

WEAMC Project (RMIS 5364)

END OF PROJECT REPORT

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Background

The WEMAC (World Econometric Model of Agricultural Crops) model is a model which has its origins at the French Research Institute INRA. Over the period 2006 to 2009 INRA, Teagasc and other partners worked on further developing the model as part of an EU Framework Project. This report details some of the project main results.

Introduction

The Teagasc contribution to this project builds on the earlier work of the other project partners. The report demonstrates the capacity of the WEMAC model to handle a variety of relevant scenarios relating to macroeconomic shocks, physical (climatic) and technical shocks.

The scenarios that have been examined using the WEMAC model and which are reported here have been agreed in consultation with the European Commission DG Agri.

The baseline (policy status quo) scenario includes the underlying assumption that there is a growth in biofuel production, in other words, it integrates an increase in industrial demand for cereals and oils.

Four categories of scenario simulations are analysed. These simulations examine the impact of changes in exchange rates, changes in the price of crude oil, changes in crop yield levels in selected regions, and changes in the level of biofuel demand growth over time. In some cases within these categories more than one scenario is conducted and reported. Table 1 summarises the definition of the six scenarios examined

Table 1: Summary of scenarios analysed

Scenario Name	Scenario description
1. Change in the exchange rate	
Scenario 1.1	euro-dollar exchange rate is near parity
Scenario 1.2	dollar-real exchange rate change
2. Change in the price of oil	
Scenario 2.	a rise in the price of oil
3. Change in crop yields	
Scenario 3.1.	Unexpected weather event for wheat in Australia
Scenario 3.2	Slowdown in technical progress
4. Change in biofuels in the EU-15	
Scenario 4	

In the ensuing sections some of the main scenario results are summarised. Detailed scenario results are available on a CD from the project coordinator and on the project website.

A Note on Interpretation

It would be naïve to assume that the present is a good approximation of the future ten years from now. We generate a baseline projection to consider what the future is likely to look like in the absence of a major shock and under the assumption that current agricultural policies and agricultural trade policies remain in place.

The scenarios simulation results then represent a counter-factual outlook to the baseline projections. The impact of a scenario should be thought of in terms of deviations from that baseline, rather than as deviations from the present market circumstances. This approach to the interpretation of the baseline scenario projections provides a proper sense of the impact of the shock or policy change that is examined in a given scenario.

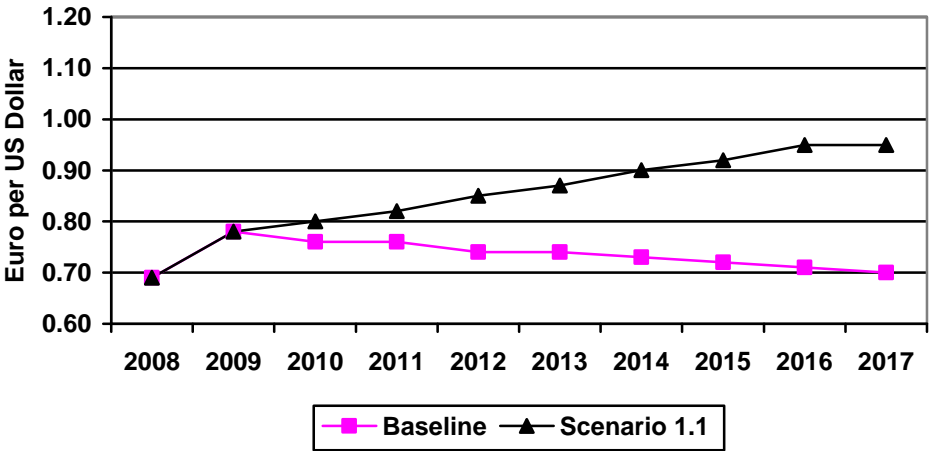
1. Change in exchange rates

Changes in currency exchange rates can impact on prices, the competitiveness of a sector in a country, its future level of production and its level of trade. Here a number of exchange rate shocks are examined. Given that there is a large set of bilateral exchange rates in the model, there are many different exchange rate shocks which could be examined. Variations in only a sample of the more important exchange rate relationships are considered here and it should be understood that implies changes in other unspecified exchange rates. Other exchange rate scenarios are also possible. Note also that exchange rates between currencies are not locked at existing levels into the future, rather they change through time in the baseline ie. the baseline does not assume fixed exchange rates into the future) and the scenarios examined address deviations in the exchange rate from the baseline path. As a result careful interpretation of the exchange rate scenarios is required since an appreciation or depreciation scenario is with respect to the baseline exchange rate projection, which is unlikely to accord with the current exchange rate.¹

1.1. Change in the Euro-dollar exchange rate (Scenario 1.1)

In the baseline the euro continues to strengthen against the US dollar throughout the projection period to 2017 (the US dollar buys fewer euro). Under scenario 1.1, the first exchange rate shock reported here, it is assumed that the euro depreciates in value against the US dollar (more euro are required to buy the US dollar) relative to the baseline and that the euro-dollar exchange rate moves gradually in the direction of parity. The euro/dollar exchange rates used in the baseline and in scenario 1.1 are presented in Figure 1.

Figure 1: Euro / US dollar exchange rates under the baseline and scenario 1.1

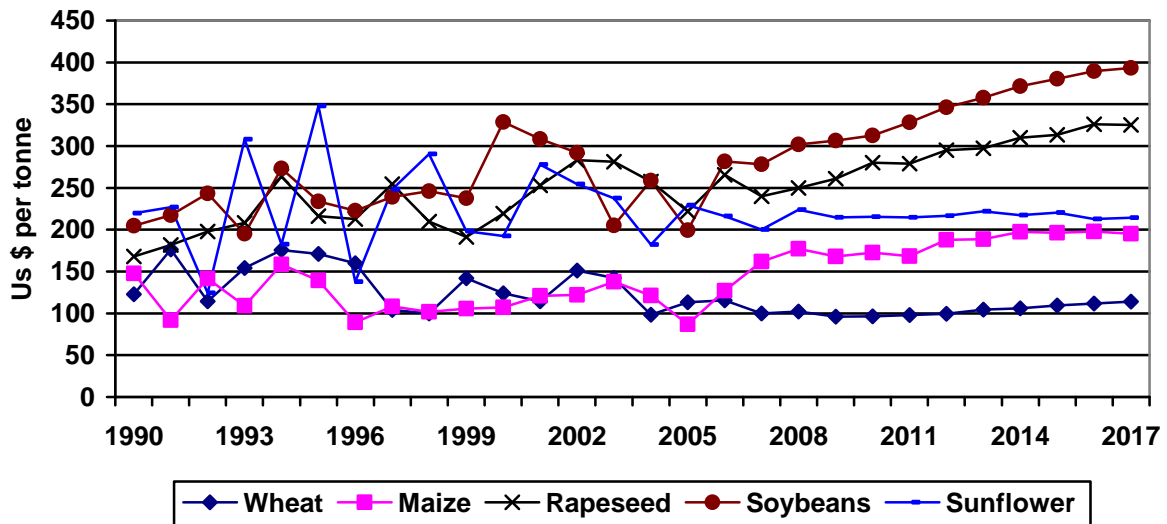


¹ This can be seen more clearly by studying Figure 1 below. Note how the difference between the Baseline exchange rate in 2020 and the scenario exchange in 2020 is far greater than the difference between the current (2008) exchange rate and the exchange rate in 2020.

