmark, France, Italy and the United Kingdom referring to years 2008-09-10: these four countries together represent 47% of wheat production of the European Union (27).

Additionally, an uncertainty assessment has been included to improve the reliability of the estimates of the socio-economic impact: it has been decided to consider a possible deviation from the calculated indices (expressed by a range of variability of plus/minus 20%) aimed at considering a confidence interval of the assessment – and a better consistency of it.

This additional procedure has been applied both to the short and long term horizon, constructing for each yield loss index an additional lower range index and a higher range index (figure 2.2).

Figure 2.2 – Uncertainty assessment: yield loss index in the short (2013) and long term (2020)
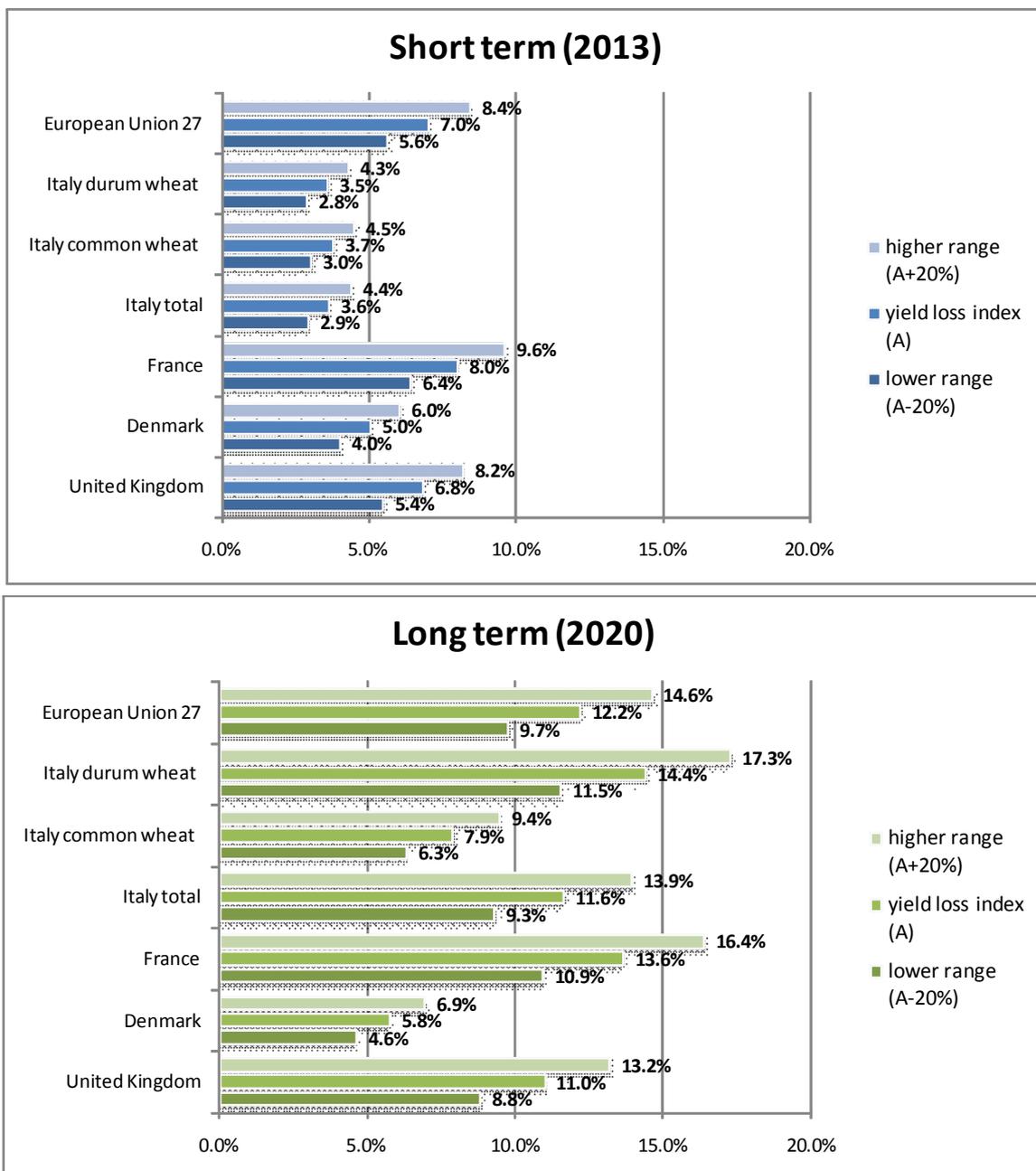
Source: Nomisma elaborations on Blake J. et al. (2011) and Salinari F. et al. (2011) data.

3. WITHDRAWAL FROM USE OF AZOLES: THE ECONOMIC IMPACT ON EU WHEAT CROP

Scenario analysis: analytical process and baseline scenarios to 2013 and 2020

This chapter will detail the economic impact of the loss of all azoles active substances on European wheat production. The methodology that has been used for the impact assessment is that of a scenario analysis. Based on long term data (1990-2010) Nomisma has built two reference scenarios, one for the short term (2013) and one for the long term (2020). These scenarios contained the projections of the main variables that were deemed necessary for the impact assessment, namely:

- the yield of wheat crop;

- the overall wheat production;

- the extension of the area cultivated with wheat resulting from the ratio of production and yield;

- the quantity of imports and exports of wheat and the resulting net trade;

- the domestic availability of wheat, given by production minus the exports and plus the imports;

- the domestic demand, which is assumed to correspond to the availability in the reference scenarios.

After having determined these variables, it has been possible, for each scenario, to calculate the demand satisfaction rate (i.e. the percentage of domestic demand that is covered by domestic availability) and the self-sufficiency rate (i.e. the percentage of demand that would be covered by the internal production alone).

Starting from this reference scenarios, two different "No azoles" scenarios have been built, both of which are based on the hypothesis of a European withdrawal from use of all azoles. The first "No azoles" scenario has estimated the short term economic impact (2013), taking into account the simple effect of the loss of azoles on total production and the related consequences for the European Union in terms of demand satisfaction and self-sufficiency. The second scenario has been projected in the long term (2020) and has considered not only the direct effect of the loss of azoles on total wheat production, but also the effect deriving from the increase of fungicide resistance by wheat crops, an effect that has been assumed as a consequence of a long term interruption in the use of active substances that are used to fight wheat diseases.

Moreover, a sensitivity analysis has been applied to both the "No azoles" scenarios, resulting in the definition of a best-case scenario and a worst-case scenario for each of the projections.

The focus of the analysis has been to assess the effect of a possible withdrawal from use of all azoles on European production of wheat, with a specific consideration of the impact on European demand satisfaction and self-sufficiency.

Figure 3.1 summarizes the analytical process, with the columns representing the timeline and the lines representing the different hypothesis. More specifically, the blue column represents the present situation of wheat production, the green column the 2013 scenarios and the purple column the 2020 scenarios. As for the lines, the first one represents the reference scenario (with azoles availability), the second one the "No azoles" scenarios (loss of azoles) and the third one the "No azoles" scenarios with the application of a sensitivity analysis (best/worst scenario).

As for the present situation, Nomisma has calculated the same variables by using the 2006-2010 averages, so to eliminate any variability effect. The present European production of wheat is 134.4 millions of tons, of which 16.7 are exported; at the same time, 5.9 millions of tons are imported,

resulting in a trade surplus of more than 10 millions of tons. The demand satisfaction rate is 100%, while the self-sufficiency rate is 108.7%. This situation is referred to as "present situation t_0".

Figure 3.1 – Scenario analysis: methodology approach
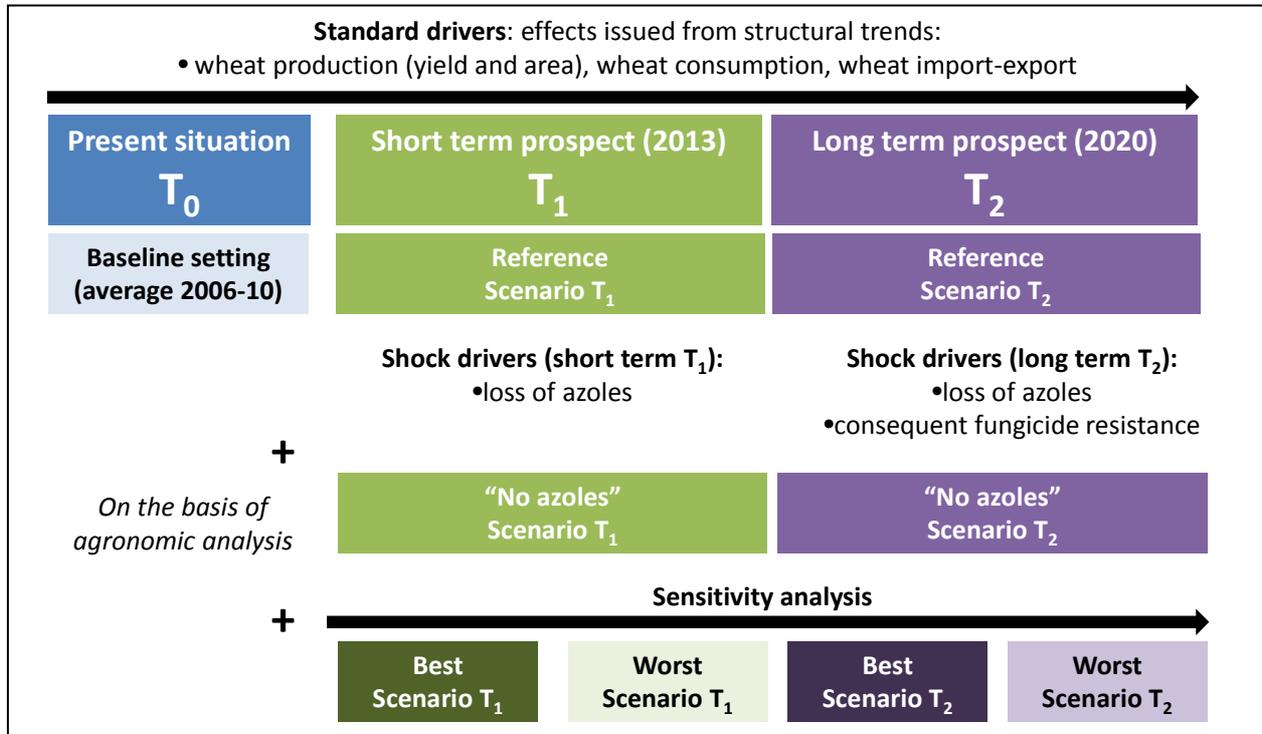
Source: Nomisma elaborations

As for the reference scenarios, Nomisma calculations have foreseen that both the yield and the cultivated area should increase (table 3.1). The overall effect of these future trends would be a constant growth of wheat production, which should augment by 5.0% in 2013 and by 13.4% in 2020. Additionally, the self-sufficiency rate would be in both cases over 100%, even if in 2013 it should slightly decrease due to the reduced trade balance. In fact, it has to be considered that an increase of exports or a decrease of imports will have a positive impact on self-sufficiency, considered as the hypothetical situation when all domestic wheat production remains within the European Union borders.

The reference scenarios clearly show that the European Union would be able to produce a constantly increasing quantity of wheat and to remain a net exporter both in the short term and in the long term horizon.

After having defined the reference scenarios, Nomisma has subsequently estimated the variation from these scenarios in case of a loss of all azoles.

The withdrawal from use of all azoles will affect directly the yields. As shown in table 3.2, halting the use of azoles would cause a drop of the yield in the short term and an even stronger decrease in the long term, due to the development of fungicide resistance. In 2013, the yield would drop from a projected 5.37 to 5.00 tons per hectare (-7%), while in 2020 it would plunge from 5.63 to 4.94 tons per hectare (-12.2%).

Table 3.1 - Wheat crop structural trends in the EU27: 2013 and 2020 baseline scenarios

	Present situation (avg 2006-10)	Short term 2013	Long term 2020	Variation	
	Baseline setting	Reference scenario T_1	Reference scenario T_2	Scenario T_1 from Baseline setting	Scenario T_2 from Baseline setting
Yield (t/ha)	5.24	5.37	5.63	2.5%	7.4%
Area (,000 ha)	25,643.4	26,265.0	27,070.4	2.4%	5.6%
BALANCE SHEET (millions t)					
Production (A)	134.4	141.1	152.4	5.0%	13.4%
Import (B)	5.9	6.6	5.5	11.3%	-7.2%
Export (C)	16.7	15.7	18.1	-5.9%	8.3%
Net trade (D=C-B)	10.8	9.1	12.6		
Domestic availability (E=A+B-C)	123.7	132.0	139.8	6.8%	13.1%
Demand (F)	123.7	132.0	139.8	6.8%	13.1%
Demand satisfaction rate (E/F)	100.0%	100.0%	100.0%		
Self-sufficiency degree (A/F)	108.7%	106.9%	109.0%	-1.7%	0.3%

Source: Nomisma elaborations on Eurostat, European Commission and FAO data.

Table 3.2 – EU27: yield loss index in the hypothesis of a loss of azoles (2013 and 2020)

Yield reference scenario (t/ha)	Short term T_1 (2013)		Long term T_2 (2020)	
	5.37		5.63	
Yield "No azoles" scenarios	Impact of loss of azoles		Impact of loss of azoles + resistance effect	
	Loss index	Yield (t/ha)	Loss index	Yield (t/ha)
"No azoles" scenario (A)	7.0%	5.00	12.2%	4.94
"No azoles" best scenario (A-20%)	5.6%	5.07	9.7%	5.08
"No azoles" worst scenario (A+20%)	8.4%	4.92	14.6%	4.81

Source: Nomisma elaborations on Blake J. et al. (2011) and Salinari F. et al. (2011) data.

Loss of azoles: impact on wheat crop in the short term (2013)

The short term "No azoles" scenario would therefore result in an overall reduction of wheat production, which would decrease from 141.1 to 131.3 millions of tons. Given the assumption that the quantity of imports and exports would not change, the European Union would continue to be a net exporter. However, a reduced production associated with a positive trade balance would result in a diminished domestic availability; consequently, the internal demand would be higher than the actual disposable product.

The overall effect would be a strong decrease of the demand satisfaction rate that would fall from 100% to 92.5%. Even more significantly, in just one year the self-sufficiency rate would go below 100%. Even in the hypothesis of a best case scenario, where the self-sufficiency rate would remain over 100%, the decrease of the capacity to be self-sufficient would be sharp, with the self-sufficiency rate diminishing of 6 percentage points (table 3.3).

Table 3.3 – Scenario analysis: short term impact in the hypothesis of a loss of azoles (2013)

	Short term 2013			
	Reference scenario T_1	"No azoles" scenario T_1	"No azoles" best scenario T_1	"No azoles" worst scenario T_1
Yield (t/ha)	5.37	5.00	5.07	4.92
Area (,000 ha)	26,265.0	26,265.0	26,265.0	26,265.0
BALANCE SHEET (millions t)				
Production (A)	141.1	131.3	133.2	129.3
Import (B)	6.6	6.6	6.6	6.6
Export (C)	15.7	15.7	15.7	15.7
Net trade (D=C-B)	9.1	9.1	9.1	9.1
Domestic availability (E=A+B-C)	132.0	122.2	124.1	120.2
Demand (F)	132.0	132.0	132.0	132.0
Demand satisfaction rate (E/F)	100.0%	92.5%	94.0%	91.0%
Self-sufficiency degree (A/F)	106.9%	99.4%	100.9%	97.9%

Source: Nomisma elaborations.

Loss of azoles: preservation of the demand satisfaction rate in the short term (2013)

The second step of the analysis has been to quantify the adjustments in terms of cultivated area, imports, exports and stocks that would be required to guarantee a 100% demand satisfaction rate. Figure 3.2 shows the effect of a loss of azoles in wheat production under three scenarios (best/average/worst) in terms of quantity (thousands of tons) and value (millions of euro).

Figure 3.2 –Demand satisfaction preservation in the short term: production impact in the hypothesis of a loss of azoles (2013)
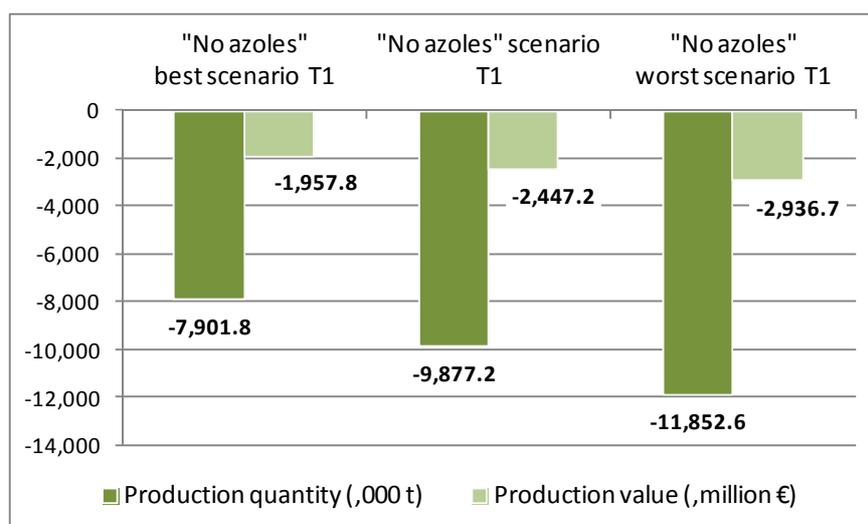
Source: Nomisma elaborations.

The production has been foreseen to decrease significantly in all three scenarios, with a loss of 11.852 thousands of tons in the worst case scenario, and a lower but still significant loss of 7,901

thousands of tons in the best case scenario. This would also result in a considerable loss in terms of value, which would range from roughly 2 to 3 billion of Euros.

To compensate for this loss of production, three options are available:

1. an increase of cultivated area;
2. a modification of the trade flows – and consequently of the trade balance;
3. a reduction of the stocks.

Table 3.4 summarizes the changes requested for these variables in order to maintain a 100% demand satisfaction rate that is to bring back the domestic availability to 132 millions of tons.

Table 3.4 – Variables changes required to preserve a 100% demand satisfaction rate in the short term (2013)

	"No azoles" best scenario T_1	"No azoles" scenario T_1	"No azoles" worst scenario T_1
Variation production (millions t)	-7.9	-9.8	-11.9
AREA IMPACT			
Variation area (,000 ha)	1,557.8	1,976.5	2,408.1
Variation area (%)	5.9%	7.5%	9.2%
NET BALANCE IMPACT			
Variation export (%)	-50.3%	-62.9%	-75.5%
Variation import (%)	119.6%	149.5%	179.4%
STOCKS IMPACT			
Variation stock (%)	-39.5%	-49.4%	-59.3%

Source: Nomisma elaborations.

Under the hypothesis of an average "No azoles" scenario, the cultivated area should increase 7.5%. Alternatively, the exports should decrease by 62.9 %, or the imports should increase by 149.5%, or the stocks of wheat should be reduced by 49.4%.

It seems evident that none of the required adjustments would be feasible, at least by itself. Firstly, it is very unlikely that the cultivated area could be extended so much in just one year, given the current trend (the forecast for 2013 is +2.6%). Secondly, it is equally unlikely that the trade balance could be modified as much as those figures require: the imports should be doubled or the exports cut by half. Thirdly, resorting to the use of the stocks can be excluded, since it would mean to consume the entire reserve of wheat in just a couple of years.

Loss of azoles: preservation of self-sufficiency rate in the short term (2013)

The same calculations have been made in reference with the internal production (i.e. without considering the net trade) and the self-sufficiency rate.

Figure 3.3 shows how a withdrawal from use of azoles would affect the internal production under three scenarios (best/average/worst scenario). As we can see, only in the occurrence of a best case scenario would the internal production be higher than the demand. However, even if a best case scenario occurred, the level of self-sufficiency would be inferior than the reference scenario. As for the other two scenarios, the internal production would go below the internal demand and therefore the self-sufficiency rate below 100%. The distance between the projected production and the production that would guarantee a 100% self-sufficiency rate is -785.2 thousands of tons (or -194.5 million Euros in value) in the "No azoles" scenario t_1, and it grows to -2,760.6 thousands of tons (or -684 million Euros in value) in the worst case scenario.

Figure 3.3 – Self-sufficiency preservation in the short term: production impact in the hypothesis of loss of azoles (2013)
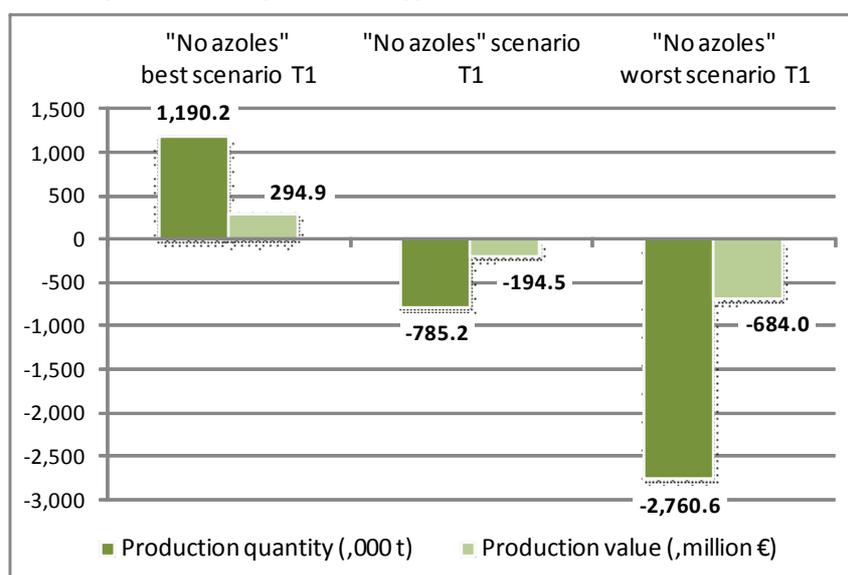
Source: Nomisma elaborations.