Source: WEMAC Model (2009)

In Figure 2 historical and projected world prices under scenario 1.1 are presented for selected crops. There is an upwards trend in soybean rapeseed and maize prices, while prices for wheat and sunflower are relatively stable by comparison.

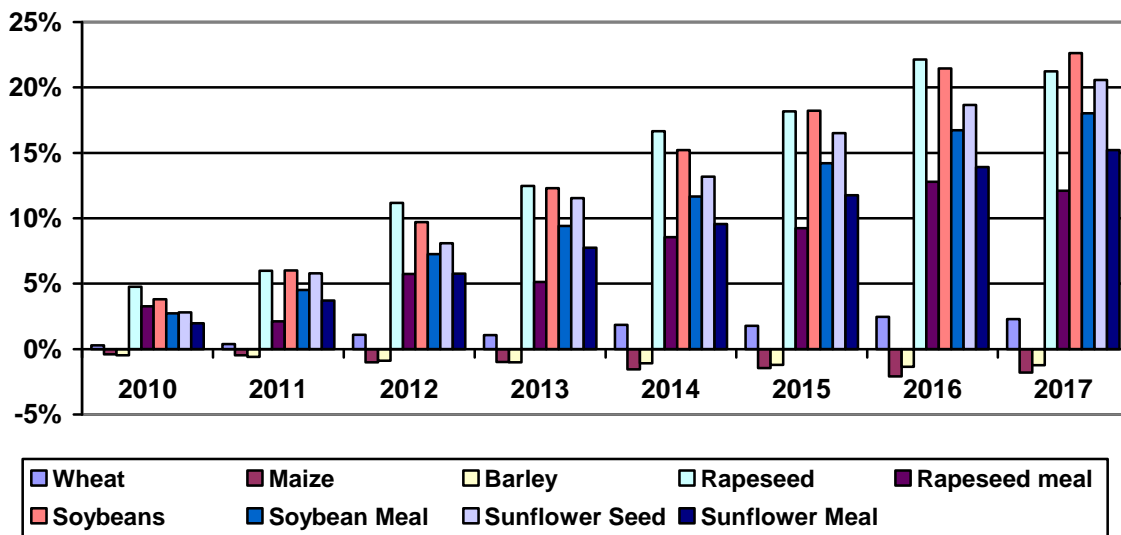
Figure 2: Historical and Projected World Prices for Selected Crops under scenario 1.1



Source: WEMAC Model (2009)

In Figure 3 the impact of this exchange rate shock on world cereal and oilseed prices is presented by way of percentage changes relative to the baseline level of these world prices.

Figure 3: Percent change in world prices under scenario 1.1 relative to the baseline



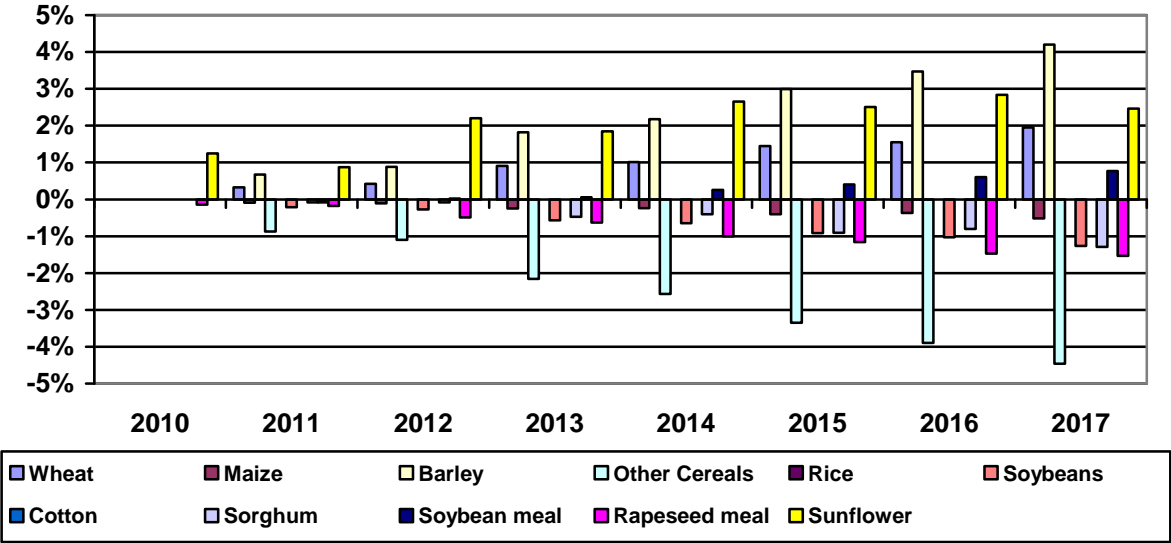
Source: WEMAC Model (2009)

As would be expected, the magnitude of the changes increase through time as the US dollar depreciates and moves further from the baseline path of the exchange rate. Under scenario 1.1, other things being equal, commodities become cheaper in euro terms as the US dollar depreciates

and would be demanded in greater quantities. Therefore to retain the equilibrium between supply and demand, world prices (measured in US dollars) increase. The overall impact of the scenario is that it induces greater prices increases in the case of oilseeds than in the case of cereals. Under the scenario there is a pronounced increase in soybean and sunflower prices in both absolute terms and relative to wheat and maize.

The impact of scenario 1.1 on US production of cereals and oilseeds is presented in Figure 3. In the US the biggest production impacts are wheat, barley, other cereals and sunflower. These production changes reflect the generally higher world (US dollar denominated) prices as well as changes in relative cereal prices, which favours oilseeds over cereals, raising the return to oilseeds relative to cereals and with a corresponding increased in oilseed area relative to cereals. Notably the price of wheat increases relative to maize and this has some consequences for the evolution in wheat and maize area. In effect the decline in wheat area at the expense of maize observed in the baseline is reduced very slightly, but the overall trend of the baseline of the increase in maize are at the expense of wheat is replicated in scenario 1.1.

Figure 4: Percent change in US Production under scenario 1.1 relative to baseline



Source: WEMAC Model (2009)

However, care is required when interpreting percentage changes such as these, since the pre-existing area shares differ greatly for the crops examined. This is particularly the case with crops whose base area is initially small. A minor movement of area away from a crop with a large base area into a crop with a small base area, can result in large percentage changes in the area of the crop with the smaller area. Therefore it is useful to graph the area shares for the various crops. Figure 5 presents historical area shares for the main US crops and projected area shares under scenarios 1.1. As can be seen, the large percentage change in US other cereals area in Figure 4 is

not really evident in Figure 5 below, since the initial area for other cereals in the US happens to be small relative to the total area in crop production. The main story in the scenario, much as in the baseline is the growth in US maize area largely at the expense of wheat.