As for the previous case, the adjustments required to compensate for the reduction of the yield have been calculated, in order to obtain an overall production that would guarantee a 100% self-sufficiency degree. As shown in table 3.5, under the hypothesis of a best case scenario, no adjustments would be necessary, because the level of production would remain higher than the demand. In the other two cases, however, the self-sufficiency rate would go below 100%.

Table 3.5 – Variables changes required to preserve a 100% self-sufficiency rate in the short term (2013)

	"No azoles" best scenario T_1	"No azoles" scenario T_1	"No azoles" worst scenario T_1
Variation production (millions t)	1.2	-0.8	-2.8
AREA IMPACT			
Variation area (,000 ha)	-234.6	157.1	560.9
Variation area (%)	-0.9%	0.6%	2.1%
NET BALANCE IMPACT			
Variation export (%)	7.6%	-5.0%	-17.6%
Variation import (%)	-18.0%	11.9%	41.8%
STOCKS IMPACT			
Variation stock (%)	6.0%	-3.9%	-13.8%

Source: Nomisma elaborations.

In the hypothesis of an average "No azoles" scenario, the single adjustments should not be too sharp: a 0.6% increase in the cultivated land would be sufficient to restore a 100% self-sufficiency rate; the same result could be achieved with a 5% decrease of exports, or an 11.9% increase of imports, or by using the stocks and reducing them by 3.9%. In the case of an average "No azoles" scenario, a combination of the three adjustments seems feasible. On the contrary, in the hypothesis of a worst

case scenario, the required adjustments become much more difficult to meet: to reach a self-sufficiency rate, in fact, it would be necessary to increase the imports by 41.8% or the cultivated land by 2.1%; alternatively, exports should be reduced by 17.6% or stocks cut by 13.8%.

Loss of azoles: impact on wheat crop in the long term

The second part of the impact analysis has been focused on the long term effects (to 2020) of a hypothetical loss of azoles. In this case, the estimates have taken into account not only the reduction of the yield, but also the fact that wheat crops would develop over time an increased resistance to other fungicides. The overall effect would be an even sharper decrease of the yield, as shown in table 3.6.

Table 3.6 – Scenario analysis: long term impact in the hypothesis of loss of azoles (2020)

	Long term 2020			
	Reference scenario T_2	"No azoles" scenario T_2	"No azoles" best scenario T_2	"No azoles" worst scenario T_2
Yield (t/ha)	5.63	4.94	5.08	4.81
Area (,000 ha)	27,070.4	27,070.4	27,070.4	27,070.4
BALANCE SHEET (millions t)				
Production (A)	152.4	133.8	137.5	130.1
Import (B)	5.5	5.5	5.5	5.5
Export (C)	18.1	18.1	18.1	18.1
Net trade (D=C-B)	12.6	12.6	12.6	12.6
Domestic availability (E=A+B-C)	139.8	121.3	125.0	117.6
Demand (F)	139.8	139.8	139.8	139.8
Demand satisfaction rate (E/F)	100.0%	86.7%	89.4%	84.1%
Self-sufficiency degree (A/F)	109.0%	95.7%	98.4%	93.1%

Source: Nomisma elaborations.

Given the estimated yield, the production would suffer a loss that would range from 14.9 to 22.3 millions of tons, depending on which scenario will occur. Assuming that the quantity of wheat imported and exported would remain the same as that in the reference scenario, the final result of the loss of production would be even stronger on domestic availability.

In the medium "No azoles" scenario, the domestic availability of wheat (production minus net trade) would satisfy just the 86.7% of the entire internal demand. Even in the best case scenario, this percentage would not get over 89.4%, while it would be 84.1% in the worst case scenario.

More significantly, in the long term the European Union would lose the capacity to be self-sufficient. In fact, even assuming the halting of wheat trade, the internal production would not be sufficient to cover the entire internal demand, and the self-sufficiency rate would drop below 100% in all three scenarios. Of course, this kind of scenario poses many questions, both from a strategic and economic point of view. The following chapters will deal more specifically with the economic impact of such hypothesis, especially with regard to the adjustments that could compensate the loss of yield and with the effect on commodity prices.

Loss of azoles: preservation of the demand satisfaction rate in the long term (2020)

As it has been done with the short-term scenarios, the analysis has estimated not only the impact on production of a possible withdrawal from use of all azoles, but also what kind of adjustments would be required to guarantee a 100% demand satisfaction rate. As shown in figure 3.4, in the long term the distance between the demand and the domestic availability (production minus net trade) would be much greater than in the short term and the loss in terms of value would be of more than 4.6 billion Euros (average "No azoles" scenario).

Table 3.7 illustrates the single adjustments that would be necessary to reduce this gap and to guarantee that the domestic availability can cover all the internal demand.

Figure 3.4 - Demand satisfaction preservation in the long term: production impact in the hypothesis of a loss of azoles (2020)
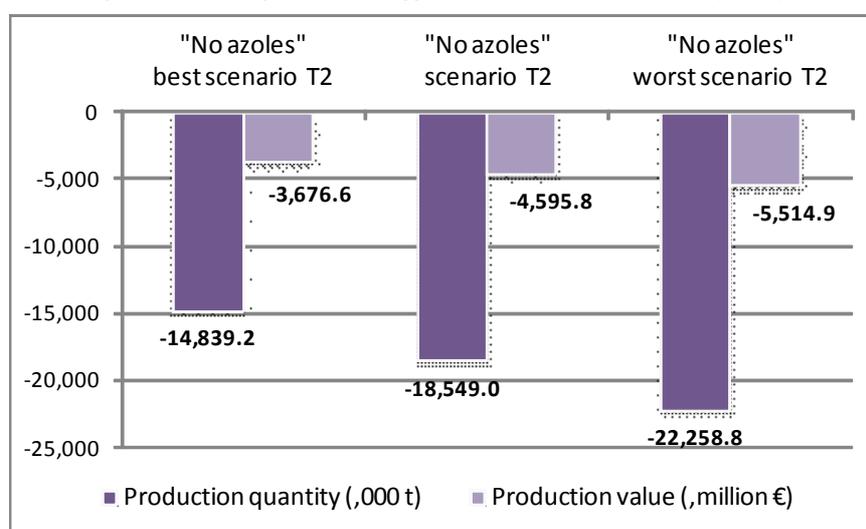
Source: Nomisma elaborations.

Table 3.7 – Variables changes required to preserve a 100% demand satisfaction rate in the long term (2020)

	"No azoles" best scenario T_2	"No azoles" scenario T_2	"No azoles" worst scenario T_2
Variation production (millions t)	-14.8	-18.6	-22.3
AREA IMPACT			
Variation area (,000 ha)	2,920.7	3,752.0	4,630.8
Variation area (%)	10.8%	13.9%	17.1%
NET BALANCE IMPACT			
Variation export (%)	-82.1%	-102.6%	-123.2%
Variation import (%)	269.3%	336.7%	404.0%
STOCKS IMPACT			
Variation stock (%)	-74.2%	-92.7%	-111.3%

Source: Nomisma elaborations.

According to the average "No azoles" scenario, the cultivated area should increase by 13.9%. Alternatively, the exports should decrease by 102.6%, or the imports increase by 336.7%. Another solution would be to cut the stocks almost entirely (by 92.7%).

As it is evident, even if looking at the best case scenario, the required adjustments appear at best unlikely.

Loss of azoles: preservation of self-sufficiency rate in the long term (2020)

The final step of the long-term analysis has been to estimate the distance between the forecast production under the hypothesis of a loss of azoles and the level of production that would guarantee a self-sufficiency rate of 100%.

Under all three scenarios the self-sufficiency rate would fall under 100%, meaning that the entire production of the European Union, even in the hypothesis that all trading was interrupted, would not be sufficient to cover the internal demand of wheat (figure 3.5). In the best case scenario, the distance between the estimated production and the production that would be necessary to guarantee a 100% self-sufficiency rate would be roughly 2.3 millions of tons, but it would grow to almost 6 millions of tons in the average scenario and to 9.7 million in the worst case scenario.

Figure 3.5 – Self-sufficiency preservation in the long term: production impact in the hypothesis of a loss of azoles (2020)
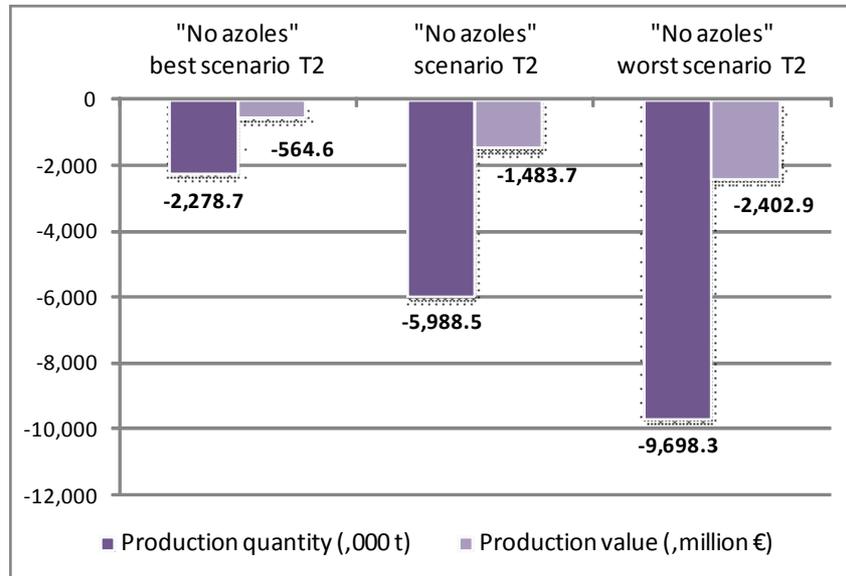
Source: Nomisma elaborations.

The adjustments that would be necessary to restore a level of production that would guarantee a 100% self-sufficiency rate are less strong than those necessary to restore a 100% demand satisfaction rate, because the European Union would still be a net exporter in 2020. However, the single adjustments would remain difficult to meet. The cultivated area should increase by 4.5%; alternatively, exports should decrease by one third (-33.1%), or imports more than double (+108.7%), or stocks of wheat be cut by almost 30% (table 3.8).

Table 3.8 – Variables changes required to preserve a 100% self-sufficiency rate in the long term (2020)

	"No azoles" best scenario T2	"No azoles" scenario T2	"No azoles" worst scenario T2
Variation production (millions t)	-2.3	-6.0	-9.7
AREA IMPACT			
Variation area (,000 ha)	448.5	1,211.3	2,017.7
Variation area (%)	1.7%	4.5%	7.5%
NET BALANCE IMPACT			
Variation export (%)	-12.6%	-33.1%	-53.7%
Variation import (%)	41.4%	108.7%	176.0%
STOCKS IMPACT			
Variation stock (%)	-11.4%	-29.9%	-48.5%

Source: Nomisma elaborations.

Loss of azoles: impact on wheat prices in the short term (2013)

This section of the study report aims at providing a quantitative assessment of the effects induced by the loss of all azoles active substances on European wheat prices. Since prices drive resource allocation decisions, they directly affect the economic welfare of both buyers and sellers in the market. In particular, commodity prices have recently become a relevant policy issue, as they reached very high levels and showed strong variability. The main shortcomings of higher prices and higher price volatility consist in a greater uncertainty for firms (e.g. investment decisions), together with higher provisioning costs and changes in trade patterns (import-export flows intensity and direction). In the end, price variations may negatively affect both economic agents along the supply chain and final consumers.

The assessment of the loss of azoles on wheat prices has been conducted following the methodological approach described in the previous section. A scenario analysis is carried out by means of a combination of a systematic review of economic literature and own estimations, based on data sets supplied by international statistical and research institutions (Eurostat, FAO, FAPRI).

Unlike the previous part of the study, the time period considered for this specific analysis is limited to the short term (2013 - T1). In fact, over a short time period (one or two years), the focus is on the direct impact of the loss of azoles on prices. On the opposite, in the long run, it also has to be considered the complex feedback effects that will occur when new prices levels will in turn affect production decisions and, eventually, the output level that will be supplied. Moreover, it has been observed that, in the short run, supply shocks (e.g. weather conditions, input availability and costs, etc.) affect price levels strongly and rapidly, while the price variations influence on production decisions is not so immediate and their impact is mitigated by other factors, such as expectations and cyclical market trends.

The economic literature that has been reviewed has allowed us to point out some general developments for agricultural commodity markets in the future. First of all, a progressive reduction in price responsiveness of demand and supply (i.e. elasticity) has been detected (Abbott, 2011). As a consequence of an increasingly inelastic demand, responses to any supply shock will become more volatile. This trend started in 2007-08 when the prices boom was also accompanied by much higher

prices volatility[7] than in the past, especially in cereals and oilseeds sectors, highlighting the greater uncertainty in the markets (FAO, 2009). Greater uncertainty limits opportunities for producers to access credit markets and tends to result in the adoption of low-risk production technologies at the expense of innovation and entrepreneurship. In addition, volatility can attract significant speculative activity, which in turn can initiate a vicious cycle of destabilizing cash prices.

A second shared result is that high price levels are expected to continue at least for the forthcoming years (both OECD-FAO and USDA estimates), since a mix of short and long term factors are contributing to higher prices (rising energy costs, increasing demand for food, non-food and feed uses, slowing yield growth, resulting in tight land supply and limited reallocation possibilities, higher weather instability, etc.).

In the medium-long term, the question is whether prices will remain at these high levels. Most studies agree that some overshooting is likely to occur and prices are foreseen to decline in real terms, due to the expected productivity growth, but would probably remain higher over the next decade compared with the previous one (Abbott, 2011; European Commission 2010; FAO, 2009; USDA, 2008).

A third consideration concerns stocks. The level of stocks in relation to demand is an important factor in commodity prices. If the "stock-to-use" ratio is low, there will be upward pressure on prices. This ratio fell sharply from 2006 onwards. Recently in EU27 the stock-to-use ratio was around 11% and the European Commission market prospects foresee a further decrease to 10% in the next two or three years, until 2020.

According to the literature review conducted, a number of factors concur to increase prices and their volatility in the short run. This trend is also reinforced by the earlier outcomes of our analysis, showing that the EU27 dependency on foreign supplies will increase as a result of the loss of the azoles, which could lead to even higher prices and greater price variability.

However, we are now specifically interested in assessing the price variations occurring as a consequence of the loss of azoles. Thus, the price impact that is going to be estimated must be considered as additional to the on-going price trends.

The main assumption made at this stage of the study is that the interaction between domestic supply and domestic demand is a major determinant of wheat prices on the EU market. In other words, it has been assumed that in the short run wheat prices in the EU27 are affected by internal market conditions rather than by world market conditions (i.e. world price).

Under this assumption, the quantitative assessment of price responses has been conducted on the basis of the drop in production estimated in the previous phase of the study and by means of elasticity estimates, provided by economic literature and research institutions (FAPRI). More precisely, the price impact has been computed by multiplying the production drop estimated in the previous phase of the study by the reciprocal of elasticity (price flexibility)[8]. The calculation indicates to what extent prices are expected to increase as a result of a shock in EU production.

The available elasticity coefficients refer to wheat prices for food and for feed, as well as to EU15 and EU12. Total wheat price elasticity and total EU27 price elasticity have been calculated as quantity weighted averages.

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[7] Volatility measures how much the price of a commodity fluctuates over a given time frame using the standard deviation of prices. Wide price fluctuations over a short period constitute "high volatility" (FAO, 2009).

[8] *Price elasticity* is a measure of how much the quantity supplied (or demanded) responds to a change in the price of that good. It is calculated as the percentage change in quantity, given a 1% change in price: $e_p = (\Delta Q/Q) / (\Delta p/p)$;

Price flexibility is the reciprocal of price elasticity and it allows to calculate percentage price variations occurring as a result of a 1% change in quantity: $\Delta p/p = (\Delta Q/Q) / e_p$

As a first step of the analysis, EU27 price variations at T1 have been calculated, under the hypotheses of the "No azoles" scenario developed in the previous part of the study, distinguishing between total, food and feed use. Then, as it has been done in the previous analysis, the "No azoles" best scenario and the "No azoles" worst scenario have been computed as well.

The following graphs show the results. In the "No azoles" scenario (figure 3.6), the estimated prices response to the loss of azoles amounts to +23% for total wheat. Wheat prices for human consumption are expected to show a slightly larger variation (+25%); while prices of wheat for feed use are estimated to vary a little less (+21%).

When we consider the other two scenarios, we observe that prices are subject to significant variations. In fact, due to the loss of azoles, by 2013 wheat prices volatility in the EU27 could increase from 17% (wheat price for feed use, in the "No azoles" best scenario) up to 30% (wheat price for food use, in the "No azoles" worst scenario). In general, it has been noticed that the most price-responsive product category is wheat for human consumption, while price variations of wheat used for animal feed are the smallest.

Figure 3.6 - EU27 wheat price variations estimated in the hypothesis of loss of azoles (2013)
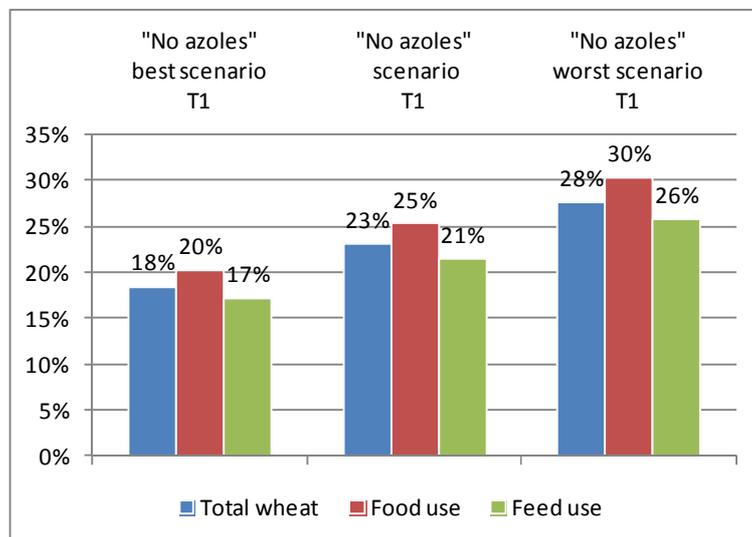
Source: Nomisma elaborations on FAO (production) and FAPRI (elasticity) data.

Figure 3.7 shows the trend of the EU27 wheat price index from 2000 to 2013. There the estimates for 2013 in the reference scenario, outlined by the DG AGRI (European Commission, 2010), are compared to price index estimates in the "No azoles" scenario we forecast, both in the best and worst hypotheses.

While the European Commission anticipates a moderate increase in wheat price for 2013 as compared with the current year, Nomisma calculations show that the withdrawal of azoles would entail a steep rise, possibly even higher than the ones occurred in 2008 and in 2010. In fact, in 2013 wheat price index has been foreseen to reach a minimum of 124 and a maximum of 133.

Figure 3.7 – Wheat price trend and estimates in the short term (index 2012=100)
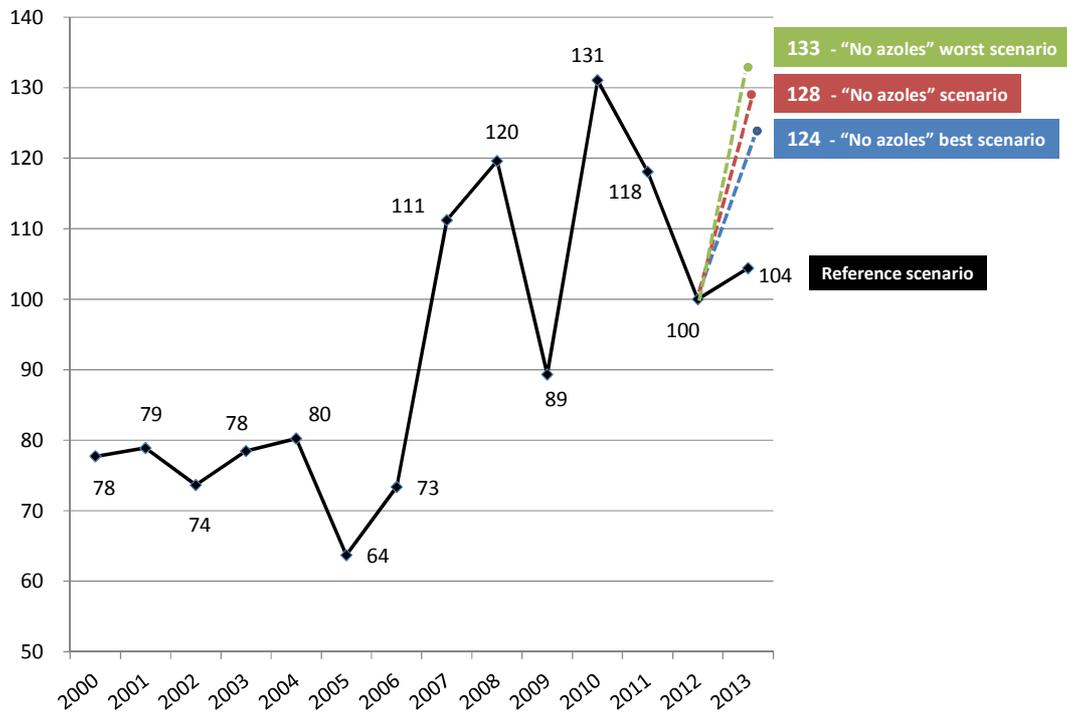
Source: Nomisma elaborations on OECD-FAO Agricultural Outlook 2011-2020 data (wheat producer price).

As a further step in the analysis of the potential impact of the azoles withdrawal on wheat prices, we can draw some considerations for EU15 and EU12 Member States, as compared to total EU27. In fact, since wheat production is mostly concentrated in few Member States, a differentiated impact on prices between the two areas is expected. More precisely, since almost half of total EU27 wheat production comes from France (28%) and United Kingdom (18%), EU15 Member States produce the large majority of wheat output, corresponding to 77% of total EU27. This is why, if we compare price variations estimated for EU15 with those estimated for total EU27 (figure 3.8), we do not detect significant differences, except a slightly larger impact on prices of wheat for food use (+1.8% in the "No azoles" scenario).

On the opposite, some differences are noticeable when comparing EU12 with EU27 outcomes (figure 3.9). As these countries contribute only with a minor share (23%) to EU27 total supply, the estimated changes in wheat price for EU12 countries are smaller than those concerning total EU27. More specifically, price variations are lower with respect to total wheat (-1.7% in the "No azoles" scenario) and especially with respect to wheat for human consumption (- 4.6% in the "No azoles" scenario).

Figure 3.8 – EU15 vs EU27 wheat price variations estimated in the hypothesis of loss of azoles (2013)
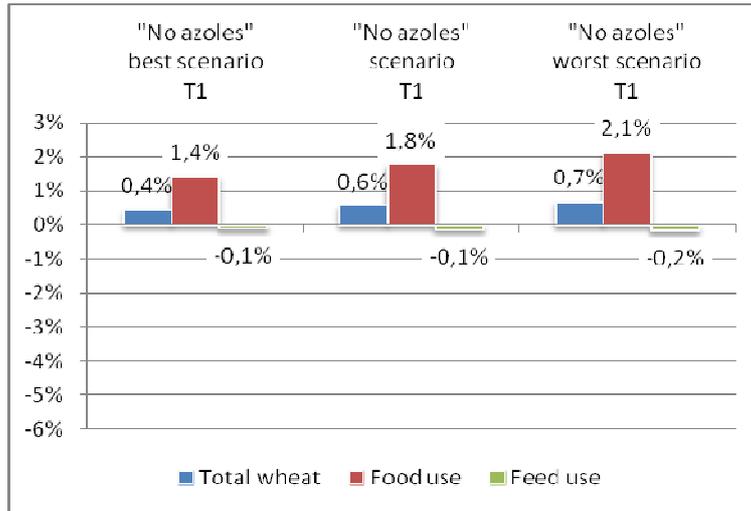
Source: Nomisma elaborations on Eurostat (production) and FAPRI (elasticity) data.

Figure 3.9 - EU12 vs EU27 wheat price variations estimated in the hypothesis of loss of azoles (2013)
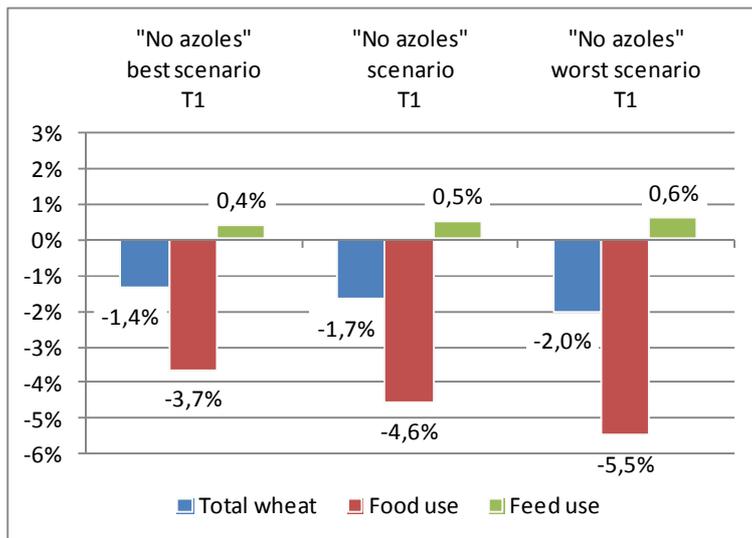
Source: Nomisma elaborations on Eurostat (production) and FAPRI (elasticity) data.

4. THE EUROPEAN WHEAT CROP ROLE ON THE INTERNATIONAL SCENARIO

This chapter of the study is aimed at considering the development of the world wheat market, where the EU27 plays a major role. Thus, the following sections examine the past trends and the anticipated evolution of the main drivers of global food commodity supply and demand, highlighting the specificities of wheat crop. Due to the strong interdependence that is a fundamental element of this system, the choices and actions of one of the largest players have a great relapse on the international market. In this wider scenery, the role of maintenance the European production levels related to azoles production inputs is significant.

The world wheat market and the role of the EU

With an overall production of 651.1 million tons and about 19% of production traded on world markets in 2010, wheat is one of the world's key staple products, following only coarse grains[9].

Wheat production is concentrated in very few countries, as the top 10 producing countries sum up 83.4% of the global wheat supply in 2010 (table 4.1). Among these, the European Union accounts for 21.0% of total production and it is by far the main producer, followed by China (representing 17.7% of world wheat production), India (12.4%) and USA (9.2%).

Table 4.1– Wheat production, export and import: Top10 country in the world (2010)

	Production	million t	% tot		Export	million t	% tot		Import	million t	% tot
1	EU27	136.5	21.0%	1	United States	36.0	27.1%	1	Egypt	10.6	8.0%
2	China	115.2	17.7%	2	EU27	22.3	16.8%	2	Brazil	6.7	5.0%
3	India	80.8	12.4%	3	Australia	18.5	13.9%	3	Indonesia	6.6	5.0%
4	United States	60.1	9.2%	4	Canada	16.8	12.6%	4	Algeria	6.4	4.8%
5	Russia	41.5	6.4%	5	Argentina	7.7	5.8%	5	Japan	5.9	4.4%
6	Australia	27.9	4.3%	6	Kazakhstan	5.5	4.2%	6	South Korea	4.8	3.6%
7	Pakistan	23.9	3.7%	7	Ukraine	4.3	3.2%	7	Nigeria	4.1	3.0%
8	Canada	23.2	3.6%	8	Russia	4.0	3.0%	8	Bangladesh	4.0	3.0%
9	Turkey	17.0	2.6%	9	Turkey	2.9	2.2%	9	Morocco	3.9	2.9%
10	Ukraine	16.8	2.6%	10	Brazil	2.5	1.9%	10	Iraq	3.6	2.7%
	Top 10	542.9	83.4%		Top 10	120.5	90.7%		Top 10	56.5	42.5%
	World	651.1			World	132.9			World	132.9	

Source: Nomisma elaborations on Eurostat and USDA data.

European production has been growing on average by about 1.9% per year in the last 15 years, even though with a non-linear trend. Actually, production declined sharply in 2003 and 2007, but it recovered immediately in 2004 and 2008. Furthermore, EU supply is characterized by a greater productivity with respect to the average world productivity rate: specifically, in 2010 the European

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[9] Source: OECD-FAO Agricultural Outlook 2011-2020 dataset.

yield was 5.3 t/ha, while the global average was 2.9 t/ha. This also explain how Europe generates 21.0% of world wheat production, despite the fact that European wheat harvested area represents only 11.6% of global harvested area. However, it has to be noted that both production and harvested area in the EU have been growing at a slower pace than the global average (figure 4.1).

World wheat exports shares are even more concentrated than production ones, since the top 10 exporting countries contribute to 90.7% of total trade flows. The main exporting countries are the United States, which cover 27.1% of world wheat trade, followed by the European Union (16.8%), Australia (13.9%) and Canada (12.6%). If we consider the trends (in particular the variations occurred between 2006 and 2010), European exports increased much more than those of other countries: while the global average increase has been 15.0%, European exports have increased by 59.7% within the considered period (figure 4.1). In spite of this trend, in the hypothesis of the loss of azoles the EU would cease to be a net exporter at world level and the new world wheat suppliers would become North America, Australia, Russia with some bordering countries (Kazakhstan and Ukraine) and South America.

Figure 4.1 - World and EU27 wheat crop production trends (2010-06, % variations)
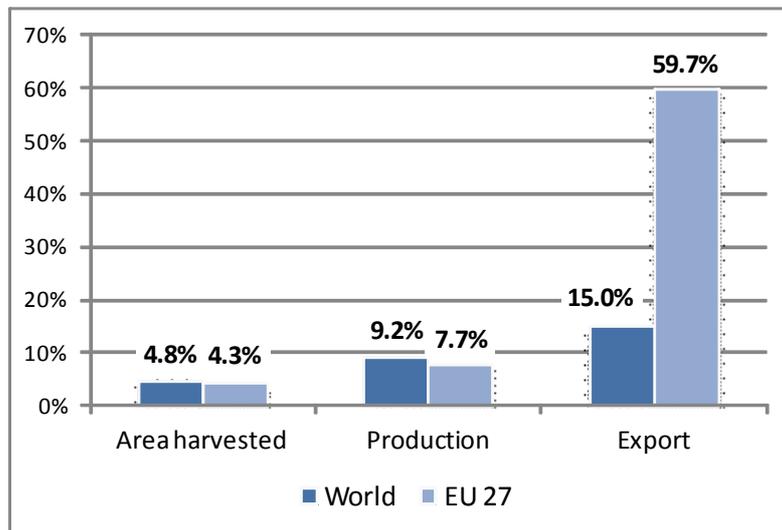
Source: Nomisma elaborations on Eurostat and USDA data

When compared to production and exports, a quite larger number of countries are involved in wheat imports. These include the EU27, Japan, South Korea, and Brazil. However, most wheat is imported by developing countries with limited production potential. Population growth in Egypt, Algeria, Iraq, Brazil, Mexico, Indonesia, Nigeria, and other developing countries will be the basis of future expansion of world wheat trade. It has to be highlighted that countries such as China, India and Pakistan have high levels of production but their production is addressed mostly to satisfy the internal demand, so they are not exporting countries, but have to import additional quantities for the internal market.

Overall, the world wheat supply is provided by few producing countries, but only some of these are also exporters: they are mostly high-income countries (namely USA, EU27, Australia and Canada) and upper middle-income countries (Russia). On the opposite, wheat is demanded by low and middle-income countries to satisfy the domestic population needs.

As a result of the on-going globalization and liberalization processes, world wheat market is almost fully integrated and any supply or demand shock is transmitted on all the actors, creating new balances (or unbalances) on the world scenario, therefore challenging food security.

Wheat market concerns: the price volatility

In order to understand the possible future market developments it is important to look at past evidence regarding the worldwide supply and demand of wheat.

World wheat consumption has been growing by a 17.3% rate between 2000 and 2011 and the production has followed the increase of the demand by an enhancement of +19.1% during the same period (figure 4.2). At the same time, it has to be underlined that there have been strains, such those occurred in the middle of the 2000s. During those years, the sudden growth of demand, which has not been offset by an adequate growth of supply, has brought a worsening in stocks between 2002 and 2003, which has been only partly restored in the following years. Additionally, the world demand of wheat resulted to be greater than the production in 2006 and 2007 – that was characterized by low levels of production due to seasonal adverse occurrences (e.g. the Australian drought) – and ulterior drops in stocks occurred. All these factors generated an acute crisis that caused a sharp growth in wheat prices. In 2007-08 wheat prices more than doubled with respect to 2005 and to the previous years, that were characterized by a substantial stability.

If we consider the change in stocks occurred between 2004 and 2007, the variation is nearly equivalent to the long term $(2020 - T_2)$ drop in production estimated by Nomisma as result of a hypothetical loss of azoles. In fact, if we consider the medium shocked scenario for 2020 the estimated loss in production is 18.5 millions of tons – and it reaches 22.3 millions of tons in the case of the worst scenario. In both cases, these changes in production level could bring to difficulties in managing the domestic demand and - in the assumption of not undermine the market stability changing the trade structure – would result in a shrinkage of the market stocks.

Figure 4.2 – Trends of worldwide wheat production, consumption and stocks (2000-11)
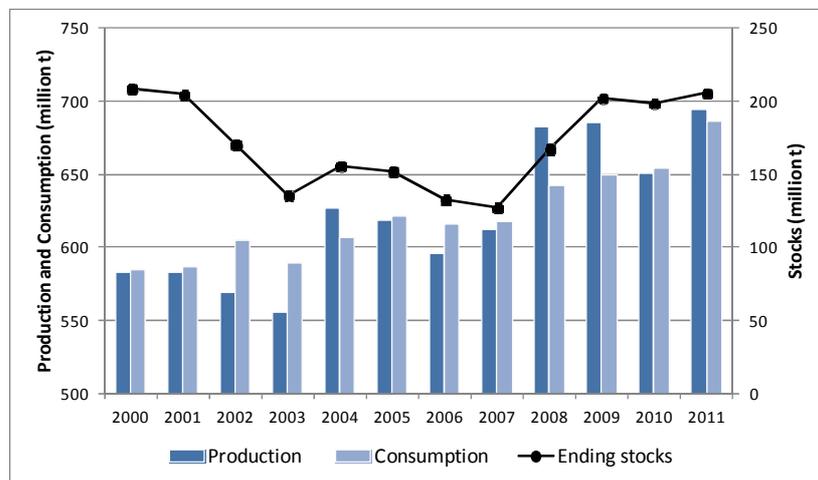
Source: Nomisma elaborations on USDA data.

Changes in market balance are transmitted on prices, as it happened in 2008 when the sudden increase in wheat price (displayed in figure 4.3) was determined by low supply and stock levels. However, we observe that a second price peak was recorded in 2011, in conjunction with higher production and stocks, but also higher demand. These phenomena suggest that not only supply shortages, but more generally any situation with tight market conditions will exert pressure on prices. Consequently, it can also be argued that the drops in wheat production foreseen in case of a withdrawal from use of all azoles could lead not only to a significant increase in price levels but also to greater price volatility over time.

Figure 4.3 – Wheat* price index trend (USD/t, January 2000 - March 2012)

*Hard Red Winter, ordinary protein, FOB Gulf of Mexico
Source: Nomisma elaborations on International Monetary Fund data.*

Steep price increase and higher volatility have become a global concern in recent years, as food commodity prices rose sharply and reached record levels again in 2010-11, just a couple of years after the 2007-08 spike. Actually, sharp increases and declines in agricultural commodities prices are not uncommon, with at least five such periods over the past 40 years. However, it has to be noted that the frequency and the intensity of these phenomena have increased in recent years: as agricultural markets are more and more integrated in the world economy, shocks in the international arena can now propagate to domestic markets much quicker than before.

Volatility indicates how much and how quickly a value changes over time. In economic theory, volatility connotes two principal concepts, variability and uncertainty: the former describing overall movement and the latter referring to an unpredictable variation.

According to OECD/FAO, volatility has been higher during the decade 2000-2010 than during the previous two decades and this is also the case of wheat and rice prices in most recent years (2006-10) compared to the 1970s (OECD/FAO, 2010). Indeed, other trustworthy sources support this conclusion. Food price volatility can be assessed by means of the food price index calculated by the International Monetary Fund (IMF). Actually, from 2002 to 2008 the index rose by 130%, then it fell by 33% and it registered a 60% surge in 2011. Volatility is even higher when calculated with respect to major crop products, such as wheat. In fact, the price index calculated by the Economic Research Service (ERS) of the USDA for a four-crop subset (wheat, rice, corn, and soybeans) has had even greater fluctuations than the IMF food price index, rinsing by 226% from January 2002 and June 2008, then declining by 40% and finally rising by 70% (Trostle et al., 2011).

Prices increase and volatility can produce negative effects not only for final consumers, but also for economic actors, and particularly farmers. On the one hand, as far as food demand is concerned, importing countries and low-income consumers are made worse off, as they have to pay more to satisfy their needs, so that price growth is a serious threat for food security.

On the other hand, it is not always true that agricultural production can benefit from the increase in prices. A first reason is that volatility implies uncertainty, which complicates decision-making for buyers and sellers. This is mainly the case for specialized farms, whose income is highly dependent on few crops, so that extreme volatility can result in large income fluctuations. The delay between production decisions and actual production creates additional risks, as farmers base their investment and planning on expected future prices. Furthermore, greater uncertainty limits opportunities for

producers to access credit markets and tends to result in the adoption of low-risk production technologies at the expense of innovation and entrepreneurship.

A second reason why farmers may not be able to benefit from high prices is cost increase. In fact, in recent years price indices for commodity categories, such as energy, rose as well. Actually, after the 2008 peak, these prices declined through 2009, but since then they have been rising more than the food commodity price index.

Market imbalances, higher prices and increased price variability are being triggered by a number of factors affecting supply and demand, both in the short term and in the long term. As far as food demand is concerned, in the present study we deemed relevant to consider the effects ensuing from per capita income growth, demographic developments and the competition with non-food uses (namely energy uses). On the supply side, we took into account issues related to agricultural production – i.e. natural resources availability and climate change effects - as well as the main drivers concerning productivity – such as inputs consumption and R&D investments. Additionally, the policy regulation affecting both production (CAP reform) and international trade (WTO) has been considered. The following sections of the study provide a qualitative assessment of each of these drivers separately.

World food demand trends

As a first step, it is important to assess the development in wheat demand that will likely take place over the coming decade. The following analysis is primarily based on OECD/FAO data and EUROSTAT data (OECD/FAO, 2011a; European Commission, 2011d), and it will help to understand the potential impact of the loss of azole compounds on the world and EU wheat market in the long term.

Due to both long-run macroeconomic trends and recent environmental and policy issues, wheat demand is expected to expand substantially in the next decade. The main drivers of this development are income (GDP) growth and demographic trends.

Following the recent global financial and economic crisis, world GDP projections are cautious in the short term, but they are quite positive over the medium and long-term. The United Nations estimates that global output will grow by 2.6% in 2012 and 3.2% in 2013 (United Nations, 2012). However, the larger income growth will take place in developing countries, countries in transition and in least developed countries. Developing countries and economies in transition are expected to continue to stoke the engine of the world economy, growing on average by 5.6% in 2012 and 5.9% in 2013. Among the major developing countries, growth in China and India is expected to remain robust; India's economy is expected to expand by between 7.7% and 7.9% in 2012-13. In the outlook for 2012, developing countries are expected to exceed the global trend, with an average gross domestic product increase of about 5.9%.

In the medium and long-term, according to the European Commission, world GDP growth is projected to accelerate, reaching 4.3% in 2014 and retracting to 3.8% by 2020. As far as the EU27 is concerned, GDP growth is expected to increase by 2.3% in 2015 and then slow down to 2.0% by 2020.

Together with the expected positive income developments, continuous population growth drives increasing demand for wheat. In fact, the number of people on earth is still rising by about 75 million (1.1%) per year and it will grow by some 760 million units until 2020, seizing a world population of more than 7.5 billion people. Again, developing countries contribute for the larger part to global population growth, with annual rates of increase of 2.3% and 2.4% in Africa and Western Asia.

This rising population adds to the global demand for agricultural products. As a result of these trends, whereas in the last ten years the world demand for wheat increased by about 0.7% per year, in the next decade it is estimated to grow by nearly 1.5% per year (figure 4.4).

Figure 4.4 - – World wheat demand prospects (Mt, 2012-20)
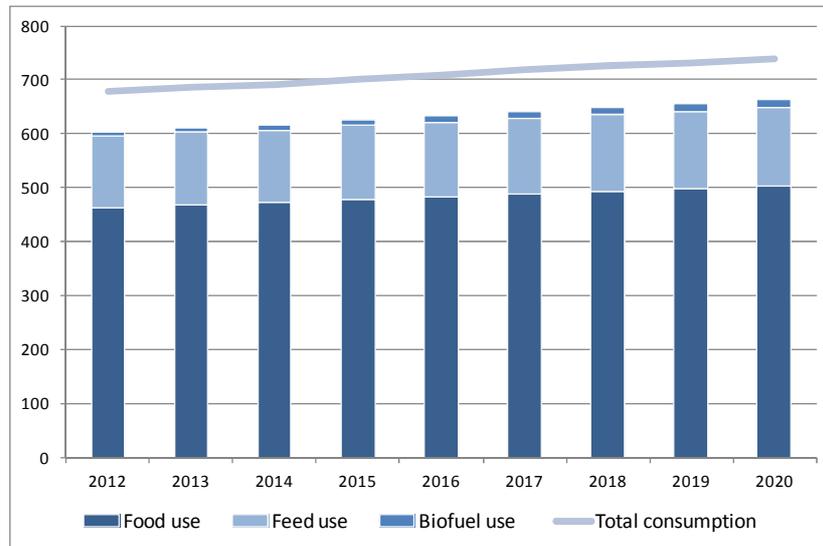
Source: Nomisma elaborations on OECD-FAO and Eurostat data.

The impact of income and population growth on demand is characterized by different trends in developed and developing countries. In fact, wheat can serve different purposes: food, feed and, lately, energy uses. Even if their relevance varies across different countries, globally, and in absolute terms, food and feed remain the largest sources of demand growth in agriculture, especially in developing countries, where the most rapid income and population growth rates occur. At the same time, in developed countries agricultural commodities are increasingly demanded to satisfy energy needs, thus amplifying the total demand.

Human food consumption accounts for about 68% of total demand at world level, and it is expected to increase by about 41 Mt until 2020 (+8.7%), maintaining the current share on total demand. In the EU(27), the food share of wheat demand is 44% and it is estimated that it will grow by only 1Mt (+2%), so that it will account for about 41% of total wheat consumption in 2020.

Besides food consumption, wheat demand growth is supported also by the continued prospects for a shift toward consumption of animal proteins. In fact, due to the rising global incomes, world per capita meat consumption has been increasing steadily over the last three decades, particularly in low- and middle-income countries. Further, it is important to note that, as the demand for meat rises, the demand for grain used for feeds increases more than proportionally. In fact, the feed-to-meat conversion rates (that is the quantity of grains needed to produce 1 kg of meat) can vary from 2 to 7 (kgs) (Trostle, 2008).

According to the OECD/FAO Outlook, world wheat utilisation for feed, which currently amounts at 132 Mt, will seize 143 Mt by 2020, growing at a slightly slower pace than in the past, though still representing around 19% of total use. In EU27 wheat feed use, currently seizes 53 Mt (accounting for a large share of total wheat demand - 41%) and it is estimated to reach 55 Mt in 2020, with a total increase of 2 Mt (+3.6%).

Competition with non-food production (bio-fuels)

In addition to the general demand trends, we must acknowledge that the issue of competing land uses is increasingly important, both at world level and particularly in the EU27. In fact, land scarcity

has become one of the main concerns of the new millennium, as it is required to deliver not only food products, but also energy and environmental services as well.