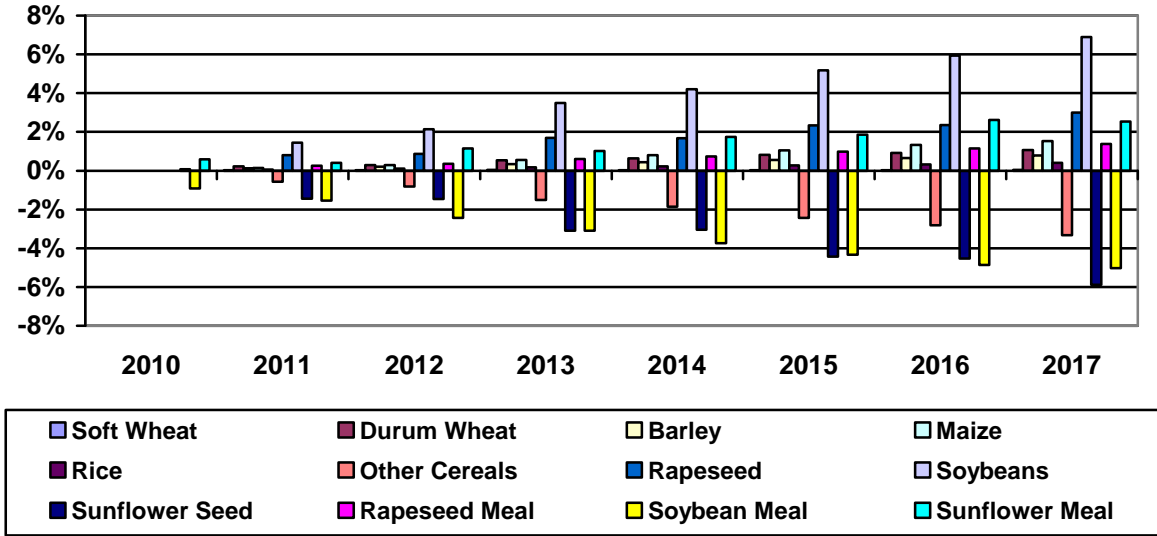
Figure 5: Area Share in the US for the main cereals under scenario 1.1



Source: WEMAC Model (2009)

The impact of scenario 1.1 on EU production of cereals and oilseeds is presented in Figure 6. In the EU the biggest production impacts are on rapeseed, soybeans and sunflower seed markets, while the impact on wheat, maize and oilseed meals is less pronounced. Since the projected rise in oilseed prices is considerably greater than the movement in cereal prices, the relative price changes cause production of oilseeds to increase.

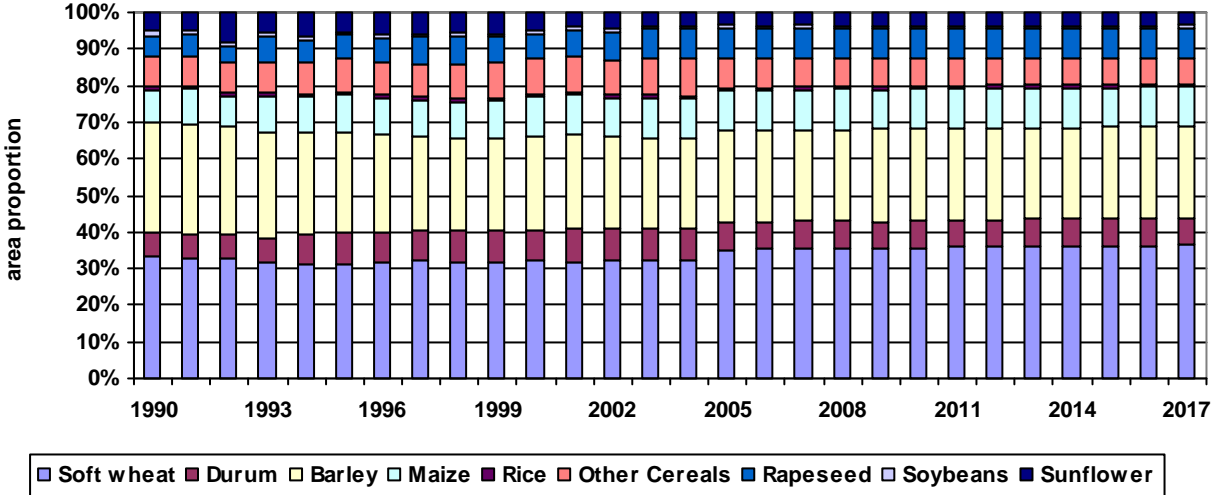
Figure 6: Percent change in EU Production under scenario 1.1 relative to baseline



Source: WEMAC Model (2009)

Since the initial area shares differ considerably for the crops examined, again care should be taken in interpreting these percentage changes. While the percentage change in rapeseed, soybeans and sunflower seed may appear substantial, these are not major crops in the EU and the change in area which these percentage changes represent is relatively small. As illustrated in Figure 7, in effect the area shares for EU crops under scenario 1.1 are not very different than those projected under the baseline, with soft wheat area increasing, durum wheat and barley area shares relatively unchanged and rapeseed and soybean area share increasing at the expense of sunflower area

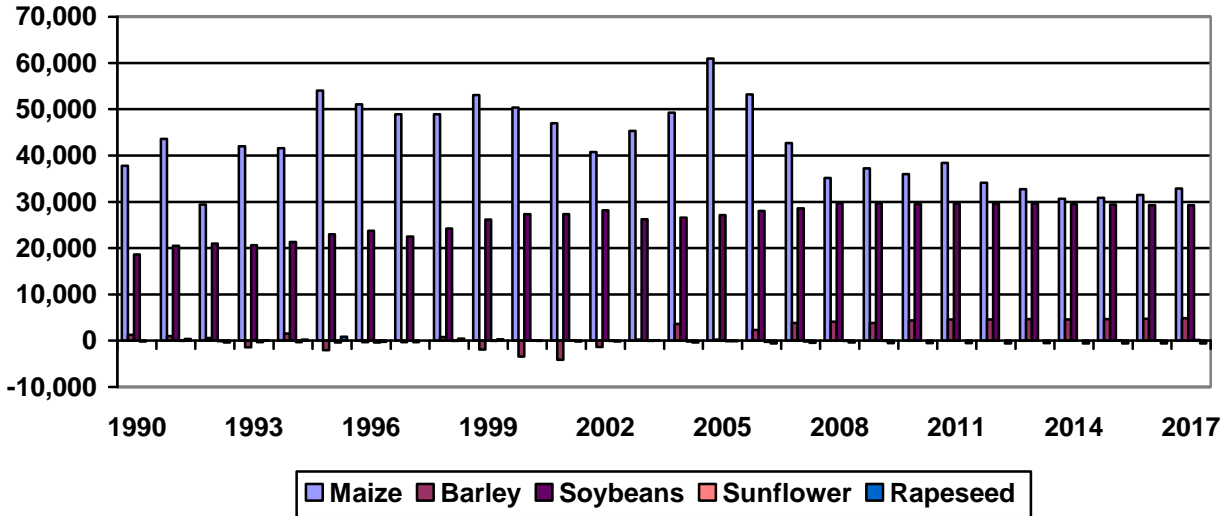
Figure 7: Area share for Crops in the EU under the scenario 1.1



Source: WEMAC Model (2009)

In Figure 8 the impact of scenario 1.1 on US net exports in crops is presented. In the US there is a decrease in the net exports of all cereals apart from barley (barley production expands relative to the baseline under scenario 1.1) but these impacts are generally modest and broadly reflect the change in production relative to the baseline. The outcome for oilseeds net exports position is somewhat different. Soybean and soybean meal net exports decline contributing to the strong increase in world prices, but net exports of rapeseed, rapeseed meal, sunflower seed and sunflower meal are all projected to increase relative to the baseline..