The demand for biofuel has been fostered by environmental concerns, economic factors and policy issues and the topic is often the centre of a heated discussion. However, we observe a steep growth in crop demand for energy use, and the shares of grain used for ethanol and vegetable oils used for biodiesel, relative to total use, continue to climb (Trostle et al., 2011). Actually, while smaller than the increase in food and feed use, biofuels constitute the largest source of new agricultural demand.

This trend is strongly affected by policy mandates and environmental goals in many regions around the world. According to the European Commission, the domestic use of cereals in the EU is projected to increase notably as a result of growth in the ethanol and biomass industry in the wake of the initiatives taken by Member States in the framework of the biofuel directive, the biomass action plan and the 2008 Renewable Energy Directive (RED).

Indeed, at present biofuels are produced from primarily food crops, such as cereals and oil seeds. This is the so called "first generation" (or conventional) biofuels. A "second generation" of biofuels is being prepared, produced from waste oils and cellulose, and thus not competing with food crops in land use. However, such biofuels are expected to enter the market only after 2015 and they are projected to account only for a marginal share by 2020 (IEA, 2010).

The strongest growth in overall biofuels production is expected to occur in Brazil, the USA and the EU. EU imports are also estimated to increase considerably following the implementation of the biofuels legislation.

As far as wheat is concerned, it is used to produce mostly ethanol, whose demand is increasing significantly over the medium-long term. As a matter of fact, EU wheat provides much of the feedstock for ethanol demand, both in the EU and in the world, with a share of about 60% global bioethanol production. A further increase is estimated in the coming years, so that by 2020 EU wheat based ethanol supply may account for almost 75% of global wheat use for biofuel production, appraised at 15.2 Mt.

Furthermore, according to OECD/FAO projections, wheat use for biofuels at world level will increase by about 140%, and reach 2% of global wheat utilisation by 2020. In the EU the expected growth is even larger (174%) so that wheat use for ethanol will seize 13Mt by 2020 (figure 4.5).

Figure 4.4.5 – Wheat use for biofuel index (2010=100)
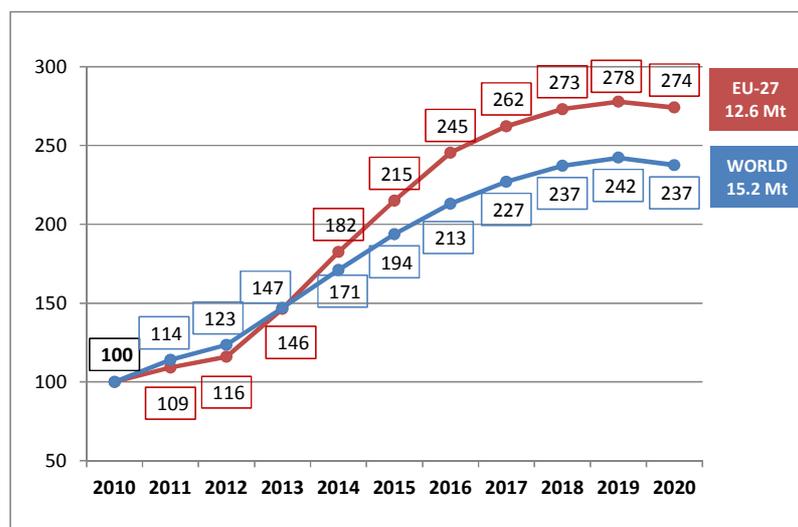
Source: Nomisma elaboration on OECD-FAO data (2011).

Finally, it has to be noticed that such estimates are subject to uncertainties, with particular reference to the future developments of oil and energy price and of the EUR/USD exchange rates. If the price of oil and energy will be higher than expected, and in case of an unpredicted depreciation of the Euro versus the US Dollar, the impact of biofuels might be underestimated. In fact, higher energy and oil prices would induce an increase in biofuels production, resulting in a proportionally higher demand for feed stocks. Moreover, a less favourable exchange rate for the Euro would imply higher prices for ethanol and imported wheat that would boost demand for domestic biofuels and crops.

The availability of natural resources for the enhancement of agricultural production

Given the increasing trend in the demand for crops, and for wheat in particular, there is a critical need to boost agricultural production in the near future. This can be done in two ways: using more natural resources and/or enhancing factor productivity (that will be dealt with in the following section "Productivity improvements: agricultural inputs and mechanization").

Natural resources are extremely important for the enhancement of agricultural production: in particular, land and water are vital elements for farming. As far as land is concerned, a distinction has to be made between *i)* total land suitable for agriculture, *ii)* arable land already in use and *iii)* land available for expanding the agricultural production, also considering the potential deriving from the specific rain occurrence. The total world land areas accounted to be 13,400 million hectares: this takes into account also those areas – e.g. peaks and deserts – that are not appropriate for agriculture. However, the total land that has characteristics suitable for agriculture[10] is much smaller, and it is estimated to be only 4,188 million hectares. Since at present the total arable land in use is assessed to be 1,602 million hectares, the land that is theoretically available for additional agricultural production amounts to 2,586 million hectares (Bruinsma, 2009). Actually, it has to be underlined that this remaining land is not always directly usable for agricultural production, because it is already covered by forests, grazing, protected areas, urban or industrial settlements. This implies that there is a tight competition of alternative uses on this "available land" and a possible conversion to agricultural production has to be confronted to the social and environmental cost of this alteration in allocation.

Such costs must be accounted particularly when considering a long-run perspective. In fact, in the latest years there is a growing awareness of the importance to pursue a sustainable development, that according to the OECD is the "*development that meets the needs of the present without compromising the ability of future generations to meet their own needs*" (World Commission on Environment and Development, 1987). This approach has important implications for agriculture, as it advocates the conservation of natural assets. Therefore, a measure to be undertaken to accrue agricultural produce could be the enhancement of productivity on existing land, by reversing the trend of land degradation and acting on existing arable land already in use – e.g. increasing the soil fertility – so that no extension on additional land would be needed. Indeed, deforestation and soil degradation represent two major negative effects that ensued as a result of the uncritical expansion of arable land. Moreover, land uses can contribute to other important social and environmental goals in a sustainable development perspective, such as Greenhouse Gases (GHG) sequestration, alternative energy sources (biofuels) and the adoption of less environmental aggressive practices.

However, it is important to underline that these issues relate mostly to developed countries, while developing countries most often face critical food security problems, due to the limited extension of cultivated land and low yields. Actually, the greater share of land still available is located in Sub-

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[10] Land is considered potentially suitable for growing crops based on agro-ecological characteristics including the conditions of the terrain, the local climate and the suitability for rain-fed agriculture.

Saharan Africa and in Latin America (figure 4.6), where also the potential deriving from water productivity in rain-fed lands has to be accounted as a positive feature[11]. These areas represent a substantial opportunity for additional enlargement of arable land. On the contrary, the current high production zones, such as the Industrial Countries and Asia, have already saturated the availability of land for agriculture expansion and in some cases - such as in Transition Countries – the surface available for agriculture is even decreasing.

Figure 4.6 – Arable and available land (million hectares) and potential for growing rain-fed crops* (2005)
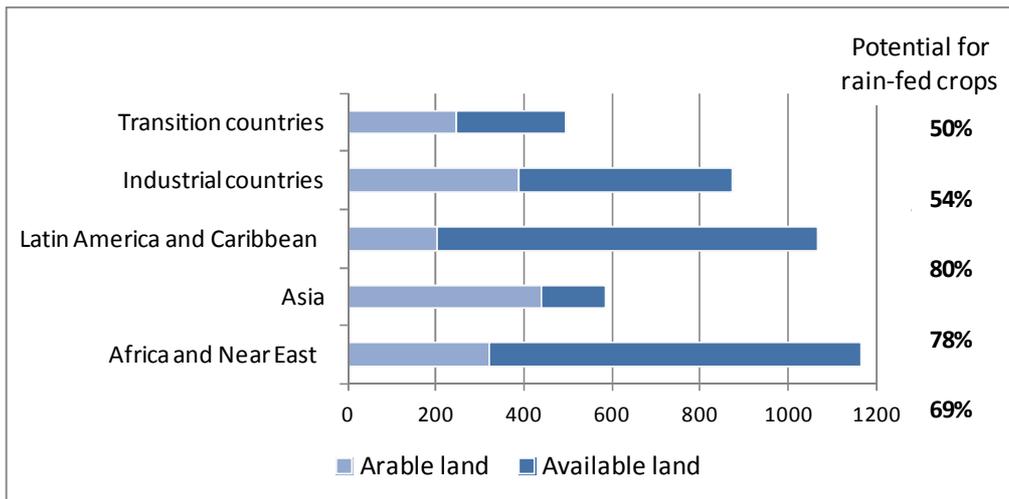
*Potential for growing rainfed crops: yield attainable is more than 60% of the maximum constraint-free yield.

Source: Nomisma elaborations on Bruinsma data (2009).

A further aspect to be considered is that the countries in which there is great potential and the possibility to enhance productivity are characterized by a vast internal demand that has to be satisfied. Asia, Africa and Latin America are characterized by a trend of population growth, which will accrue even more the demand for food commodities and with the changing pattern of the food consumption (as a result of the development of the country economy) the demand will be modified in term of quantities – greater - and variety of the demanded commodities.

In this scenario, it is important to focus the attention also on some negative phenomena such as the so-called "land grabbing" issue[12], i.e. the recent strong increase of land acquisitions made by international investors, in areas that until a few years ago were not under interest. These croplands, located in developing countries, are made both to ensure food security but also economic return (Cotula et al., 2009).

The investors are on the one hand countries with large – and growing - population and with related commodities supply issues, as it is the case with China, India and South Korea; on the other hand, they are represented by high-income countries with natural resources limitations and that are net food importer, such as the Gulf States. These countries seek abroad to purchase land, thus to solve the internal supply problems for food and not to be dependent on international market conjuncture factors (e.g. the food price crises occurred in 2007-08). In addition to food security concerns, some of the acquirements of land in developing countries are made for other aims, more directed to

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[11] These lands have a potential for growing rain-fed crops if the yields are above an "acceptable" minimum level, which is estimated to be at least the 60% of the maximum constraint-free yield.

[12] Land grabbing is a large-scale land acquisitions, broadly defined as acquisitions (whether purchases, leases or other) of land areas over 1,000 ha.

investment opportunities with high rates of return, such as the production of biofuels or other non-food agricultural production.

In conclusion, even if these investments are made in order to keep under control eventual global food supply crisis, it is important to ensure that the opportunities of extending the arable land would be carried out following a sustainable raise of agricultural production.

Global climate change: impacts and threats regarding agricultural production

Natural resources use is nowadays strictly bounded to the impact of greenhouse gas emissions (GHG) on environment (the so called "greenhouse effect") and the related climate change phenomenon. Climate change has direct negative impacts on agricultural production: this could be related both to the gradual rising of the global temperature and to the frequent occurrence of extreme weather events.

Global warming is a phenomenon that has been increasingly gaining a worldwide attention due to the great dangerousness associated with the effect produced, starting from the rising of temperature. According to FAO "*Climate has been changing slowly since the early 1900s. This is an accepted scientific fact; by the year 2000, the global average temperature had increased by 0.74ºC*" (FAO, 2009a). These negative effects are widely recognized by literature: "*Rising temperatures and changes in rainfall patterns have direct effects on crop yields, as well as indirect effects through changes in irrigation water availability*" (IFPRI, 2009).

The environment is extremely susceptible to changes in global temperature, resulting in outcomes such as changes in rainfall, weather worsening (such as more sudden heat waves, droughts, storms and floods) and glacier retreat. Therefore, these negatives effects have pointedly consequences on agriculture, both in term of production and productivity.

First, the changes in seasons – and the related alteration to precipitation patterns – will reduce the availability of water with adverse impacts on agriculture, such as crop losses and overall production declines. Additionally, an inferior and less steady water availability combined with climate warming could lead to a more severe disease occurrence – in terms of intensity and spread - and cause difficulties in managing the related effects on crops: thus, the result is an additional negative influence on productivity. Furthermore, the supply of agricultural production will be undermined by weather changes consequent the GHG emissions, because the harvested quantities will diminish. At the same time, it has to be underlined that in some cases an increase in carbon dioxide (one of the more relevant gases that cause the greenhouse effect) could ameliorate agricultural performances, in terms of productivity.

Again, there is widespread evidence in literature on this topic especially about the fact that the effects of temperature rising due to the GHG emissions is particularly marked in some areas of the world, which are Europe (particularly marked in France), China, India and Russia (IFPRI, 2009). In these areas, it has also been noticed an impact on specific crop yields – such as wheat – issuing from climate changes. Considering that all these countries are big wheat producers, a drop in yield could represent a threat to global food security, putting increasing pressure on agriculture – already strained by other factors such as global population growth.

The importance of global warming is worldwide recognized and since the 1990s an international collective action has been undertaken: the most important commitment has been the setting of the United Nations Framework Convention on Climate Change (UNFCCC) and the related Kyoto Protocol in order to find global solutions to the climate change challenge. At international level, this aim is planned to be reached through targets of emission reduction: for what concerns the European Union, there are also additional commitments in term of GHG decline that are stricter than Kyoto Protocol legally binding targets (specifically a reduction of 30% by 2020 instead of a 5% by 2012).

Another consideration has to be made: there is an evident growth in emission regarding developing countries. Whilst industrial countries have national commitments to reduce GHG emissions and are involved in international treaties, the developing countries emissions have been on the contrary drastically growing at a much higher rate than industrial countries. Even though in some cases these emissions are related to production to be exported to developed countries, it is extremely important to provide incentives to reduce GHG emission also in developing countries and to extend the inclusion in international commitments on this topic. Their rapid growth in recent years and the related pattern of industrialization has brought them to fill the gap with industrial countries.

The global warming is expected to grow continuously in the future; hence, it is necessary to take adaptation measures or spark off mitigation measures to contrast this phenomenon and agriculture could play a relevant role (European Commission, 2009a). Indeed, a decline in emissions could be led by changes in farming activities: table 4.2 shows some examples of farm management options that could reduce the influence on climate change. Additionally, agriculture could lessen the global warming through the maintenance and sequestration of carbon dioxide in soils and could implement other sectors support (e.g. through energy production from biomasses and use of renewable materials).

Table 4.2 - Mitigation measures: farm management options to contrast agriculture emissions of GHG

Fertiliser and agricultural input rationale use: optimisation of mineral and organic nitrogen application, overall reduction of external inputs (e.g. in organic farming), use of precision farming;
Livestock and manure management: diet, breeding and technical solutions to control methane from digestion processes of cattle, extensive forms of pasture management
Soil management: conservation agriculture (reduced or no tillage), maintenance of soil cover, protection and incorporation of organic matter in the soil, contrast of erosion and desertification;
Land management: crop rotations, set-aside, conversion of arable land to permanent grassland, organic farming, forestation;
Incentive bio-energies

Source: Nomisma elaboration of European Commission data (2009)

However, it has to be pointed out that mitigation measures intended to reduce the influence on climate change could besides bring effects that could lead to further decreases in production and productivity (specifically with regard to changes in fertilization, land management and bio-energy).

Therefore, the conclusion of these evidences is that the negative impact on production will result to be double: on the one hand, the direct effects issuing from the climate change – for which adjustments will be possible to occur only in a long-term horizon; on the other hand, the loss in production as result of applying the above mentioned mitigation measures.

Productivity improvements: agricultural inputs and mechanization

The alternative solution to satisfy the growing demand for agricultural raw materials is to operate on the factor productivity side. As already mentioned in the previous paragraphs, the increasing demand for agricultural commodities is bounded to the possibility of crop yields enhancements, because of the binds of natural resources shortage and the effects of climate change.

As showed in figure 4.7, in the past years yield enhancement has been demonstrating a minor dynamism for the main arable crops (i.e. wheat, maize, rice, soy). Specifically, if we consider the wheat case study, the main world producers are characterized by moderate growth rates of the yields. On the contrary, we observe considerably higher variations in low-income countries, which have low yields and consequently still have wide margin of advance compared to the others.

Figure 4.7 – Wheat yield growth
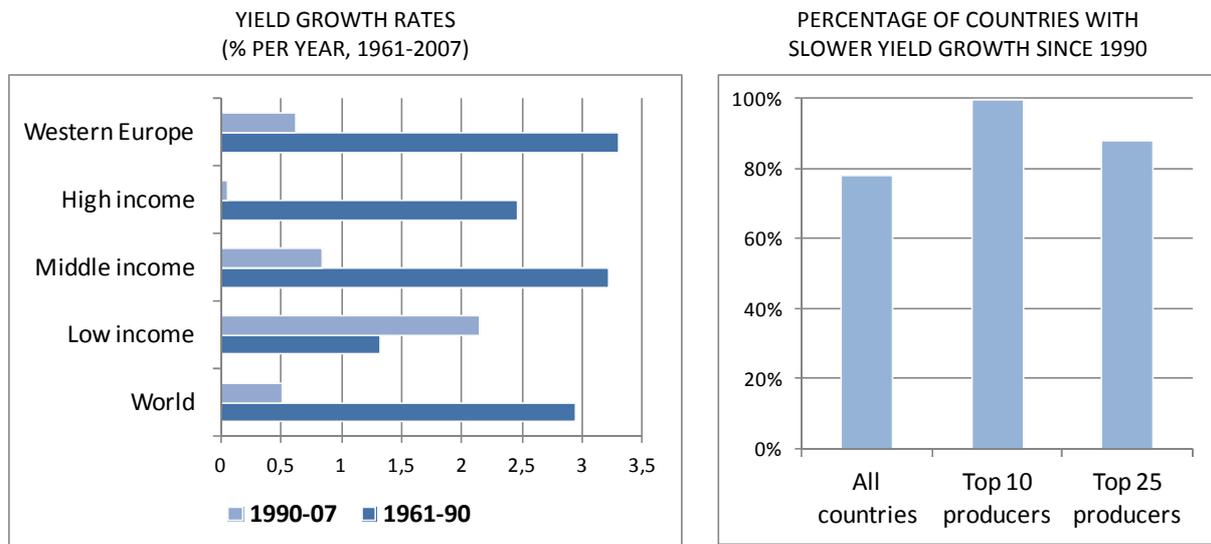
Source: Nomisma elaborations on Alston, Pardey and Beddow data (2010).

The elements that influence yield trends are several: among the most important, the technical endowment and the investments in Research and Development (R&D), in addition to environmental patterns.

The agricultural productivity enhancement can be reached by means of fertilizers, plant breeding, plant protection products and mechanisation. Even if this evidence is well recognized, their availability – and therefore employment – is not homogeneous across the different areas of the world. Specifically, the industrialized countries have in general adequate supply of these means, some emerging countries (mainly China, India and Latin America countries) have minor factor endowments, while the other developing countries still demonstrate to have a gap in input availability.

The 164.4 million tons of total fertilizer nutrient (N+P2O5+K2O) consumption is related for the 62% to Asia, the 20% to America, the 14% to Europe, the 3% to Africa and merely the 1% to Oceania (FAO, 2009). More specifically, it is estimated that 107 kilograms of fertilizer are applied on average to every hectare of cropland at world level. As we can see in figure 4.8, the average consumption of these classes of fertilizer changes among different areas, ranging from the high consumption ratios in Asia (mainly referred to China and India) and in the industrial countries to the extremely reduced ratios of Africa. The enhancement in production and productivity is partly associated to the use of fertilizers and the increase in their consumption. This becomes even more relevant when considering that the cultivation methods point progressively to intensive practices and that the advantage of fertilizer use in less rain-fed areas has a direct impact on production.

Furthermore, the importance of a rational use and management of the fertilizer as well as plant protection products to enhance crop productivity - avoiding undesired impacts on the environment - has to be underlined.

Likewise, the availability of agricultural machineries is heterogeneously distributed among the different countries: data show that low-income countries and middle-income countries have a tractor supply per hectare of cultivated area that is respectively only 10% and 40% of the ratio registered in high income countries (World Bank, 2010).

Figure 4.8 - Consumption of three macronutrients: nitrogen (N), phosphorous (P), and potassium (K) (kg/ha of cropland, 2009)
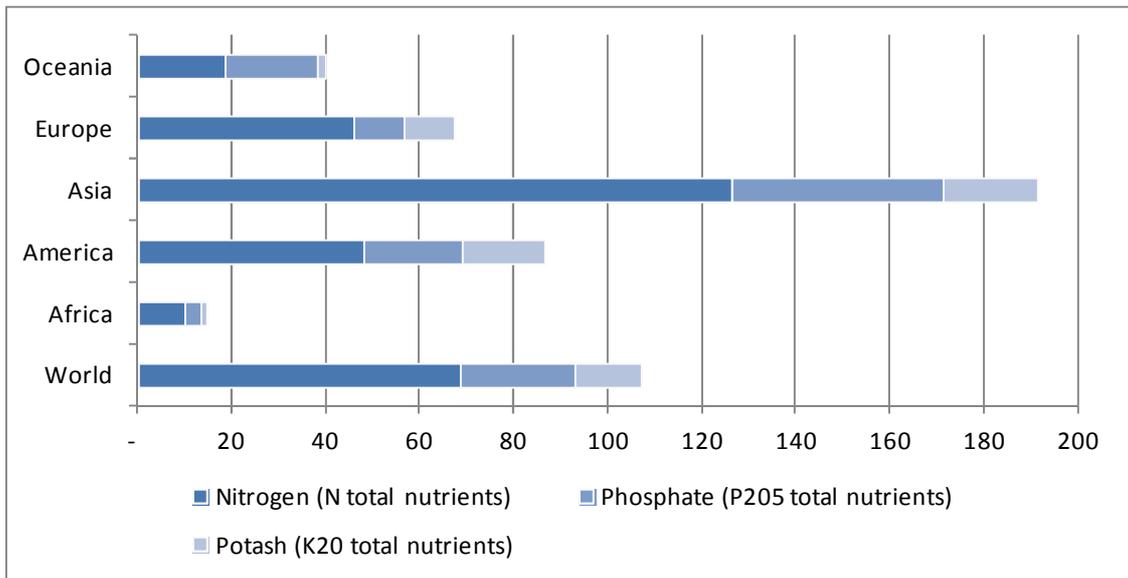
Source: Nomisma elaborations on FAO data.