Figure 8: Historical US Crop Net Exports and projections under scenario 1.1

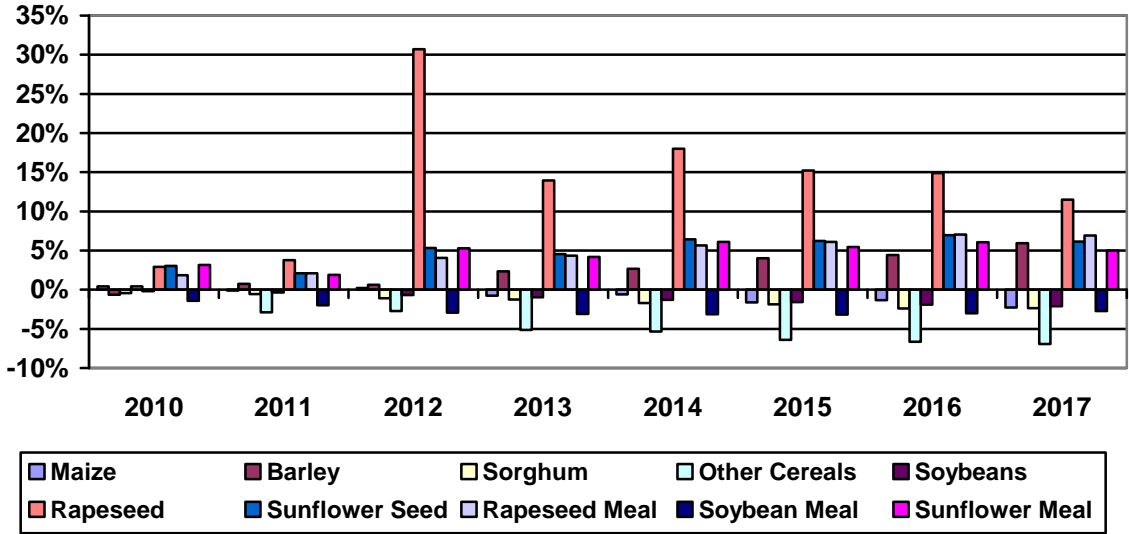


Source: WEMAC Model (2009)

The trends of the baseline story tend to dominate over the impacts induced by the scenario. US net exports of maize decline in spite of increasing indigenous production, because domestic use is increasing at a faster rate. By contrast US net exports of barley increase over the projection period under scenario 1.1, but again this is also a feature of the baseline.

In analysing the scenarios discussed here, careful interpretation is again required since positive changes in US net exports under the scenario relative to the baseline are possible even when the absolute level of US net exports is negative, such as in the case of rapeseed. Despite a large positive change in US net exports of rapeseed under the scenario, US net exports of rapeseed remain slightly negative by 2017. The percentage change in US net exports of cereals, oilseeds and oilseed meals in scenario 1.1 relative to the baseline are presented in Figure 9.

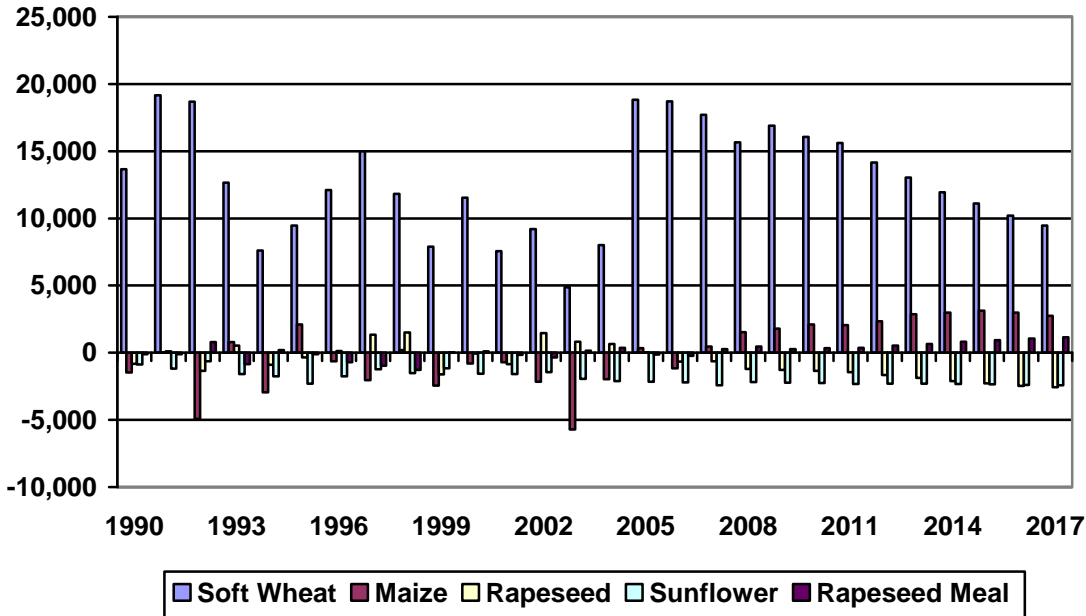
Figure 9: Percent change in US Net Exports under scenario 1.1 relative to baseline



Source: WEMAC Model (2009)

Figure 10 shows EU net exports under scenario 1.1 for the main EU crops. As can be seen, the main feature of the projected change in net exports in the EU is that net exports of soft wheat decline significantly and net exports of maize increase, but again these trends are also features of the baseline.

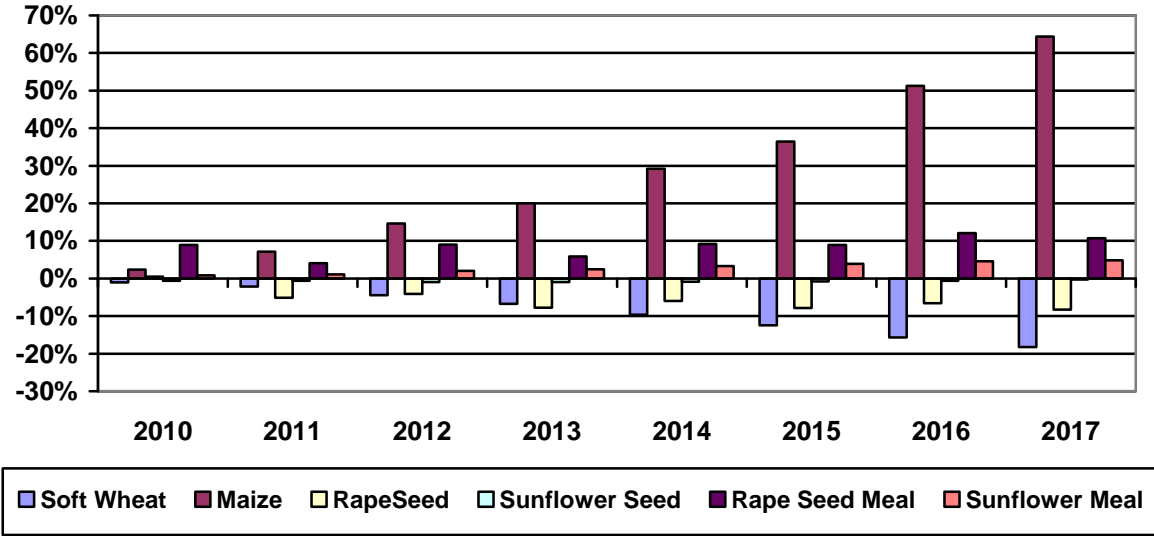
Figure 10: Historical EU crop net exports and projections under scenario 1.1.