Another important factor that has to be considered in order to enhance the agricultural sector is that the use of technical means is subject to an adequate development of rural infrastructures, such as the improvement of roads, energy sources, irrigation and storing buildings. The development of agricultural markets in transition countries and emerging countries is strictly bounded to investments in basic rural infrastructure and therefore essential for the overall productivity growth. According to FAO, "*this is the case for sub- Saharan Africa, where large commercial input enterprises have yet to emerge. High transaction costs, risks, and the major economies of scale involved in producing, importing, and transporting inputs, such as fertilizer, are to blame; but a key factor for the region's low input uptake is that it is generally cheaper to expand cropland to achieve production targets. As a consequence, chemical fertilizer usage is much lower in sub-Saharan Africa than elsewhere*" (FAO, 2012). In conclusion, if a global development of the agricultural sector is to be reached, it is vital to enhance the rural infrastructure, with specific regards to developing countries and rural areas, giving at the same time more dynamism to their markets.

Productivity improvements: importance of R&D

The relation between productivity enhancement in agriculture and the improvement in technical innovation (R&D) has great effects on the supply of commodities. In fact, as already mentioned, the growth in productivity cannot be everywhere driven by the enlargements of the cultivated land and at the same time the water resources result to be in progressive shorter supply. The R&D represents an essential element that could lead to productivity improvements and this is largely underlined in literature: "*productivity improvements in agriculture are strongly associated with lagged R&D spending*" (Alston, 2010).

Even though the results of R&D activity cannot be clearly and directly related to the investments and a long-term time horizon is needed to detect the consequences (Alston, 2011), the importance of investment in R&D in agriculture is widely recognized to be essential, especially in order to assure a global food security.

Nevertheless, evidence shows that the rate of research development in the agricultural sector has been decreasing (Beintema and Elliott, 2011). As displayed by figure 4.9, the annual growth rate of

spending in agricultural R&D has been sharply diminishing since the beginning of the 1980s. Therefore, the achievement of a keener enhancement of productivity is related to a recover of the growth rate of agricultural R&D. Even if an effort in this direction in terms of spending will take place, made more difficult by the challenges of the global economic crisis, the outcomes will be noticeable only in the long-term (Alston, 2011).

Figure 4.9 - Annual growth rates in agricultural R&D spending (1976-2000, in 2000 international PPP dollars))
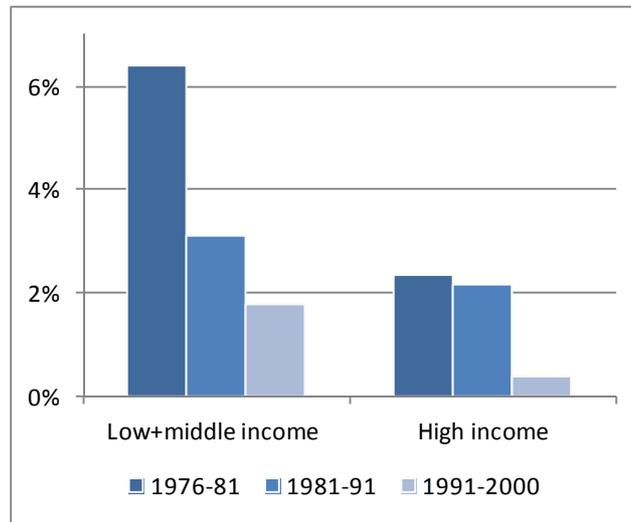
Excluding Former Soviet Union and Eastern European countries due to lack data.

Source: Nomisma elaborations on Beintema and Stads (2008) based on ASTI data set.

The productivity growth in agriculture that occurred in the past has been brought by investment, both deriving from the public and private sector. In 2000[13], at a world level, the spending on agricultural R&D amounted to 39.6 billion dollars[14] (Beintema and Stads, 2008). The investment is primarily public in the countries with low and middle income, while in the high-income countries both public and private financing coexist.

The public sector investments in agricultural R&D represent nearly 60% of global spending and it originates from government, education sector (mostly higher education) and non-profit public agencies (figure 4.10). The public spending has been growing significantly in the past (specifically it grew by 50% since 1981), but its development was not equal across regions: it has been on the contrary largely concentrated. This was attributable to the high growth in spending of three middle-low countries – China, India and Brazil – that together with USA and Japan represent the first five countries in term of investments and which together accounted for 48% of public spending in agricultural R&D (Beintema N., Elliott H., 2011). Private investments account for 41% of total spending; they mostly originate from private companies and are located in high-income countries, and only 2% of the global agricultural R&D spending is attributable to low-middle income countries, more specifically to Asian private companies (Beintema and Stads, 2008).

The private funding of research activity is strictly bounded to the economic return of the investments made. In addition, it has to be considered that for the private sector research a main problem is the appropriability of the results. Indeed, the knowledge produced by research has a public-good nature,

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[13] The latest year for which comparable global data are available and excluding Eastern Europe and the former Soviet Union, for which no time series data were available.

[14] Expressed in 2000 purchasing power parity (PPP) dollars

thus part of its results are not fully appropriable by the private entity that has carried out the research - in other words, the benefits could be shared, whereas the costs are not. Hence, in absence of an adequate guarantee of the investments rates of return, the private research is discouraged especially in the developing countries (Pardey and Pingali, 2010).

Figure 4.10 - Agricultural and Food R&D expenditures[15]:
share of public and private investments (2000, in 2005 international PPP dollars)
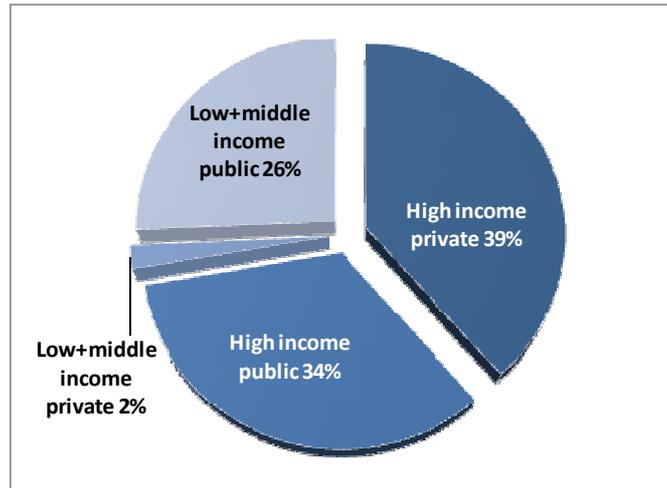
Excluding Former Soviet Union and Eastern European countries due to lack data.

Source: Nomisma elaborations on Beintema and Stads (2008) based on ASTI data set.

The transfer of innovation to enhance productivity in developing countries faces another obstacle: it cannot be done by directly transferring and applying the technologies conceived in developed countries. An additional step has to be made: the adaptation and integration of the results of the agricultural research to the specific local requirements. In fact, the agricultural activity is bounded to specific biological cycles and to pedo-climatic characteristics (Pardey and Pingali, 2010): these include specific agro ecological factors that have great inferences on agricultural technologies, thus the enhancement in productivity relies on the feasibility and adaptability of agricultural technologies to the specific area and to its features.

In conclusion, the response to a growing global demand for agricultural raw materials could arise from an enhancement of productivity and be linked to adequate investments in R&D in the long term. The evidences concerning a group of middle-low income countries seem to confirm that there is a willingness to improve the spending in R&D, together with the high income countries continuing in realizing both public and private agricultural research. On the contrary, the low-income countries still have to improve in terms of research and could benefit only from the positive spillovers of the R&D conceived in developed countries.

Policy regulation influences

In order to complete the general scenario, the analysis of the sector policies has to be considered, with the related influences on economic trends. The international agreements on trade liberalization as well as the European Union policies – mainly the Common Agricultural Policy (CAP) – have a strong

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[15] The data are referred to 2000 because of the lack of recent data. Additionally, precise data on private spending on agricultural R&D are not so widespread.

influence on the agricultural sector, especially due to the progressive opening of agricultural commodity markets to international trade.

In fact, the global trading of agricultural products has progressively grown in the last two decades. In particular, a great dynamism has been noticed in the last decade (2000-2010), when the value of agricultural trade grew by 147% (figure 4.11). Thus, it can be considered that the market of agricultural commodities is highly integrated.

Figure 4.11 – World agriculture export trend 1990-2010 (billion dollars)
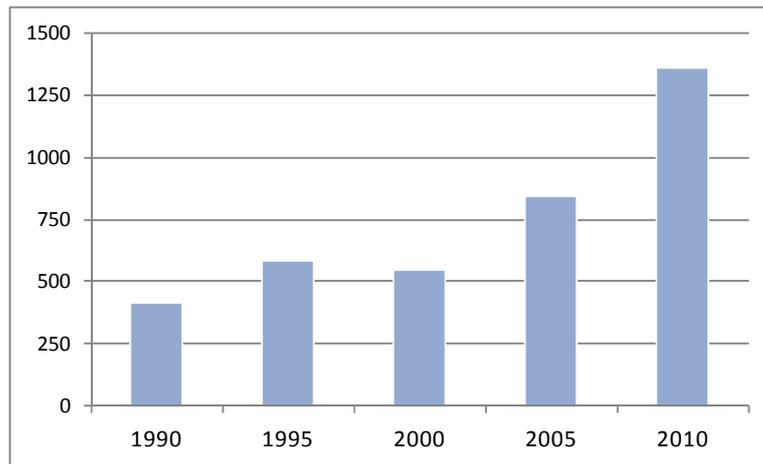
Source: Nomisma elaborations on WTO data.

A significant contribution to international markets integration has been provided by the World Trade Organization (WTO), which now involves 153 members. However, after the achievement of the Uruguay Round (1986-94), the negotiations currently face difficulties (e.g. in the Doha Round) also due to the great attention that is nowadays focused on the food security topic.

In fact, in the occurrence of the recent food supply crises, with the related high global prices, some producing countries have adopted restrictive trade policies, raising import barriers or/and restricting export, to preserve internal supply. These measures have also the effect of further stimulating the prices growth and contributing to their high volatility (Giordani et al., 2012). Consequently, these countries do not correspond to the improvement of market access aimed by the WTO and could cause damages to the net importer countries, which are mainly developing countries.

These concerns have reached other important international organizations, insomuch that in occasion of the G20 of November 2011 in Cannes, the international leaders accepted to exclude the humanitarian aid food supplies from the export restriction or from trade barriers in order to guarantee the food security of the poorest areas of the world.

Despite this engagement, the future developments of international trade policies are not clearly defined: as a matter of facts, during the Geneva Conference of December 2011 an international shared agreement was not reached. This was not possible even if several countries had renovated their commitment of not implementing new protectionist policies. Thereby, the director-general Pascal Lamy has demonstrated scepticism toward the possibility of having great developments in a short-term horizon.

The WTO has been working to favour the reduction of agricultural subsidies in the high-income group of countries, which comprises Europe, and to influence the shape of the common agricultural policy of European Union since 1992. The conclusive shift from a production payments system toward an income support system has been marked by the 2003 reform and the 2008 Health Check; additionally, the agricultural sector has been oriented toward the market and to the promotion of rural development policies.

The currently discussed regulation proposal "the CAP towards 2020" – that was launched in October 2011 – is also headed to a sustainable orientation of the agricultural sector. Specifically, the new CAP 2014-2020 melt together objectives of the previous policies with further intents related to brand new needs: the support to the competitiveness of the European agricultural sector has been therefore combined to the food security, to new tools to handle the price volatility and to environmental sustainability integrated (with measures aimed at mitigating the climate change effects and at biodiversity protection). The greater attention toward sustainability of agriculture fit in to the policies promoted by the European Union, such as environmental regulation aimed at contrasting climate change and to promote renewable energies – specifically the already mentioned bioenergy.

Despite the negotiations on the CAP reform is still talked-about, the proposal of the new regulations points towards new developments. The structure of the CAP centred on two pillars confirms the complementarity of the undertaken measures. The support to basic income to farmers through direct payments and market measures is stated in pillar I - introducing a greening component to integrate the requirements of cross compliance and environmental and climate benefits in farmers activities. Rural development is stated in pillar II, with references to elaboration of multiannual programmes – and the related co-financing – under a common framework (European Commission, 2011d).

The precise functioning of the CAP will be outlined during 2012-13, following the co-decision procedure between the European Commission, the European Parliament and the European Council: the set of legal proposal is expected to come into force from 1st January 2014.

The geographical scope of the new Cap has been broadened to 27 members: this mean that the specificities of each country have to be considered. Additionally, the balancing of the distribution of financial resources is a matter under discussion. This introduces additional complexities in a general scenario that is already characterized by a decrease of the Community budget designed to agriculture.

As the CAP is being is discussed, it is expected that decisions on the new EU financial perspectives (Multiannual Financial Framework 2014-2020 - MFF) will be formalized: the expectations point towards a progressive reduction of the European budgetary spending assigned to the agricultural sector. In 2011, 58.7 billion euros on the total of 141.9 billion euros of EU budget (41.3% of the total amount) are assigned to the cost issue related to agriculture "2. Preservation and management of natural resources", of which 42.9 billion euros are related to "Direct aids & market related expenditure" and 15.7 billion euros "Rural development, environment & fisheries". If the recent proposal of the European Commission on the Multiannual Financial Framework 2014-2020 will be approved, this cost issue will be progressively reduced to 51.8 billion euros in 2020, which represent 34% of total EU budget (150.7 billion euros).

Final remarks

This chapter has examined elements that allow to better grasp the effects of a rational use in European agriculture of inputs such as azole active substances, and more specifically referring to a largely important crops such as wheat is.

If these substances were withdrawn from use, the direct result will be a drop in European wheat production, particularly sensitive in a long-term horizon because it could lead the European Union to switch from the position of net exporter to net importer.

The overall scenario is therefore based on the followings:

1. The world food commodities demand is significantly increasing both in the medium and long term, driven by per capita income growth and population increase. This demand is largely boosted by developing countries that actually cannot satisfy their national demand with their

internal production. The role of the European Union is therefore leading to assure their supplies, due to the evidence that EU is the first wheat producer and is among the larger exporters.

2. The biofuel market is expected to continue being an important source of demand for cereals (ethanol in the case of wheat), even if its role will be largely influenced by both policy mandates and conventional energy prices (crude oil). These policies are mainly pursued by industrial countries and Europe, in order to respond to the new objectives of environmental protection and of climate change mitigation (which correspond to the CAP basic issues).

3. The strengthening of the supply can be related to a wider utilization of natural resources. The available and suitable land is placed in areas characterized by narrow production outcomes – i.e. Sub-Saharan Africa – or emerging countries – i.e. Latin America: these areas are already facing a pressing growth of commodities internal demand. On the other hand, little chance for widening can be related to the industrial countries and Europe itself. A minor productivity is bounded to the loss of azoles in the European Union: thus, this gap could be offset by an enhancement of wheat cropland to the detriment of other competing crops.

4. The productive performances are influenced by the climate change, which in Europe has mainly adverse effects. The GHG mitigation measures fostered by the European Commission partly hinder the productivity enhancement of European agriculture (e.g. changes in fertilization, land management).

5. The technological endowment represents an essential driver to enhance crops productivity, as highlighted in our study, which assesses the importance of azoles through the impact of their eventual withdrawal from use. In Europe, the technological endowment is already more than sufficient, thus a significant growth rate of productivity is not expected to be reached through a larger utilization of agricultural inputs. This could occur only in developing countries or emerging countries – some of which have already inputs consumption patterns similar to industrial countries – but this seems to be not feasible in the short term.

6. The investments in R&D constitute a very essential element, even if the growth rates of these investments are more reduced than in the past. The likelihood to enhance the technology borders seems to be less incisive that in the past and is once more bounded to the role of industrial countries. The minor spending of developing countries, mainly related to public investments, and the limited appropriability and portability of R&D results from high income countries to low income ones raise questions on the extent of future support of innovation to the productivity enhancement.

7. Despite the world market openness ruled by WTO, which point towards a steady growth of global trade and the possibility for countries with limited supply to import from countries with surplus, during crisis times the individual interest prevail against the general interest: export restrictions are not unusual, of which the WTO impose sanctions on.

8. In the new CAP 2014-2020 the support to the competitiveness of the European agricultural sector has been combined to new objectives (food security, price volatility, environmental sustainability). The pursuing of these objectives is bounded to the financial funding, which is progressively sinking.

The more evident effects ensuing from the food security matter – which has been prominently emerging over the last years - are: the drop in stocks, the increase of prices and the price volatility upsurge.

An important factor to anticipate the future developments of agricultural commodity markets and prices is the increasing reliance on international trade to meet food needs at the expense of stock holding. If stocks are low relative to use, markets are less able to cope with supply and demand shocks and supply shortfalls or demand increases will lead to bigger price increases. Stock levels relative to consumption decreased substantially over the past decade and the ratio of world wheat

stocks to-use is expected to remain below historical averages in 2020, approaching 27% that is slightly only three percentage points above 2007, when prices increased and triggered the food crisis (OECD/FAO 2011). These developments on the internal and external markets are expected to lead to relatively tight cereal markets over the medium term in the EU. As a result, wheat prices are anticipated to be more volatile than in the past by 2020 and they are projected to average well above the historical mean (about 35% more than the 1990-2012 average).

Figure 4.4.12 – World wheat price* (USD/t)
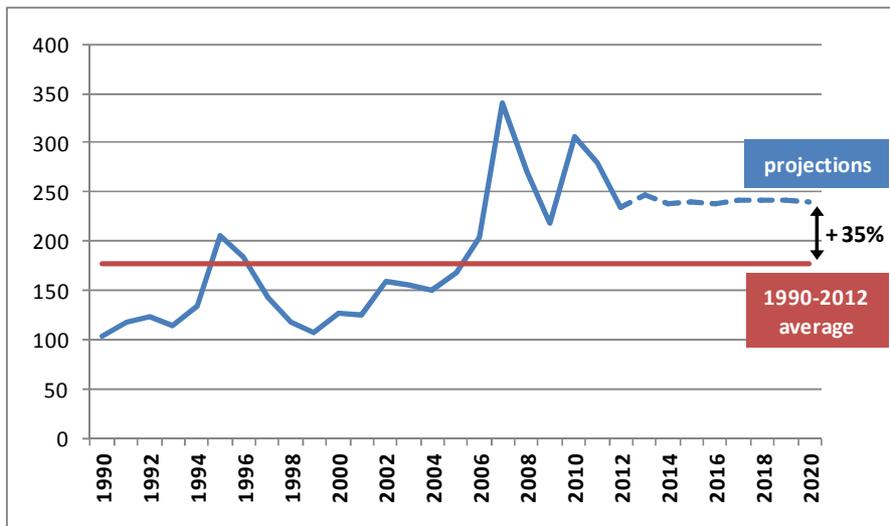
* World reference price for wheat - No. 2 Hard Red Winter, USA f.o.b. Gulf Ports

Source: Nomisma elaborations on OECD-FAO data.

The role of azoles is vital for EU in order to maintain the actual status of net exporter: in case of a withdrawal from use of these active substances, this situation could be exacerbated. The assessment of the economic importance of azoles in European agriculture and specifically referred to the wheat case study through the analysis of the loss of these active substances has therefore underlined the international interdependence of European agriculture and the world commodities balance.

PART II
COUNTRY CASE STUDIES

5. ECONOMIC IMPORTANCE OF AZOLES IN WHEAT: COUNTRY CASE STUDIES

Main results of the country case studies

The impact of a hypothetical loss of azoles differs among the different case studies that have been analysed:

- In Denmark, where the average self-sufficiency rate during the 2006-2010 period is slightly over 100%, the loss of azoles would cause the self-sufficiency rate to go below the 100% threshold, both in the short and long term, even if the Danish loss indices are the lowest of all country case studies. At farm level, the impact on gross margin ranges between -17% in the short term to -20% in the long term, while the decrease of the plant protection costs that would be necessary to compensate for the loss of azoles could range from 32% to 62%.

- France is a strong net exporter, with an average self-sufficiency rate equivalent to 188% in the 2006-2010 period. Thus, even in the absence of azoles, French self-sufficiency rate would not be significantly affected. At the same time, the contribution of azoles to the yield is particularly relevant, so in their absence the demand satisfaction rate would drop to 86% in the short term and to 76% in the long term. At farm level, the gross margin would considerably decrease, varying from -27% in the short term and -47% in the long term. To compensate for this loss, crop protection costs should be reduced by -48% and -83% respectively.

- The United Kingdom, with an average self-sufficiency rate of 105.5% during the 2006-2010 period, would lose its self-sufficiency in case of a withdrawal from use of azoles, although the strongest effects would be exerted in the long term rather than in the short term. At farm level, specialised English farms would suffer a strong reduction of the gross margin (ranging from -19% in the short term to -31% in the long term). To compensate for this loss, crop protection costs should be reduced by -43% and -72% respectively.

- Italy is a strong wheat importer: the average self-sufficiency rate for the period 2006-2010 was 48.1% for durum wheat and 61.9% for common wheat (therefore this rate will not be taken into consideration while examining the impact of the loss of azoles). As for the impact on yield and production, the absence of azoles would have a stronger influence in the long term than in the short term. At farm level (data are available only for the common wheat component) even if the gross margin reduction would be limited (-10% in the short term and -20% in the long term), crop protection costs would have to be cut drastically to compensate for this reduction, especially in the long term.

Assumptions

This chapter proposes an analysis of the economic impact of azoles at EU country level.

The countries that have been selected for the national-level analysis are Denmark, France, United Kingdom and Italy. The choice of the countries has taken into consideration different aspects, including the fact that they are representative of different trends and agricultural specificities across Europe.

Denmark is an example of a small country with a relatively low wheat production in comparison to the overall European production, but with a high level of average yield rate. On the other hand, France and the United Kingdom are large producers, but with a different trade balance, with France being a strong net exporter while the United Kingdom imports almost as much as it exports. Finally, Italy has a very distinct productive structure, because it is a large producer of both common and durum wheat: thus, the two cases will be separately analysed.