Source: WEMAC Model (2009)

EU net exports of maize increase substantially, both in absolute terms and relative to the baseline, while there is a notable decline in soft wheat net exports in both absolute terms and relative to the baseline. The higher euro price of maize in the scenario impacts on EU maize net exports. Albeit from a low level, EU net exports of rapeseed meal also increase considerably under the scenario relative to the baseline. In Figure 11 the impact of scenario 1.1 on EU net exports relative to the baseline is presented in terms of percentage changes.

Figure 11: Percent change in EU Net Exports under scenario 1.1 relative to baseline

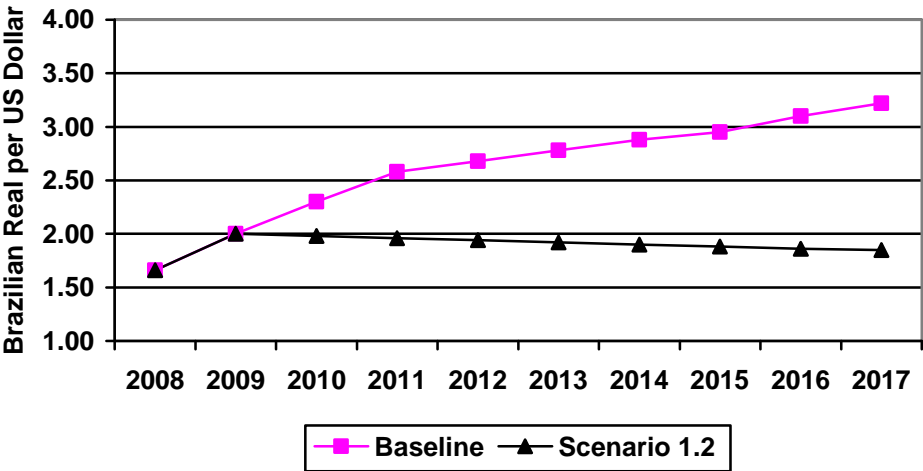


Source: WEMAC Model (2009)

1.2. Change in the dollar-real exchange rate (Scenario 1.2)

In the baseline scenario, the Brazilian real depreciates steeply against the US dollar over the projection period (the US dollar buys more Brazilian real) reaching a level of 3.22 real per dollar by 2017. In scenario 1.2 the exchange rate between the US and the Brazilian real is changed relative to the baseline so that the Brazilian real experiences a modest appreciation against the US dollar through time reaching a level of 1.85 real per dollar by 2017. This implies that under the scenario there is little change in the exchange rate over time relative to recent history, but the scenario exchange rate in 2017 is substantially different than the baseline exchange rate in 2017. Relative to the present, Brazilian net exports become more competitive in the baseline, while they become less competitive in the scenario. The impact of scenario 1.1 can be expected to be greatest in the case of commodities where alternative suppliers to the world market cannot easily be found. The currency exchange rates used in the baseline and in scenario 1.2 are presented in Figure 12.

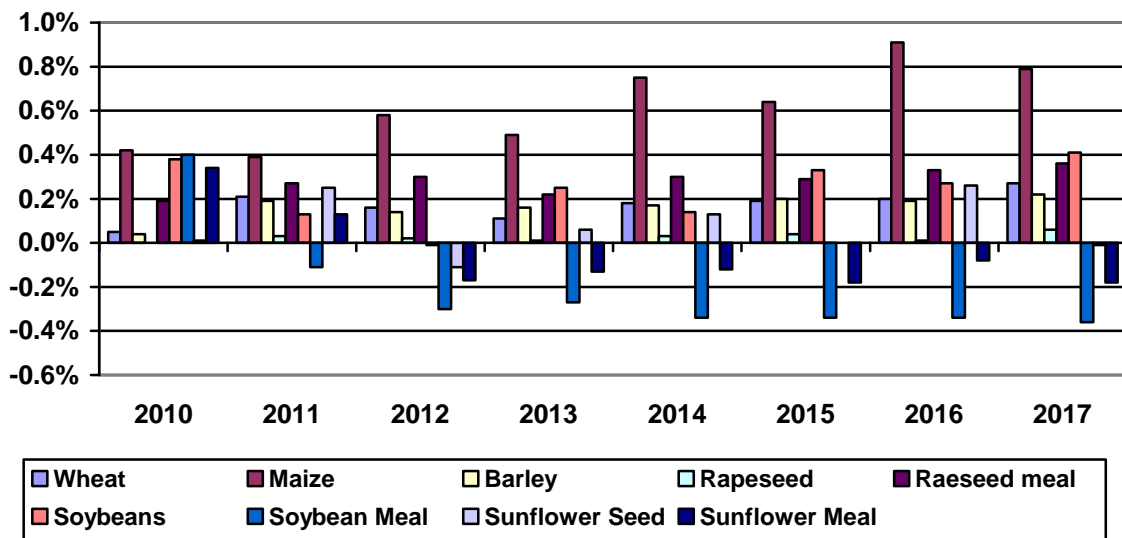
Figure 12: Brazilian Real / US dollar Exchange rates under the baseline and scenario 1.2



Source: WEMAC Model (2009)

The impact of scenario 1.2 where the real appreciates against the US dollar, is felt in the maize and soybean markets given that Brazil is a major player in both of these commodities on the world market. In Figure 13 the impact on world prices of the change in the exchange rate assumption is presented. Price impacts of scenario 1.2 are generally very modest at less than 1 percent.

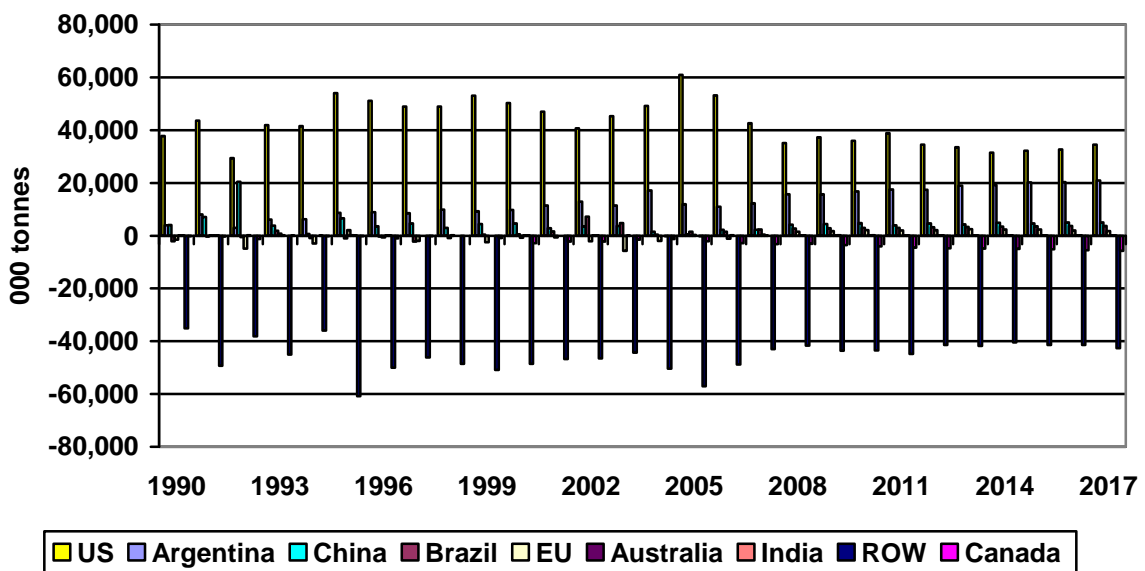
Figure 13: Percent change in world prices under scenario 1.2 relative to the baseline



Source: WEMAC Model (2009)

As expected, the main trade impacts are felt in Brazil as one might expect given the definition of the scenario. For other countries the impact of the scenario does not substantially alter the trends that are projected to prevail in the baseline. In Figure 14 historical and projected net exports under scenario 1.2 are presented. Under the baseline Argentina increases its share of world trade at the expense of the US and this trend continues in the scenario.