Table 5.1 - Weights of the four case-studies wheat production on total EU27 wheat production (2010)

Country	% of total EU27 production
Denmark	3.8
France	27.3
United Kingdom	11.0
Italy	5.4

Source: Nomisma elaborations on Eurostat data.

The impact analysis has been conducted on two levels:

1. on overall wheat production (scenario analysis), describing the consequences of an hypothetical loss of azoles for the country balance sheet, with the same methodological approach that was used for the EU-level analysis in chapter 2 of part I of the report;

2. at farm level (static analysis); in this case the analysis has estimated the contribution of azoles on single farms, calculating the impact of the hypothetical loss of azoles on profit margins. More specifically, the analysis has considered the gross margin, which is the output value from growing wheat, less the variable costs associated with the production of the crop.

In the scenario analysis, the single-country case studies differ from the EU-level analysis in some methodological aspects:

- stocks are not taken into consideration when analysing the change of variables required to maintain the demand satisfaction and the self-sufficiency rate at 100%. Given the limited impact that stocks could have on those scenarios, the choice of not using them will not affect the final considerations;

- it has to be considered that when we look at imports and exports, the single-country data refer also to intra-EU trade, that is the wheat which is imported from or exported to other European countries, whereas the EU-level analysis considers only extra-EU trade. Therefore, there can be diverging trends.

- the estimate of the changes that would be required to maintain the demand satisfaction rate at 100% and the self-sufficiency rate at 100% has been conducted for all cases except those where the self-sufficiency-rate would be either too high (France) or too low (Italy) to be significant (see schema below).

Country	International wheat trade	Scenario analysis developed
Denmark	Net exporter (self-sufficiency 2006-10: 101.9%)	Impact in the short and long term: • demand satisfaction • self-sufficiency
France	Net exporter (self-sufficiency 2006-10: 188.2%)	Impact in the short and long term: • demand satisfaction
United Kingdom	Net exporter (self-sufficiency 2006-10: 107.1%)	Impact in the short and long term: • demand satisfaction • self-sufficiency
Italy Durum wheat	Net importer (self-sufficiency 2006-10: 48.9%)	Impact in the short and long term: • demand satisfaction
Italy Common wheat	Net importer (self-sufficiency 2006-10: 61.9%)	Impact in the short and long term: • demand satisfaction

The impact analysis at farm level is relevant only at country level: in other words, this means that the results from different countries cannot be compared, due to the difference between the elements that influence the gross margin structure (farm size, machinery, labour costs, inputs costs, etc.). Consequently, this variable may not provide a reasonably representative view of similarities and difference between different countries. In order to guarantee the homogeneity of the sources, the study has been based on the EU FADN database, which gathers the balance sheets of a wide sample of farms specialised in common wheat production. Due to the composition of the sample, which includes better-performing farms, some indicators (e.g. yields) are not comparable with those resulting from the scenario analysis.

The Baseline setting has been derived from a 2006-2010 average of the main balance sheet indicators, calculated on an hectare basis (€/ha). Subsequently, the impact on receipts of reduced yield has been estimated, leaving all other balance sheet indicators unchanged (including crop protection costs, since specific data on azoles costs are not available).

The analysis follows a static approach, focussing on the impact of the potential loss of azoles on farm balance sheets as a result of the production reduction (i.e. yield reduction).

Actually many variables affect farm budget (such as energy costs, input costs, prices etc.) and they should be taken into account in the analysis. However, such factors are subject to a high level of variability that makes it very difficult to predict their future value and the final composition of farm balance sheets. This is why it has been decided to carry out the risk analysis in the dynamic/macroeconomic part of the study, while in the present section a static analysis has been conducted, where all these variables are kept constant.

The tables, therefore, show the impact that the reduced production will exert at the actual conditions on the short term and on the long term, estimating the reduction of plant protection costs necessary to compensate gross margin decrease for the different scenarios.

6. ECONOMIC IMPORTANCE OF AZOLES IN WHEAT: DENMARK CASE STUDY

Denmark case study: general considerations

At present Denmark produces 5.1 million tons of wheat and this production is projected to grow both in 2013 and in 2020. The self-sufficiency rate is slightly over 100% and it would remain on this level both in the short and long term, thanks to the high level of yields, which at present stand at 7.22 tons per hectare, almost two points above the European average of 5.2.

In Denmark, the impact of a hypothetical loss of azoles is very similar in the short term and in the long term, since it is a country - together with Italy - where the contribution of azoles has the lowest impact on production.

The estimate is that azoles contribute to 5% of the total yield, so in their absence the production would decrease of 0.2 million tons, resulting in a reduction of the demand satisfaction rate. In order to compensate for this loss of production and to fully satisfy the national demand, given the decline of the yield, it would be theoretically possible to intervene by extending the cultivated area (+4.2%), or by reducing the exports (-28%) or by increasing the imports (+35.9%). To guarantee a 100% self-sufficiency rate in the short term, it would be necessary to extend the area cultivated with wheat by 0.9%; or to cut the exports of wheat by 6.2%; or to increase the imports by 7.9%.

In the long term, a hypothetical loss of azoles would result in a reduction of production (-0.3 million tons). The demand satisfaction rate would drop to 94.1% and the self-sufficiency degree to 95.8%. In the long term, the quantity of wheat required to guarantee a 100% demand satisfaction rate would be 334.6 thousand tons (equivalent to 82.9 million euros). The changes needed to compensate for this loss of production in order to re-establish a 100% demand satisfaction rate would be an increase of 4.8% in the cultivated area; or a strong reduction of exports (-36.7%), or an equally strong increase in imports (+ 42.2%). As already mentioned, a loss of azoles would have a deep impact also on the self-sufficiency rate. The quantity of wheat needed to guarantee a 100% self-sufficiency rate in the long term would be 239.4 thousand tons (equivalent to 59.3 million euros). In terms of required adjustments, the preservation of a 100% self-sufficiency rate would require an increase of 3.1% in the cultivated area; or a reduction of 23.6% of exports; or an increase of 27.2% in imports.

At farm level, Denmark shows the lowest gross margin among the country-case studies (249 €/ha in the period 2006-2010), but also a less strong yield loss in case of a loss of azoles. Therefore the consequent contractions of gross margin vary between 31 and 60 €/ha (from -12% to -24%), with few differences between the short term and the long term. The decrease of plant protection costs that would be necessary to compensate for the decrease of the gross margin vary between -32% and -62%.

Table 6.1 - Wheat crop structural trends in Denmark: 2013 and 2020 baseline scenarios

	Present situation (avg 2006-10)	Short term 2013	Long term 2020	Variation	
	Baseline setting	Reference scenario T_1	Reference scenario T_2	Scenario T_1 from Baseline setting	Scenario T_2 from Baseline setting
Yield (t/ha)	7.22	7.41	7.80	2.6%	8.1%
Area (,000 ha)	702.2	732.3	744.4	4.3%	6.0%
BALANCE SHEET (.million t)					
Production (A)	5.1	5.4	5.8	7.0%	14.6%
Import (B)	0.65	0.61	0.63	-6.4%	-1.9%
Export (C)	0.74	0.77	0.73	4.6%	-1.4%
Net trade (D=C-B)	0.09	0.17	0.10		
Domestic availability (E=A+B-C)	5.0	5.3	5.7	5.6%	14.9%
Demand (F)	5.0	5.3	5.7	5.6%	14.9%
Demand satisfaction rate (E/F)	100.0%	100.0%	100.0%	-	-
Self-sufficiency degree (A/F)	101.9%	103.2%	101.7%	1.3%	-0.2%

Source: Nomisma elaborations on Eurostat, European Commission and FAO data.

Table 6.2 – Denmark: yield loss index in the hypothesis of a loss of azoles (2013 and 2020)

Yield reference scenario (t/ha)	Short term T_1 (2013)		Long term T_2 (2020)	
	7.41		7.80	
Yield "No azoles" scenarios	Impact of loss of azoles		Impact of loss of azoles + resistance effect	
	Loss index	Yield (t/ha)	Loss index	Yield (t/ha)
"No azoles" scenario (A)	5.0%	7.04	5.8%	7.35
"No azoles" best scenario (A-20%)	4.0%	7.11	4.6%	7.44
"No azoles" worst scenario (A+20%)	6.0%	6.96	6.9%	7.26

Source: Nomisma elaborations on Blake J. et al. (2011) and Salinari F. et al. (2011) data.

Loss of azoles in Denmark: impact on wheat crop in the short term (2013)

Table 6.3 –Denmark scenario analysis: short-term impact in the hypothesis of a loss of azoles (2013)

	Short term 2013			
	Reference scenario T_1	"No azoles" scenario T_1	"No azoles" best scenario T_1	"No azoles" worst scenario T_1
Yield (t/ha)	7.41	7.04	7.11	6.96
Area (,000 ha)	732.3	732.3	732.3	732.3
BALANCE SHEET (.million t)				
Production (A)	5.42	5.15	5.21	5.10
Import (B)	0.61	0.61	0.61	0.61
Export (C)	0.77	0.77	0.77	0.77
Net trade (D=C-B)	0.17	0.17	0.17	0.17
Domestic availability (E=A+B-C)	5.26	4.98	5.04	4.93
Demand (F)	5.26	5.26	5.26	5.26
Demand satisfaction rate (E/F)	100.0%	94.8%	95.9%	93.8%
Self-sufficiency degree (A/F)	103.2%	98.1%	99.1%	97.0%

Source: Nomisma elaborations.

Loss of azoles in Denmark: preservation of the demand satisfaction rate in the short term (2013)

Figure 6.1 –Denmark, demand satisfaction preservation in the short term: production impact in the hypothesis of a loss of azoles (2013)
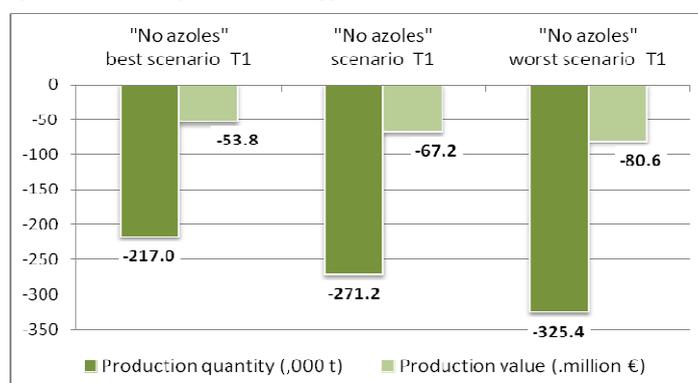
Value= production * EU price

Source: Nomisma elaborations.

Table 6.4 – Denmark: variables changes required to preserve a 100% demand satisfaction rate in the short term (2013)

	"No azoles" best scenario T_1	"No azoles" scenario T_1	"No azoles" worst scenario T_1
Variation production (,000 t)	-217.0	-271.2	-325.4
AREA IMPACT			
Variation area (,000 ha)	30.5	38.5	46.7
Variation area (%)	4.2%	5.3%	6.4%
NET BALANCE IMPACT			
Variation export (%)	-28.0%	-35.0%	-42.0%
Variation import (%)	35.9%	44.8%	53.8%

Source: Nomisma elaborations.

Loss of azole in Denmark: preservation of self-sufficiency rate in the short term (2013)

Figure 6.2 – Denmark, self-sufficiency preservation in the short term: production impact in the hypothesis of loss of azoles (2013)
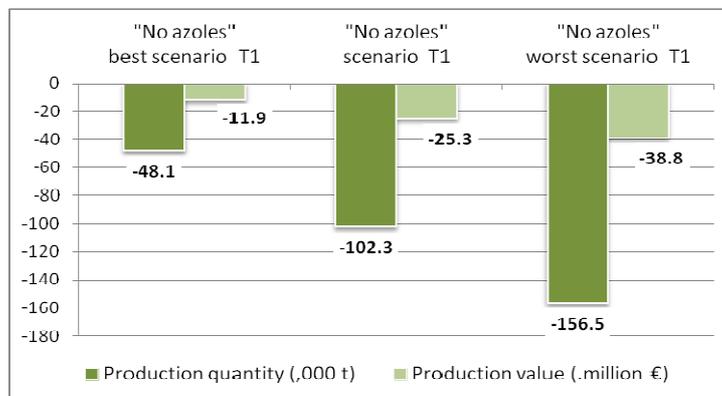
Value= production * EU price

Source: Nomisma elaborations.

Table 6.5 – Denmark: variables changes required to preserve a 100% self-sufficiency rate in the short term (2013)

	"No azoles" best scenario T_1	"No azoles" scenario T_1	"No azoles" worst scenario T_1
Variation production (,000 t)	-48.1	-102.3	-156.5
AREA IMPACT			
Variation area (,000 ha)	6.8	14.5	22.5
Variation area (%)	0.9%	2.0%	3.1%
NET BALANCE IMPACT			
Variation export (%)	-6.2%	-13.2%	-20.2%
Variation import (%)	7.9%	16.9%	25.9%

Source: Nomisma elaborations.

Loss of azoles in Denmark: impact on wheat crop in the long term

Table 6.6 – Denmark scenario analysis: long-term impact in the hypothesis of loss of azoles (2020)

	Long term 2020			
	Reference scenario T_2	"No azoles" scenario T_2	"No azoles" best scenario T_2	"No azoles" worst scenario T_2
Yield (t/ha)	7.80	7.35	7.44	7.26
Area (,000 ha)	744.4	744.4	744.4	744.4
BALANCE SHEET (.million t)				
Production (A)	5.81	5.47	5.54	5.41
Import (B)	0.63	0.63	0.63	0.63
Export (C)	0.73	0.73	0.73	0.73
Net trade (D=C-B)	0.10	0.10	0.10	0.10
Domestic availability (E=A+B-C)	5.71	5.38	5.45	5.31
Demand (F)	5.71	5.71	5.71	5.71
Demand satisfaction rate (E/F)	100.0%	94.1%	95.3%	93.0%
Self-sufficiency degree (A/F)	101.7%	95.8%	97.0%	94.6%

Source: Nomisma elaborations.

Loss of azoles in Denmark: preservation of the demand satisfaction rate in the long term (2020)

Figure 6.3 – Denmark, demand satisfaction preservation in the long term: production impact in the hypothesis of a loss of azoles (2020)
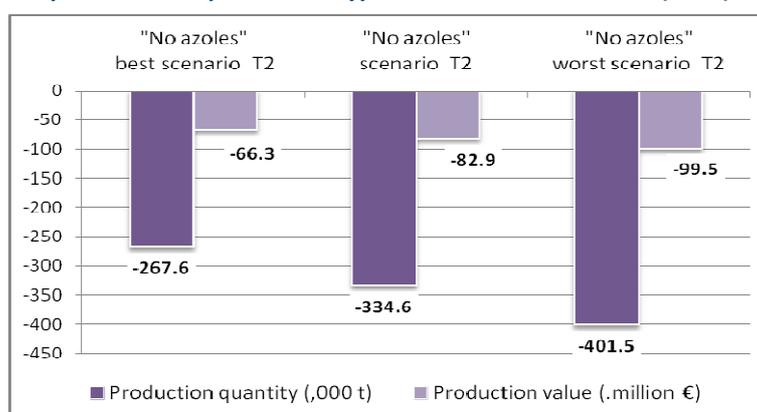
Value= production * EU price

Source: Nomisma elaborations.

Table 6.7 – Denmark: variables changes required to preserve a 100% demand satisfaction rate in the long term (2020)

	"No azoles" best scenario T_2	"No azoles" scenario T_2	"No azoles" worst scenario T_2
Variation production (,000 t)	-267.6	-334.6	-401.5
AREA IMPACT			
Variation area (,000 ha)	36.0	45.5	55.3
Variation area (%)	4.8%	6.1%	7.4%
NET BALANCE IMPACT			
Variation export (%)	-36.7%	-45.9%	-55.0%
Variation import (%)	42.2%	52.7%	63.3%

Source: Nomisma elaborations.

Loss of azoles in Denmark: preservation of self-sufficiency rate in the long term (2020)

Figure 6.4 – Denmark, self-sufficiency preservation in the long term: production impact in the hypothesis of a loss of azoles (2020)
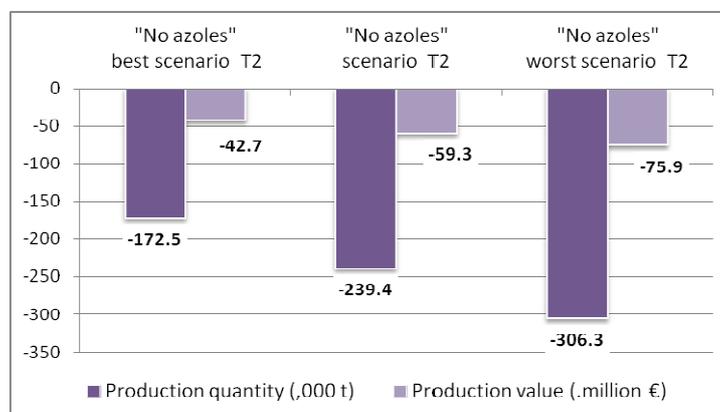
Value= production * EU price

Source: Nomisma elaborations.

Table 6.8 – Denmark: variables changes required to preserve a 100% self-sufficiency rate in the long term (2020)

	"No azoles" best scenario T2	"No azoles" scenario T2	"No azoles" worst scenario T2
Variation production (,000 t)	-172.5	-239.4	-306.3
AREA IMPACT			
Variation area (,000 ha)	23.2	32.5	42.2
Variation area (%)	3.1%	4.4%	5.7%
NET BALANCE IMPACT			
Variation export (%)	-23.6%	-32.8%	-42.0%
Variation import (%)	27.2%	37.7%	48.3%

Source: Nomisma elaborations.

Loss of azoles in Denmark: impact at farm level

Table 6.9 – Danish farm specialised in the production of wheat: Gross margin calculation (average 2006-10)

Denmark - Baseline setting	avg 2006-10
Yield (t/ha)	7.1
Price	143
Receipts (€/ha)	**1,041**
Grain	1,000
By-products (straw)	41
Coupled direct payments	0
Operating costs (€/ha)	**792**
Specific costs	*367*
Seeds	67
Fertilizers	136
Crop protection	98
Other specific costs	67
Non-specific costs	*425*
Motor fuels and lubricants	54
Machines and building upkeep	160
Contract work	74
Energy	16
Other direct costs	122
Gross margin (€/ha)	**249**

Source: Nomisma elaborations on EU FADN data.

Table 6.10 – Danish farm specialised in the production of wheat:
impact on Gross margin in the hypothesis of a loss of azoles in the short (2013) and long term (2020)

€/ha	Baseline setting (avg 2006-10)	Short term 2013			Long term 2020		
		"No azoles" scenario T_1	"No azoles" Best scenario T_1	"No azoles" Worst scenario T_1	"No azoles" scenario T_2	"No azoles" Best scenario T_2	"No azoles" Worst scenario T_2
Yield (t/ha)	7.1	6.73	6.80	6.66	6.67	6.75	6.59
Receipts	1,041	1,000	1,010	990	992	1004	980
Operating costs	792	792	792	792	792	792	792
Gross margin	249	208	218	197	200	211	188
Gross margin variation from Reference Scenario	€/ha	-41	-31	-51	-49	-37	-60
	%	-17%	-12%	-21%	-20%	-15%	-24%
Required reduction of crop protection costs	%	-42%	-32%	-52%	-50%	-38%	-62%

Source: Nomisma elaborations on EU FADN data.

7. ECONOMIC IMPORTANCE OF AZOLES IN WHEAT: FRANCE CASE STUDY

France case study: general considerations

France is one of the most important producers of wheat in the European Union (roughly 27% of all European wheat production is French). This predominance is estimated to continue in the next years, with a projected growth of current production (+3.9% in 2013 and + 13.1% in 2020).

France is a structural net exporter, selling half of its wheat production outside its national borders. This means that the French self-sufficiency degree is much higher than that of other European countries (188.2% is the 2006-2010 average), so much that even in the case of a loss of azoles, the self-sufficiency degree would not go below 100%. Therefore, the analysis has been concentrated on the demand satisfaction rate and has not taken into consideration the evolution of the self-sufficiency degree.

In case of a loss of azoles, production would decrease by 3.1 million tons (corresponding to 756 million euros) in the short term, resulting in a drastic reduction of the demand satisfaction rate (from 100% to 86.0% in 2013). To maintain a 100% demand satisfaction rate, France should increase the wheat cultivated area by 8.7%; or cutting the exports by 17.3%; or increasing the imports by 244.2%.

The effect of losing azoles would be just as strong in 2020. The production decrease would be of 5.7 million tons (corresponding to 1,404 million euros), with a consequent reduction of the demand satisfaction rate, that would drop below 100% to 74.7%. To compensate for this loss of production and to guarantee a 100% demand satisfaction rate, it would be necessary to increase the cultivated area by 15.8%; or to reduce the exports by 28.0%; or to increase the imports by 527.0%.

The French farms specialised in the production of wheat show for the period 2006-2010 an average gross margin of 311 €/ha (without coupled direct payments). The reduction of the yield linked to the contribution of azoles is the strongest of all case studies, resulting in a gross margin decrease that in the different scenarios would range from 22% to 33% in the short term (which is from -67 €/ha to -102 €/ha), and from 37% to 56% in the long term (which is from -116 €/ha to -146 €/ha). To compensate for this decrease, crop protection costs should be strongly reduced respectively by 38%-58% in the short term and by 66%-99% in the long term.

Table 7.1 - Wheat crop structural trends in France: 2013 and 2020 baseline scenarios

	Present situation (avg 2006-10)	Short term 2013	Long term 2020	Variation	
	Baseline setting	Reference scenario T_1	Reference scenario T_2	Scenario T_1 from Baseline setting	Scenario T_2 from Baseline setting
Yield (t/ha)	6.92	7.06	7.32	2.1%	5.9%
Area (,000 ha)	5,310.6	5,403.7	5,673.4	1.8%	6.8%
BALANCE SHEET (.million t)					
Production (A)	36.7	38.2	41.6	3.9%	13.1%
Import (B)	1.25	1.25	1.08	-0.1%	-14.1%
Export (C)	18.47	17.63	20.26	-4.5%	9.7%
Net trade (D=C-B)	17.22	16.38	19.19		
Domestic availability (E=A+B-C)	19.5	21.8	22.4	11.5%	14.6%
Demand (F)	19.5	21.8	22.4	11.5%	14.6%
Demand satisfaction rate (E/F)	100.0%	100.0%	100.0%		
Self-sufficiency degree (A/F)	188.2%	175.3%	185.8%	-6.9%	-1.3%

Source: Nomisma elaborations on Eurostat, European Commission and FAO data.