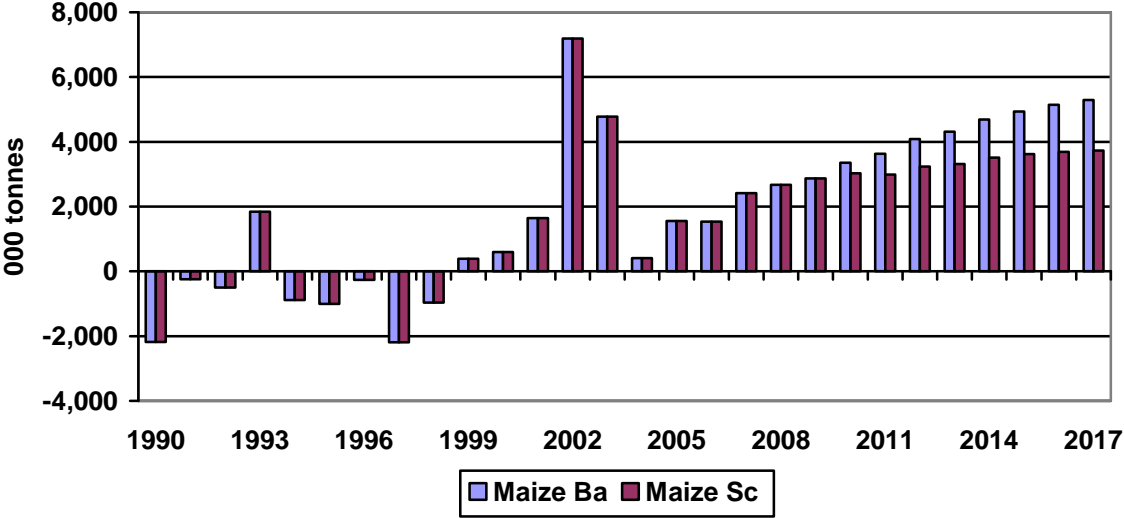
Figure 14 : Historical maize Net Export and projections under scenario 1.2



Source: WEMAC Model (2009)

Of note under scenario 1.2 is that there is a decline in Brazilian maize net exports relative to the baseline is projected in Figure 15, as Brazilian exports become less competitive due to the appreciation of the real.

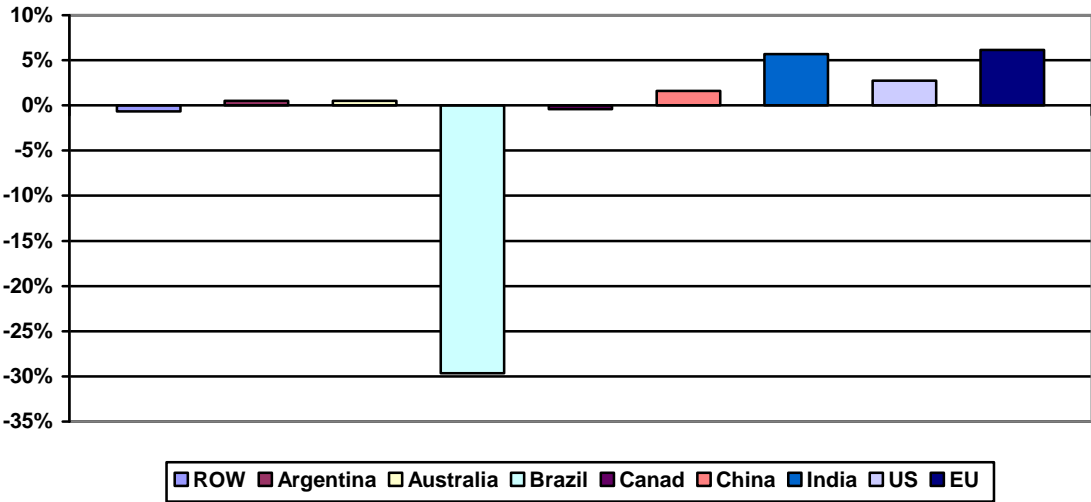
Figure 15 : Brazilian Net Exports under the baseline and scenario



Source: WEMAC Model (2009)

Under Scenario 1.2, India, the US and EU see their net exports of maize increase relative to the baseline by 5%, 3% and 6% respectively by 2017. These increases in exports fill the gap in the market left following the contraction in exports from Brazil.

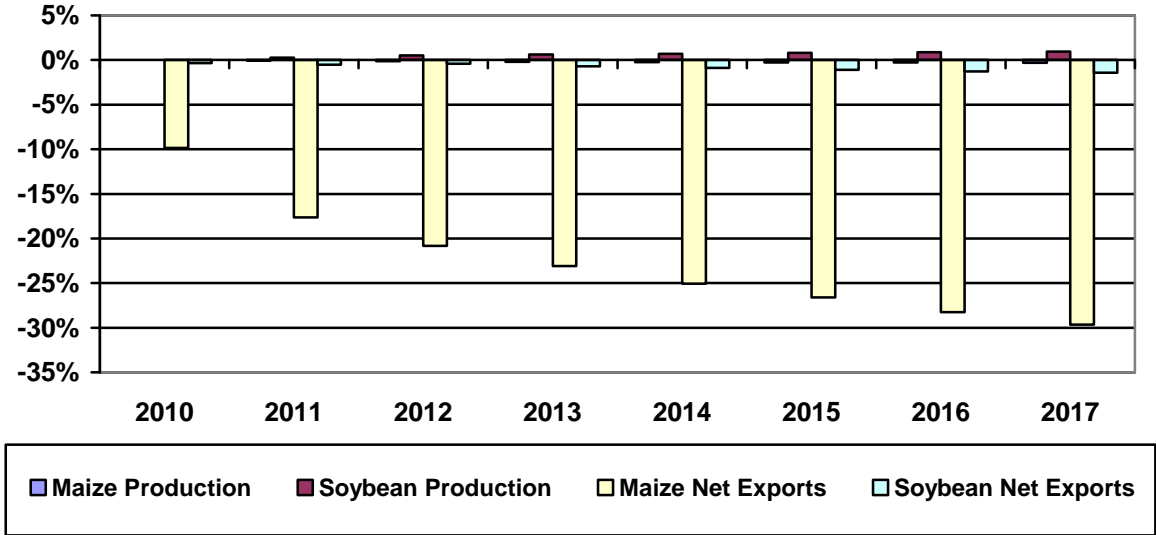
Figure 16 : Percentage change in maize net exports under scenario 1.2 relative to the baseline in 2017



Source: WEMAC Model (2009)