Table 7.2 – France: yield loss index in the hypothesis of a loss of azoles (2013 and 2020)

Yield reference scenario (t/ha)	Short term T_1 (2013)		Long term T_2 (2020)	
	7.06		7.32	
Yield "No azoles" scenarios	Impact of loss of azoles		Impact of loss of azoles + resistance effect	
	Loss index	Yield (t/ha)	Loss index	Yield (t/ha)
"No azoles" scenario (A)	8.0%	6.50	13.6%	6.32
"No azoles" best scenario (A-20%)	6.4%	6.61	10.9%	6.52
"No azoles" worst scenario (A+20%)	9.6%	6.38	16.4%	6.13

Source: Nomisma elaborations on Blake J. et al. (2011) and Salinari F. et al. (2011) data.

Loss of azoles in France: impact on wheat crop in the short term (2013)

Table 7.3 – France scenario analysis: short-term impact in the hypothesis of a loss of azoles (2013)

	Short term 2013			
	Reference scenario T_1	"No azoles" scenario T_1	"No azoles" best scenario T_1	"No azoles" worst scenario T_1
Yield (t/ha)	7.06	6.50	6.61	6.38
Area (,000 ha)	5,403.7	5,403.7	5,403.7	5,403.7
BALANCE SHEET (.million t)				
Production (A)	38.2	35.1	35.7	34.5
Import (B)	1.25	1.25	1.25	1.25
Export (C)	17.63	17.63	17.63	17.63
Net trade (D=C-B)	16.38	16.38	16.38	16.38
Domestic availability (E=A+B-C)	21.8	18.7	19.3	18.1
Demand (F)	21.8	21.8	21.8	21.8
Demand satisfaction rate (E/F)	100.0%	86.0%	88.8%	83.2%
Self-sufficiency degree (A/F)	175.3%	161.2%	164.0%	158.4%

Source: Nomisma elaborations.

Loss of azoles in France: preservation of the demand satisfaction rate in the short term (2013)

Figure 7.1 –France, demand satisfaction preservation in the short term: production impact in the hypothesis of a loss of azoles (2013)
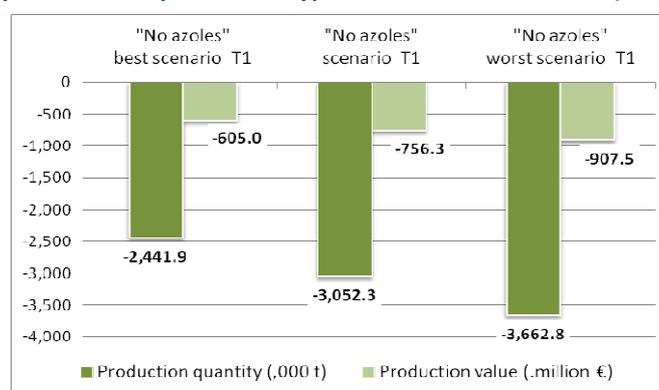
Value= production * EU price

Source: Nomisma elaborations.

Table 7.4 – France: variables changes required to preserve a 100% demand satisfaction rate in the short term (2013)

	"No azoles" best scenario T_1	"No azoles" scenario T_1	"No azoles" worst scenario T_1
Variation production (.million t)	-2.4	-3.1	-3.7
AREA IMPACT			
Variation area (,000 ha)	369.5	469.9	573.8
Variation area (%)	6.8%	8.7%	10.6%
NET BALANCE IMPACT			
Variation export (%)	-13.8%	-17.3%	-20.8%
Variation import (%)	195.4%	244.2%	293.0%

Source: Nomisma elaborations.

Loss of azoles in France: impact on wheat crop in the long term

Table 7.5 – France scenario analysis: long-term impact in the hypothesis of loss of azoles (2020)

	Long term 2020			
	Reference scenario T_2	"No azoles" scenario T_2	"No azoles" best scenario T_2	"No azoles" worst scenario T_2
Yield (t/ha)	7.32	6.32	6.52	6.13
Area (,000 ha)	5,673.4	5,673.4	5,673.4	5,673.4
BALANCE SHEET (.million t)				
Production (A)	41.6	35.9	37.0	34.8
Import (B)	1.08	1.1	1.1	1.1
Export (C)	20.26	20.3	20.3	20.3
Net trade (D=C-B)	19.19	19.2	19.2	19.2
Domestic availability (E=A+B-C)	22.4	16.7	17.8	15.6
Demand (F)	22.4	22.4	22.4	22.4
Demand satisfaction rate (E/F)	100.0%	74.7%	79.7%	69.6%
Self-sufficiency degree (A/F)	185.8%	160.4%	165.5%	155.4%

Source: Nomisma elaborations.

Loss of azoles in France: preservation of the demand satisfaction rate in the long term (2020)

Figure 7.2 – France, demand satisfaction preservation in the long term: production impact in the hypothesis of a loss of azoles (2020)
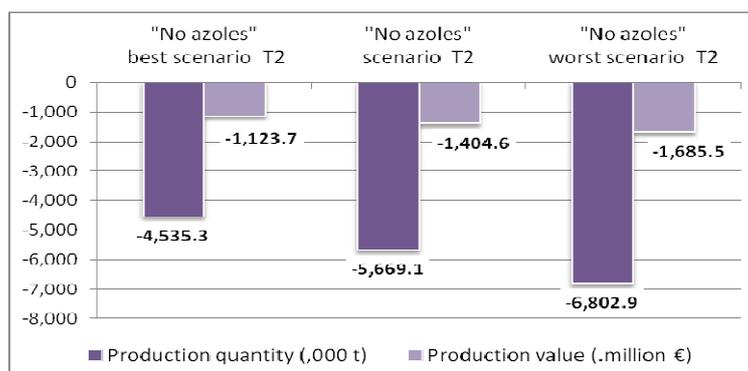
Value= production * EU price

Source: Nomisma elaborations.

Table 7.6 – France: variables changes required to preserve a 100% demand satisfaction rate in the long term (2020)

	"No azoles" best scenario T_2	"No azoles" scenario T_2	"No azoles" worst scenario T_2
Variation production (.million t)	-4.5	-5.7	-6.8
AREA IMPACT			
Variation area (,000 ha)	695.1	896.3	1,110.7
Variation area (%)	12.3%	15.8%	19.6%
NET BALANCE IMPACT			
Variation export (%)	-22.4%	-28.0%	-33.6%
Variation import (%)	421.6%	527.0%	632.4%

Source: Nomisma elaborations.

Loss of azoles in France: impact at farm level

Table 7.7 – French farm specialised in the production of wheat: Gross margin calculation (average 2006-10)

France - Baseline setting	avg 2006-10
Yield (t/ha)	7,4
Price	146
Receipts (€/ha)*	**1,087**
Grain	1,077
By-products (straw)	9
Coupled direct payments	84
Operating costs (€/ha)	**776**
Specific costs	*449*
Seeds	64
Fertilizers	208
Crop protection	176
Other specific costs	0
Non-specific costs	*327*
Motor fuels and lubricants	59
Machines and building upkeep	78
Contract work	64
Energy	9
Other direct costs	117
Gross margin (€/ha)	**311**

*Without coupled direct payments

Source: Nomisma elaborations on EU FADN data.

Table 7.8 – French farm specialised in the production of wheat:
impact on Gross margin in the hypothesis of a loss of azoles in the short (2013) and long term (2020)

€/ha	Baseline setting (avg 2006-10)	Short term 2013			Long term 2020		
		"No azoles" scenario T_1	"No azoles" Best scenario T_1	"No azoles" Worst scenario T_1	"No azoles" scenario T_2	"No azoles" Best scenario T_2	"No azoles" Worst scenario T_2
Yield (t/ha)	7.4	6.79	6.91	6.67	6.37	6.57	6.17
Receipts*	1,087	1,002	1,019	985	941	970	912
Operating costs	776	776	776	776	776	776	776
Gross margin	311	226	243	209	165	195	136
Gross margin variation from Reference Scenario	€/ha	-85	-67	-102	-146	-116	-175
	%	-27%	-22%	-33%	-47%	-37%	-56%
Required reduction of crop protection costs	%	-48%	-38%	-58%	-83%	-66%	-99%

*Without coupled direct payments

Source: Nomisma elaborations on EU FADN data.

8. ECONOMIC IMPORTANCE OF AZOLES IN WHEAT: UNITED KINGDOM CASE STUDY

United Kingdom case study: general considerations

In the United Kingdom, the current production of wheat accounts for approximately 14.8 million tons and is estimated to grow in the next years, to reach up to 15.6 million tons in 2013 and 16.6 million tons in 2020. As for the trade balance, the United Kingdom shows a positive balance (self-sufficiency 2006-2010 105.5%); in the next years imports are expected to diminish, while the exports should grow, resulting in an increasingly positive balance trade.

In the short term (2013) under the hypothesis of a loss of azoles, the United Kingdom would lose 1.1 million tons of wheat (corresponding to 262.5 million euros). In terms of demand satisfaction, the hypothetical loss of azoles would strongly affect domestic availability and send the demand satisfaction rate below 100% to 92.7%. To compensate for the loss of production and to guarantee a 100% demand satisfaction rate it would be necessary to increase the cultivated area by 5.8%, or to cut the export by 29.3% or to increase the imports by 45.5%. As for the self-sufficiency degree, in the short term it would be slightly affected and most likely go below 100%. To guarantee the 100% threshold, the United Kingdom should increase the cultivated area by 0.2%; or the imports by 1.7%; or cut the exports by 1.1%.

In the long term (2020), a hypothetical loss of azoles would cause an estimated drop of wheat production of 1.8 million tons (corresponding to 451.0 million euros). The reduced production would in turn push the demand satisfaction rate under 100%. To guarantee a 100% demand satisfaction rate, the United Kingdom could increase the cultivated area by 12.3%; or its imports by 93.9%; or cut the exports by 63.6%. The self-sufficiency rate would also drop below 100%, and the adjustments required to pull it back to at least a 100% level would still be significant: the cultivated area should be expanded by 6.1%; or the imports increased by 31.4%; or the exports cut by 46.3%.

At farm level, the United Kingdom shows the highest gross margin (an average of 414 €/ha in the 2006-2010 period) among the four case studies, which partly compensates the strong yield reduction that would take place were the azoles withdrawn. The consequent variations in the gross margin, even if strong in absolute terms (from 60 €/ha to 94 €/ha), are more limited in relative terms (from -15% to -23% in the short term). In the long term the impact is stronger, and gross margin would be reduced by 25%-38% (or 102-157 €/ha). To compensate for this loss, plant protection costs should decrease by 43% in the short term and by 72% in the long term.

Table 8.1 - Wheat crop structural trends in the United Kingdom: 2013 and 2020 baseline scenarios

	Present situation (avg 2006-10)	Short term 2013	Long term 2020	Variation	
	Baseline setting	Reference scenario T$_1$	Reference scenario T$_2$	Scenario T$_1$ from Baseline setting	Scenario T$_2$ from Baseline setting
Yield (t/ha)	7.66	7.76	8.30	1.3%	8.4%
Area (,000 ha)	1,936.5	2,008.6	1,994.3	3.7%	3.0%
BALANCE SHEET (.million t)					
Production (A)	14.8	15.6	16.6	5.1%	11.7%
Import (B)	1.93	1.86	1.94	-3.6%	0.2%
Export (C)	2.71	2.89	2.86	6.8%	5.7%
Net trade (D=C-B)	0.77	1.03	0.92		
Domestic availability (E=A+B-C)	14.1	14.6	15.6	3.5%	11.2%
Demand (F)	14.1	14.6	15.6	3.5%	11.2%
Demand satisfaction rate (E/F)	100.0%	100.0%	100.0%	-	-
Self-sufficiency degree (A/F)	105.5%	107.1%	105.9%	1.5%	0.4%

Source: Nomisma elaborations on Eurostat, European Commission and FAO data.

Table 8.2 – United Kingdom: yield loss index in the hypothesis of a loss of azoles (2013 and 2020)

	Short term T$_1$ (2013)		Long term T$_2$ (2020)	
Yield reference scenario (t/ha)	7.76		8.30	
Yield "No azoles" scenarios	Impact of loss of azoles		Impact of loss of azoles + resistance effect	
	Loss index	Yield (t/ha)	Loss index	Yield (t/ha)
"No azoles" scenario (A)	6.8%	7.23	11.0%	7.39
"No azoles" best scenario (A-20%)	5.4%	7.34	8.8%	7.57
"No azoles" worst scenario (A+20%)	8.2%	7.12	13.2%	7.21

Source: Nomisma elaborations on Blake J. et al. (2011) and Salinari F. et al. (2011) data.

Loss of azoles in United Kingdom: impact on wheat crop in the short term (2013)

Table 8.3 – United Kingdom scenario analysis: short-term impact in the hypothesis of a loss of azoles (2013)

	Short term 2013			
	Reference scenario T_1	"No azoles" scenario T_1	"No azoles" best scenario T_1	"No azoles" worst scenario T_1
Yield (t/ha)	7.76	7.23	7.34	7.12
Area (,000 ha)	2,008.6	2,008.6	2,008.6	2,008.6
BALANCE SHEET (.million t)				
Production (A)	15.6	14.5	14.7	14.3
Import (B)	1.86	1.86	1.86	1.86
Export (C)	2.89	2.89	2.89	2.89
Net trade (D=C-B)	1.03	1.03	1.03	1.03
Domestic availability (E=A+B-C)	14.6	13.5	13.7	13.3
Demand (F)	14.6	14.6	14.6	14.6
Demand satisfaction rate (E/F)	100.0%	92.7%	94.2%	91.3%
Self-sufficiency degree (A/F)	107.1%	99.8%	101.2%	98.3%

Source: Nomisma elaborations.

Loss of azoles in UK: preservation of the demand satisfaction rate in the short term (2013)

Figure 8.1 –United Kingdom, demand satisfaction preservation in the short term: production impact in the hypothesis of a loss of azoles (2013)
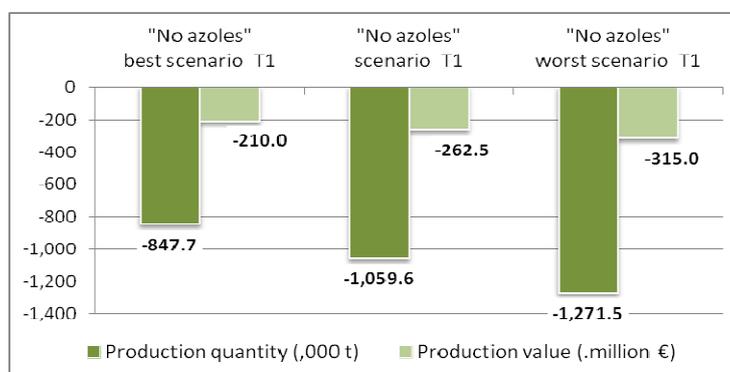
Value= production * EU price

Source: Nomisma elaborations.

**Table 8.4 – United Kingdom: variables changes required
to preserve a 100% demand satisfaction rate in the short term (2013)**

	"No azoles" best scenario T_1	"No azoles" scenario T_1	"No azoles" worst scenario T_1
Variation production (,000 t)	-847.7	-1,059.6	-1,271.5
AREA IMPACT			
Variation area (,000 ha)	115.6	146.5	178.5
Variation area (%)	5.8%	7.3%	8.9%
NET BALANCE IMPACT			
Variation export (%)	-29.3%	-36.7%	-44.0%
Variation import (%)	45.5%	56.9%	68.3%

Source: Nomisma elaborations.

Loss of azoles in UK: preservation of self-sufficiency rate in the short term (2013)

Figure 8.2 – United Kingdom, self-sufficiency preservation in the short term: production impact in the hypothesis of loss of azoles (2013)

Value= production * EU price

Source: Nomisma elaborations.

Table 8.5 – United Kingdom: variables changes required to preserve a 100% self-sufficiency rate in the short term (2013)

	"No azoles" best scenario T_1	"No azoles" scenario T_1	"No azoles" worst scenario T_1
Variation production (,000 t)	180.3	-31.6	-243.6
AREA IMPACT			
Variation area (,000 ha)	-24.6	4.4	34.2
Variation area (%)	-1.2%	0.2%	1.7%
NET BALANCE IMPACT			
Variation export (%)	6.2%	-1.1%	-8.4%
Variation import (%)	-9.7%	1.7%	13.1%

Source: Nomisma elaborations.

Loss of azoles in United Kingdom: impact on wheat crop in the long term

Table 8.6 – United Kingdom scenario analysis: long-term impact in the hypothesis of loss of azoles (2020)

| | Long term 2020 | | | |
	Reference scenario T_2	"No azoles" scenario T_2	"No azoles" best scenario T_2	"No azoles" worst scenario T_2
Yield (t/ha)	8.30	7.39	7.57	7.21
Area (,000 ha)	1,994.3	1,994.3	1,994.3	1,994.3
BALANCE SHEET (.million t)				
Production (A)	16.6	14.7	15.1	14.4
Import (B)	1.94	1.9	1.9	1.9
Export (C)	2.86	2.9	2.9	2.9
Net trade (D=C-B)	0.92	0.9	0.9	0.9
Domestic availability (E=A+B-C)	15.6	13.8	14.2	13.5
Demand (F)	15.6	15.6	15.6	15.6
Demand satisfaction rate (E/F)	100.0%	88.4%	90.7%	86.0%
Self-sufficiency degree (A/F)	105.9%	94.3%	96.6%	91.9%

Source: Nomisma elaborations.

Loss of azoles in UK: preservation of the demand satisfaction rate in the long term (2020)

Figure 8.3 – United Kingdom, demand satisfaction preservation in the long term: production impact in the hypothesis of a loss of azoles (2020)
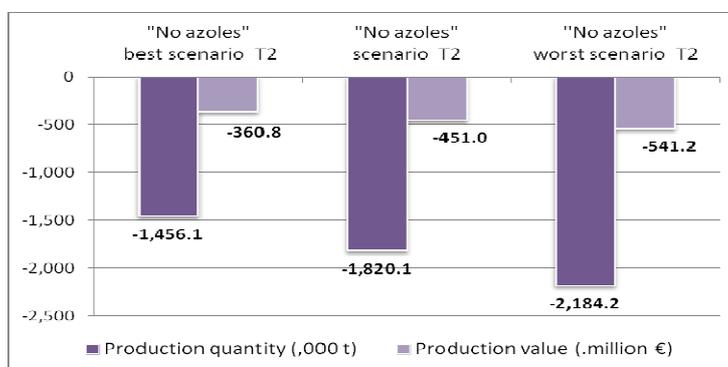
Value= production * EU price
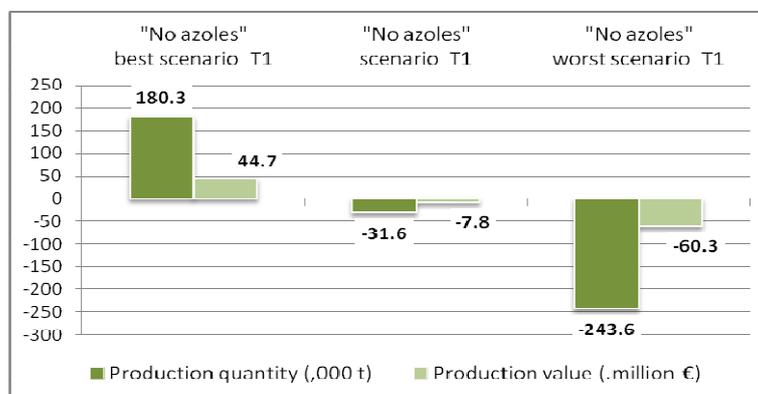
Source: Nomisma elaborations.

Table 8.7 – United Kingdom: variables changes required to preserve a 100% demand satisfaction rate in the long term (2020)

	"No azoles" best scenario T_2	"No azoles" scenario T_2	"No azoles" worst scenario T_2
Variation production (,000 t)	-1,456.1	-1,820.1	-2,184.2
AREA IMPACT			
Variation area (,000 ha)	192.3	246.3	303.0
Variation area (%)	9.6%	12.3%	15.2%
NET BALANCE IMPACT			
Variation export (%)	-50.9%	-63.6%	-76.4%
Variation import (%)	75.2%	93.9%	112.7%

Source: Nomisma elaborations.

Loss of azoles in UK: preservation of self-sufficiency rate in the long term (2020)

Figure 8.4 – United Kingdom, self-sufficiency preservation in the long term: production impact in the hypothesis of a loss of azoles (2020)

Value= production * EU price

Source: Nomisma elaborations.

Table 8.8 – United Kingdom: variables changes required to preserve a 100% self-sufficiency rate in the long term (2020)

	"No azoles" best scenario T_2	"No azoles" scenario T_2	"No azoles" worst scenario T_2
Variation production (,000 t)	-533.5	-897.6	-1,261.6
AREA IMPACT			
Variation area (,000 ha)	70.4	121.4	175.0
Variation area (%)	3.5%	6.1%	8.8%
NET BALANCE IMPACT			
Variation export (%)	-18.7%	-31.4%	-44.1%
Variation import (%)	27.5%	46.3%	65.1%

Source: Nomisma elaborations.

Loss of azoles in United kingdom: impact at farm level

Table 8.9 – English farm specialised in the production of wheat: Gross margin calculation (average 2006-10)

United Kingdom - Baseline setting	avg 2006-10
Yield (t/ha)	8.4
Price	148
Receipts (€/ha)	**1,276**
Grain	1,241
By-products (straw)	35
Coupled direct payments	0
Operating costs (€/ha)	**862**
Specific costs	*471*
Seeds	71
Fertilizers	186
Crop protection	179
Other specific costs	34
Non-specific costs	*391*
Motor fuels and lubricants	83
Machines and building upkeep	113
Contract work	79
Energy	21
Other direct costs	95
Gross margin (€/ha)	**414**

Source: Nomisma elaborations on EU FADN data.