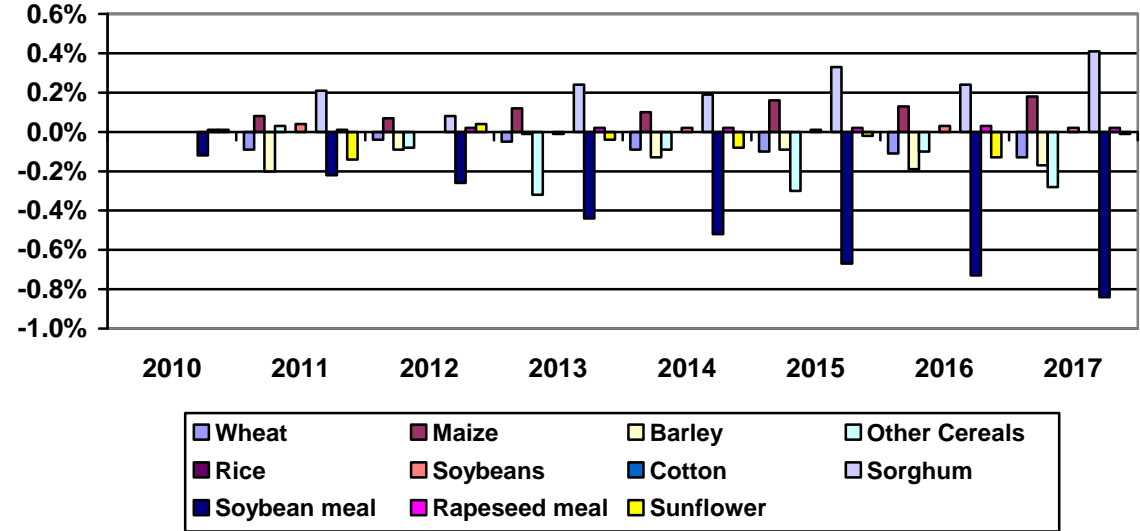
Despite the scale of the changes in net exports, the production impacts under scenario 1.2 are in general modest. Markets adjust through changes in trade volumes. In Figure 17, Figure 18, Figure 19, Figure 20 and Figure 21 projected production and trade impact of scenario 1.2 is presented

Figure 17: Percent change in Brazilian Production and Net Exports under scenario 1.2 relative to baseline



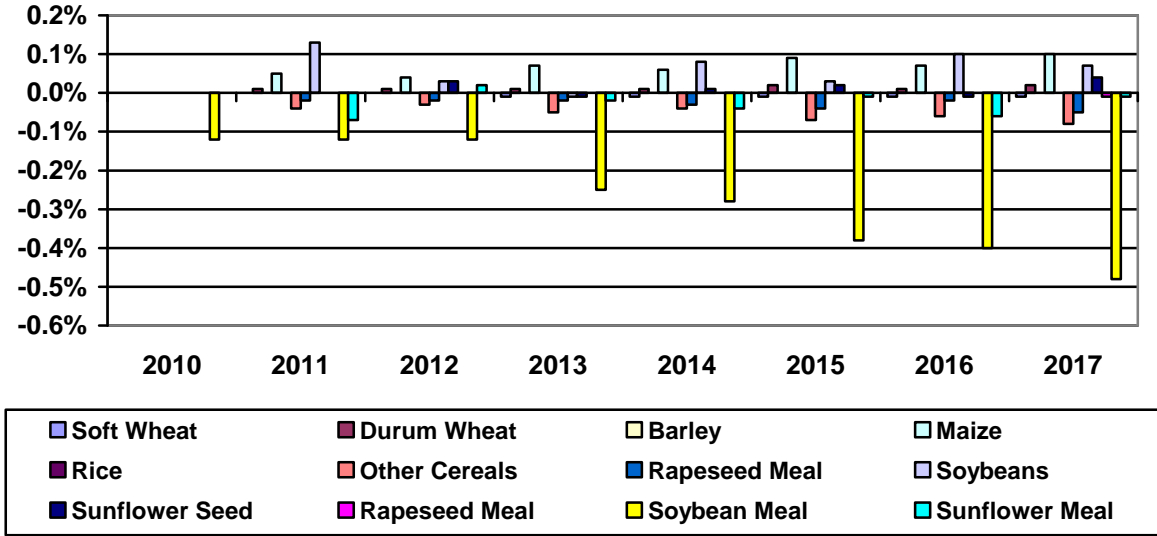
Source: WEMAC Model (2009)

Figure 18: Percent change in US Production under scenario 1.2 relative to baseline



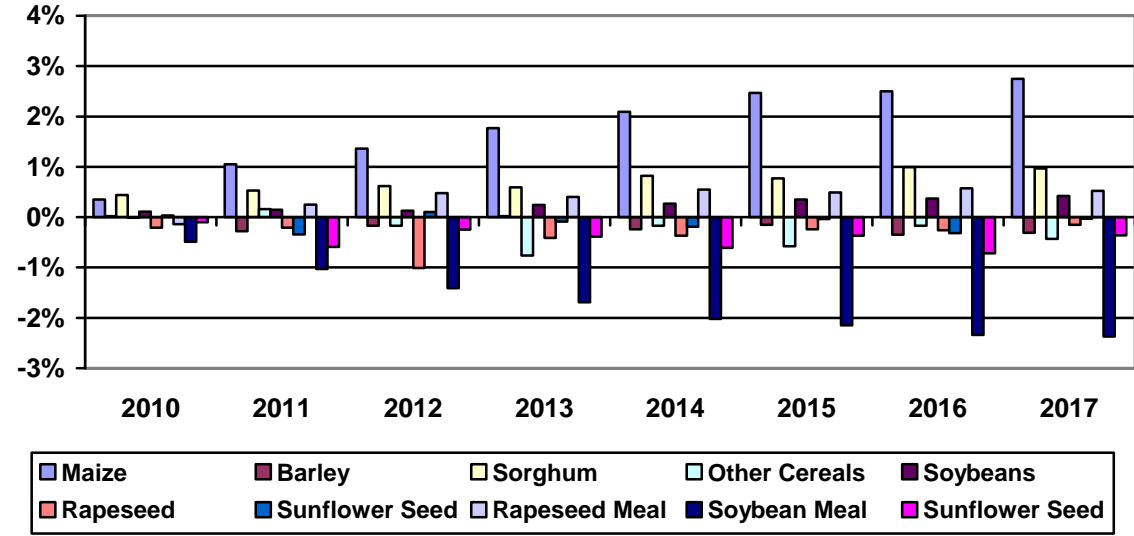
Source: WEMAC Model (2009)

Figure 19: Percent change in EU Production under scenario 1.2 relative to baseline



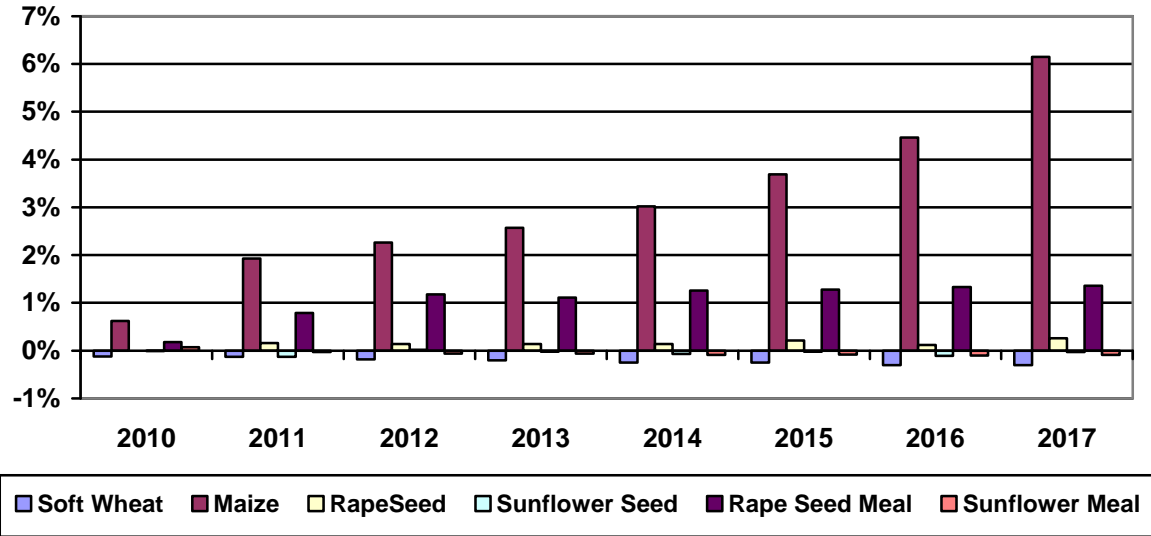
Source: WEMAC Model (2009)