Table 8.10 – English farm specialised in the production of wheat:
impact on Gross margin in the hypothesis of a loss of azoles in the short (2013) and long term (2020)

€/ha	Baseline setting (avg 2006-10)	Short term 2013			Long term 2020		
		"No azoles" scenario T_1	"No azoles" Best scenario T_1	"No azoles" Worst scenario T_1	"No azoles" scenario T_2	"No azoles" Best scenario T_2	"No azoles" Worst scenario T_2
Yield (t/ha)	8.4	7.87	7.98	7.75	7.51	7.70	7.33
Receipts*	1,276	1,199	1,216	1,182	1,146	1,174	1,119
Operating costs	862	862	862	862	862	862	862
Gross margin	414	337	354	320	284	312	257
Gross margin variation from Reference Scenario	€/ha	-77	-60	-94	-129	-102	-157
	%	-19%	-15%	-23%	-31%	-25%	-38%
Required reduction of crop protection costs	%	-43%	-34%	-53%	-72%	-57%	-88%

Source: Nomisma elaborations on EU FADN data.

9. ECONOMIC IMPORTANCE OF AZOLES IN WHEAT: ITALY DURUM WHEAT CASE STUDY

Italy durum wheat case study: general considerations

The current production of durum wheat is roughly 4.1 million tons and is projected to increase by 9.4% in 2013 and by 14.4% in 2020. However, the constant increase in durum wheat production would not be strong enough to satisfy the growing internal demand. Parallel to that, imports are estimated to increase (+5.2% in 2013 and +3.1% in 2020).

Italy is, in fact, a net importer of durum wheat: roughly half of the durum wheat that is consumed in Italy comes from abroad, so that the self-sufficiency rate is particularly low (48.1% in the period 2006-2010). This is the reason why the scenario analysis does not take into consideration this rate.

Under the hypothesis of a loss of azoles, given their limited use, the reduction of production in the short term (2013) would not be as strong as in the other countries (-0.159 million tons, corresponding to 39.4 million euros). However, the demand satisfaction rate would drop to 98.3%. To guarantee a 100% demand satisfaction rate the required adjustments would be an expansion of durum wheat cultivated area by 3.7% or alternatively, an increase of imports by 3.4%.

In the long term (2020) the estimated loss of production would be greater (-0.7 million tons corresponding to 167.2 million euros). The demand satisfaction rate would drop to 92.7%. To reach back a 100% degree, it would be necessary to expand the cultivated area by 16.8% or to increase the already strong imports by 14.5%.

Table 9.1 – Durum wheat crop structural trends in Italy: 2013 and 2020 baseline scenarios

	Present situation (avg 2006-10)	Short term 2013	Long term 2020	Variation	
	Baseline setting	Reference scenario T_1	Reference scenario T_2	Scenario T_1 from Baseline setting	Scenario T_2 from Baseline setting
Yield (t/ha)	2.97	3.11	3.33	4.7%	12.1%
Area (,000 ha)	1,380.3	1,441.3	1,408.7	4.4%	2.1%
BALANCE SHEET (.million t)					
Production (A)	4.1	4.5	4.7	9.4%	14.4%
Import (B)	4.51	4.74	4.65	5.2%	3.1%
Export (C)	0.08	0.07	0.07	-15.2%	-9.1%
Net trade (D=C-B)	-4.43	-4.68	-4.58		
Domestic availability (E=A+B-C)	8.5	9.2	9.3	7.4%	8.7%
Demand (F)	8.5	9.2	9.3	7.4%	8.7%
Demand satisfaction rate (E/F)	100.0%	100.0%	100.0%		
Self-sufficiency degree (A/F)	48.1%	48.9%	50.6%	1.8%	5.3%

Source: Nomisma elaborations on Eurostat, European Commission and FAO data.

Table 9.2 – Durum wheat in Italy: yield loss index in the hypothesis of a loss of azoles (2013 and 2020)

	Short term T_1 (2013)		Long term T_2 (2020)	
Yield reference scenario (t/ha)	3,11		3,33	
Yield "No azoles" scenarios	Impact of loss of azoles		Impact of loss of azoles + resistance effect	
	Loss index	Yield (t/ha)	Loss index	Yield (t/ha)
"No azoles" scenario (A)	3.5%	3.00	14.4%	2.85
"No azoles" best scenario (A-20%)	2.8%	3.02	11.5%	2.95
"No azoles" worst scenario (A+20%)	4.3%	2.98	17.3%	2.75

Source: Nomisma elaborations on Blake J. et al. (2011) and Salinari F. et al. (2011) data.

## Loss of azoles in Italy: impact on durum wheat crop in the short term (2013)

Table 9.3 – Durum wheat in Italy, scenario analysis:
short-term impact in the hypothesis of a loss of azoles (2013)

	Short term 2013			
	Reference scenario T_1	"No azoles" scenario T_1	"No azoles" Best scenario T_1	"No azoles" Worst scenario T_1
Yield (t/ha)	3.11	3.00	3.02	2.98
Area (.000 ha)	1,441.3	1,441.3	1,441.3	1,441.3
BALANCE SHEET (million t)				
Production (A)	4.5	4.3	4.4	4.3
Import (B)	4.74	4.74	4.74	4.74
Export (C)	0.07	0.07	0.07	0.07
Net trade (D=C-B)	-4.68	-4.68	-4.68	-4.68
Domestic availability (E=A+B-C)	9.2	9.0	9.0	9.0
Demand (F)	9.2	9.2	9.2	9.2
Demand satisfaction rate (E/F)	100.0%	98.3%	98.6%	97.9%
Self-sufficiency degree (A/F)	48.9%	47.2%	47.6%	46.9%

Source: Nomisma elaborations.

Loss of azoles in Italian durum wheat: preservation of the demand satisfaction rate in the short term (2013)

Figure 9.1 – Durum wheat in Italy, demand satisfaction preservation in the short term:
production impact in the hypothesis of a loss of azoles (2013)
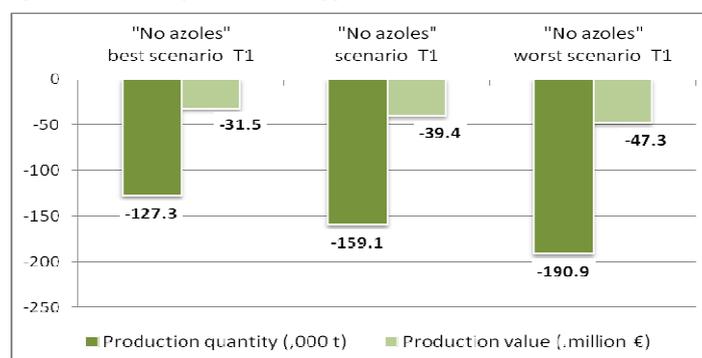
Value= production * EU price

Source: Nomisma elaborations.

Table 9.4 – Durum wheat in Italy: variables changes required
to preserve a 100% demand satisfaction rate in the short term (2013)

	"No azoles" best scenario T_1	"No azoles" scenario T_1	"No azoles" worst scenario T_1
Variation production (,000 t)	-127.3	-159.1	-190.9
AREA IMPACT			
Variation area (,000 ha)	42,1	53,0	64,1
Variation area (%)	2,9%	3,7%	4,4%
NET BALANCE IMPACT			
Variation export (%)	-193,1%	-241,4%	-289,7%
Variation import (%)	2,7%	3,4%	4,0%

Source: Nomisma elaborations.

## Loss of azoles in Italian durum wheat: impact on wheat crop in the long term

Table 9.5 – Durum wheat in Italy, scenario analysis:
long-term impact in the hypothesis of loss of azoles (2020)

	Long term 2020			
	Reference scenario T_2	"No azoles" scenario T_2	"No azoles" best scenario T_2	"No azoles" worst scenario T_2
Yield (t/ha)	3.33	2.85	2.95	2.75
Area (,000 ha)	1,408.7	1,408.7	1,408.7	1,408.7
BALANCE SHEET (.million t)				
Production (A)	4.7	4.0	4.1	3.9
Import (B)	4.7	4.7	4.7	4.7
Export (C)	0.1	0.1	0.1	0.1
Net trade (D=C-B)	-4.6	-4.6	-4.6	-4.6
Domestic availability (E=A+B-C)	9.3	8.6	8.7	8.5
Demand (F)	9.3	9.3	9.3	9.3
Demand satisfaction rate (E/F)	100.0%	92.7%	94.2%	91.3%
Self-sufficiency degree (A/F)	50.6%	43.3%	44.8%	41,9%

Source: Nomisma elaborations.

Loss of azoles in Italian durum wheat: preservation of the demand satisfaction rate in the long term (2020)

Figure 9.2 - Durum wheat in Italy, demand satisfaction preservation in the long term:
production impact in the hypothesis of a loss of azoles (2020)
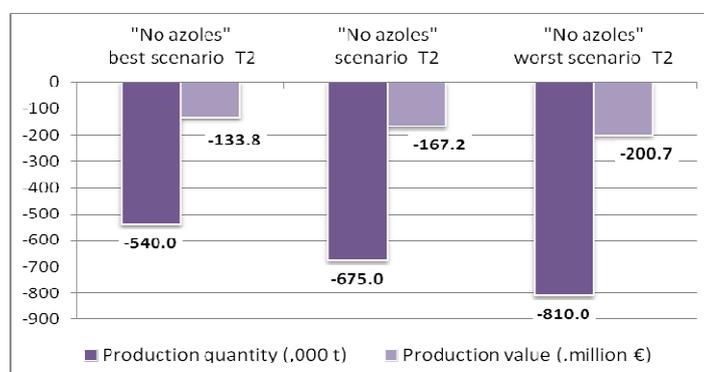
Value= production * EU price

Source: Nomisma elaborations.

Table 9.6 – Durum wheat in Italy: variables changes required
to preserve a 100% demand satisfaction rate in the long term (2020)

	"No azoles" best scenario T_1	"No azoles" scenario T_1	"No azoles" worst scenario T_1
Variation production (,000 t)	-540.0	-675.0	-810.0
AREA IMPACT			
Variation area (,000 ha)	183.3	236.9	294.1
Variation area (%)	13.0%	16.8%	20.9%
NET BALANCE IMPACT			
Variation export (%)	-764.6%	-955.8%	-1,147.0%
Variation import (%)	11.6%	14.5%	17.4%

Source: Nomisma elaborations.

10. ECONOMIC IMPORTANCE OF AZOLES IN WHEAT: ITALY COMMON WHEAT CASE STUDY

Italy common wheat case study: general considerations

Contrary to wheat production in other countries and to durum wheat production in Italy, common wheat production in Italy is estimated to be decreasing in the short term (-1.4% in 2013) as a direct effect of a reduction of the cultivated area. The decrease of common wheat production would only worsen a situation of dependency on foreign production: the average self-sufficiency rate for the 2006-2010 period was 61.9%.

A hypothetical loss of azoles would worsen this situation, by decreasing total production. In the short term, the impact is more limited: production would be reduced by 0.1 million tons (corresponding to 28.9 million euros), which would cause the demand satisfaction rate to go below 100% to 97.8%. To guarantee a 100% demand satisfaction rate the required adjustments would be: an increase of cultivated area by 3.9%; or an increase of imports by 5.1%; or a decrease of exports of 59.1%.

In the long term (2020) production will decrease by 0.48 million tons (corresponding to 118.6 million euros), resulting in a demand satisfaction rate of 91.3%. To guarantee a 100% demand satisfaction rate, the required adjustments would be: an expansion of cultivated area by 16.8%; or, an increase of imports by 19.1%.

The Italian farms that are specialised in common wheat production have an elevated gross margin (an average of 401€/ha during the 2006-2010 period), also thanks to limited expenditures in crop protection (63 €/ha). For this reason, in case of a loss of azoles the gross margin would not decrease as strongly as in the other case studies (between -8% and -11%, depending on the scenario). However, to compensate for this loss, plant protection costs should be strongly reduced (between -49% and -61%). In the long term, the impact is stronger: the gross margin would drop by 16-24% (between 64 €/ha and 96 €/ha) and the required adjustments for what concerns the protection costs will be a reduction that oscillates between -102% and -152%.

Table 10.1 – Common wheat crop structural trends in Italy: 2013 and 2020 baseline scenarios

	Present situation (avg 2006-10)	Short term 2013	Long term 2020	Variation	
	Baseline setting	Reference scenario T_1	Reference scenario T_2	Scenario T_1 from Baseline setting	Scenario T_2 from Baseline setting
Yield (t/ha)	5.07	5.19	5.38	2.4%	6.2%
Area (,000 ha)	625.2	601.7	618.7	-3.7%	-1.0%
BALANCE SHEET (.million t)					
Production (A)	3.2	3.1	3.3	-1.4%	5.1%
Import (B)	2.15	2.30	2.42	6.8%	12.6%
Export (C)	0.20	0.20	0.22	-0.4%	10.7%
Net trade (D=C-B)	-1.95	-1.80	-1.90		
Domestic availability (E=A+B-C)	5.1	5.2	5.5	2.0%	8.0%
Demand (F)	5.1	5.2	5.5	2.0%	8.0%
Demand satisfaction rate (E/F)	100.0%	100.0%	100.0%		
Self-sufficiency degree (A/F)	61.9%	59.8%	60.2%	-3.3%	-2.7%

Source: Nomisma elaborations on Eurostat, European Commission and FAO data.

Table 10.2 – Common wheat in Italy: yield loss index in the hypothesis of a loss of azoles (2013 and 2020)

Yield reference scenario (t/ha)	Short term T_1 (2013)		Long term T_2 (2020)	
	5,19		5,38	
Yield "No azoles" scenarios	Impact of loss of azoles		Impact of loss of azoles + resistance effect	
	Loss index	Yield (t/ha)	Loss index	Yield (t/ha)
"No azoles" scenario (A)	3.7%	4.99	7,9%	4,95
"No azoles" best scenario (A-20%)	3.0%	5.03	6,3%	5,04
"No azoles" worst scenario (A+20%)	4.5%	4.96	9,4%	4,87

Source: Nomisma elaborations on Blake J. et al. (2011) and Salinari F. et al. (2011) data.

## Loss of azoles in Italy: impact on common wheat crop in the short term (2013)

Table 10.3 – Italy common wheat, scenario analysis:
short-term impact in the hypothesis of a loss of azoles (2013)

	Short term 2013			
	Reference scenario T_1	"No azoles" scenario T_1	"No azoles" best scenario T_1	"No azoles" worst scenario T_1
Yield (t/ha)	5.19	4.99	5.03	4.96
Area (,000 ha)	601.7	601.7	601.7	601.7
BALANCE SHEET (.million t)				
Production (A)	3.12	3.01	3.03	2.98
Import (B)	2.30	2.30	2.30	2.30
Export (C)	0.20	0.20	0.20	0.20
Net trade (D=C-B)	-1.80	-1.80	-1.80	-1.80
Domestic availability (E=A+B-C)	5.22	5.10	4.83	4.78
Demand (F)	5.22	5.22	5.22	5.22
Demand satisfaction rate (E/F)	100.0%	97.8%	92.5%	91.6%
Self-sufficiency degree (A/F)	59.8%	57.6%	58.0%	57.1%

Source: Nomisma elaborations.

Loss of azoles in Italian common wheat: preservation of the demand satisfaction rate in the short term (2013)

Figure 10.1 – Italy common wheat, demand satisfaction preservation in the short term:
production impact in the hypothesis of a loss of azoles (2013)
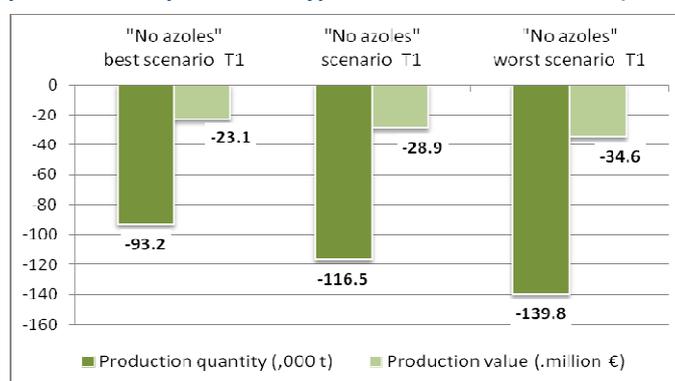
Value= production * EU price

Source: Nomisma elaborations.

Table 10.4 – Italy common wheat, variables changes required
to preserve a 100% demand satisfaction rate in the short term (2013)

	"No azoles" best scenario T_1	"No azoles" scenario T_1	"No azoles" worst scenario T_1
Variation production (,000 t)	-93.2	-116.5	-139.8
AREA IMPACT			
Variation area (,000 ha)	18.5	23.3	28.2
Variation area (%)	3.1%	3.9%	4.7%
NET BALANCE IMPACT			
Variation export (%)	-47.3%	-59.1%	-71.0%
Variation import (%)	4.1%	5.1%	6.1%

Source: Nomisma elaboruons.

Loss of azoles in Italy: impact on common wheat crop in the long term

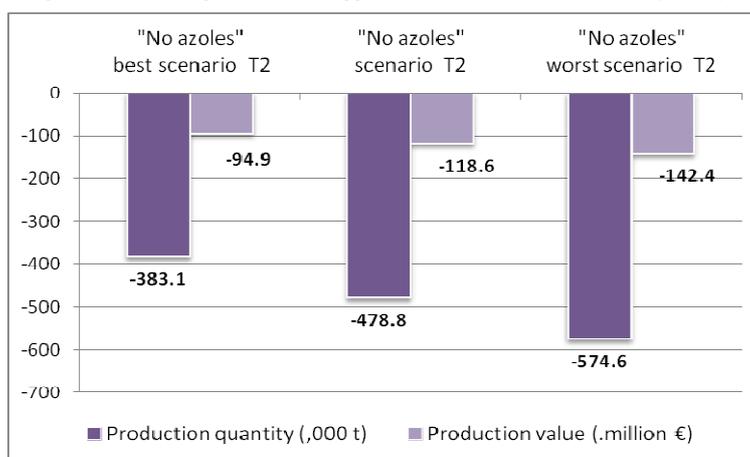### Table 10.5 – Italy common wheat, scenario analysis: long-term impact in the hypothesis of loss of azoles (2020)

	Long term 2020			
	Reference scenario T_2	"No azoles" scenario T2	"No azoles" best scenario T2	"No azoles" worst scenario T2
Yield (t/ha)	5.38	4.60	4.76	4.45
Area (,000 ha)	618.7	618.7	618.7	618.7
BALANCE SHEET (.million t)				
Production (A)	3.33	2.85	2.94	2.75
Import (B)	2.42	2.4	2.4	2.4
Export (C)	0.22	0.2	0.2	0.2
Net trade (D=C-B)	-2.20	-2.2	-2.2	-2.2
Domestic availability (E=A+B-C)	5.53	5.05	5.15	4.95
Demand (F)	5.53	5.53	5.53	5.53
Demand satisfaction rate (E/F)	100.0%	91.3%	93.1%	89.6%
Self-sufficiency degree (A/F)	60.2%	51.5%	53.2%	49.8%

Source: Nomisma elaborations.

Loss of azoles in Italian common wheat: preservation of the demand satisfaction rate in the long term (2020)

Figure 10.2 - Italy common wheat, demand satisfaction preservation in the long term: production impact in the hypothesis of a loss of azoles (2020)

Value= production * EU price

Source: Nomisma elaborations.

Table 10.6 – Italy common wheat, variables changes required to preserve a 100% demand satisfaction rate in the long term (2020)

	"No azoles" best scenario T_2	"No azoles" scenario T_2	"No azoles" worst scenario T_2
Variation production (,000 t)	-383.1	-478.8	-574.6
AREA IMPACT			
Variation area (,000 ha)	80.5	104.0	129.2
Variation area (%)	13.0%	16.8%	20.9%
NET BALANCE IMPACT			
Variation export (%)	-174.8%	-218.5%	-262.2%
Variation import (%)	15.8%	19.8%	23.7%

Source: Nomisma elaborations.

Loss of azoles in Italy: impact at farm level

Table 10.7 – Italian farm specialised in the production of wheat: Gross margin calculation (average 2006-10)

Italy (common wheat) - Baseline setting	avg 2006-10
Yield (t/ha)	5.7
Price	176
Receipts (€/ha)	**1,048**
Grain	1,003
By-products (straw)	45
Coupled direct payments	0
Operating costs (€/ha)	**647**
Specific costs	*297*
Seeds	94
Fertilizers	118
Crop protection	63
Other specific costs	22
Non-specific costs	*351*
Motor fuels and lubricants	107
Machines and building upkeep	39
Contract work	93
Energy	8
Other direct costs	104
Gross margin (€/ha)	**401**

Source: Nomisma elaborations on EU FADN data.

Table 10.8 – Italian farm specialised in the production of wheat:
impact on Gross margin in the hypothesis of a loss of azoles in the short (2013) and long term (2020)

€/ha	Baseline setting (avg 2006-10)	Short term 2013			Long term 2020		
		"No azoles" scenario T_1	"No azoles" Best scenario T_1	"No azoles" Worst scenario T_1	"No azoles" scenario T_2	"No azoles" Best scenario T_2	"No azoles" Worst scenario T_2
Yield (t/ha)	5.7	5.24	5.34	5.15	4.92	5.08	4.77
Receipts*	1,048	1,010	1,017	1,002	968	984	952
Operating costs	647	647	647	647	647	647	647
Gross margin	401	362	370	355	321	337	305
Gross margin variation from Reference Scenario	€/ha	-39	-31	-46	-80	-64	-96
	%	-10%	-8%	-11%	-20%	-16%	-24%
Required reduction of crop protection costs	%	-61%	-49%	-73%	-127%	-102%	-152%

Source: Nomisma elaborations on EU FADN data.

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