Figure 20: Percent change in US Net Exports under scenario 1.2 relative to baseline



Source: WEMAC Model (2009)

Figure 21: Percent change in EU Net Exports under scenario 1.2 relative to baseline

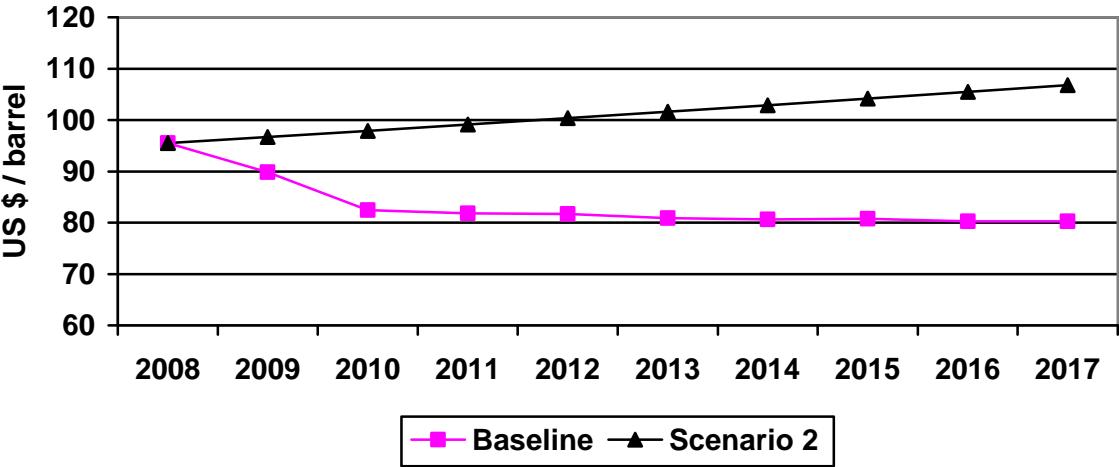


Source: WEMAC Model (2009)

2. Change in the price of Crude Oil (Scenario 2)

Under the baseline the price of crude oil declines from the historical high levels of 2007 and 2008 and settles by the end of the projection period at close to 80 dollars per barrel. In scenario 2 we assume an increase in the price of petroleum of 1.25% a year from 2009 onwards with oil prices reaching a level of US\$ 107 by the end of the projection period. We assume a similar rise in the price of other variable inputs to that of the price of oil. The projected price of inputs for the EU countries, the United States, Australia and Canada is reported. The crude oil prices used in the baseline and in scenario 2 are presented in Figure 22.

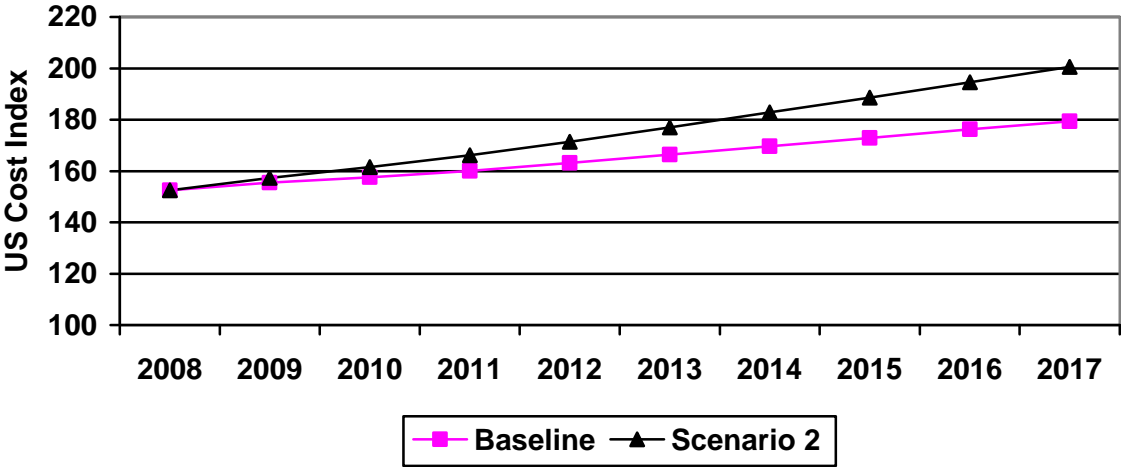
Figure 22: Oil Price projections under the baseline and scenario 2



Source: WEMAC Model (2009)

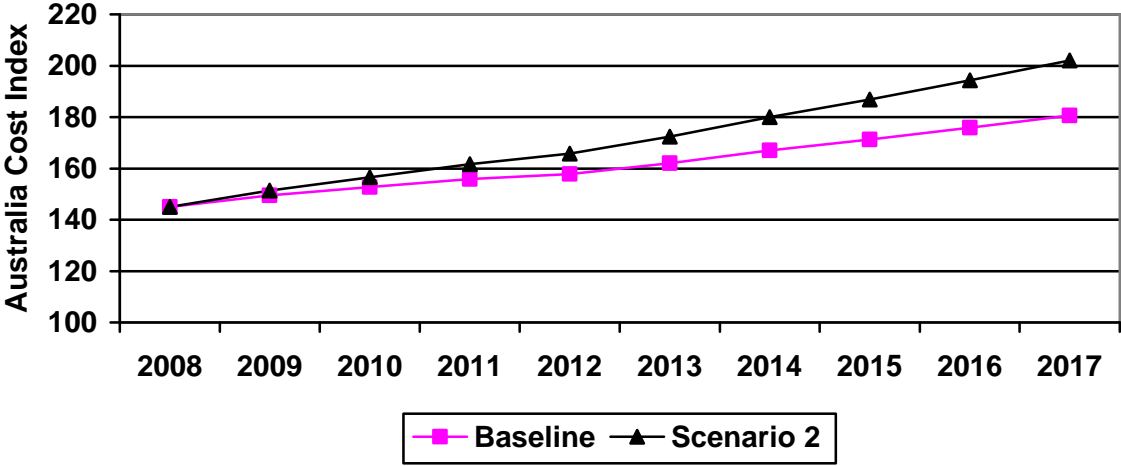
In Figure 23 through Figure 26 input prices projections for the US, Australia, Canada and France are presented. It should be noted that the evolution of input costs in other EU MS is similar to that of France. Under the scenario production costs increase by 11 percent relative to the baseline in 2017

Figure 23: US input cost projection under the baseline and scenario 2



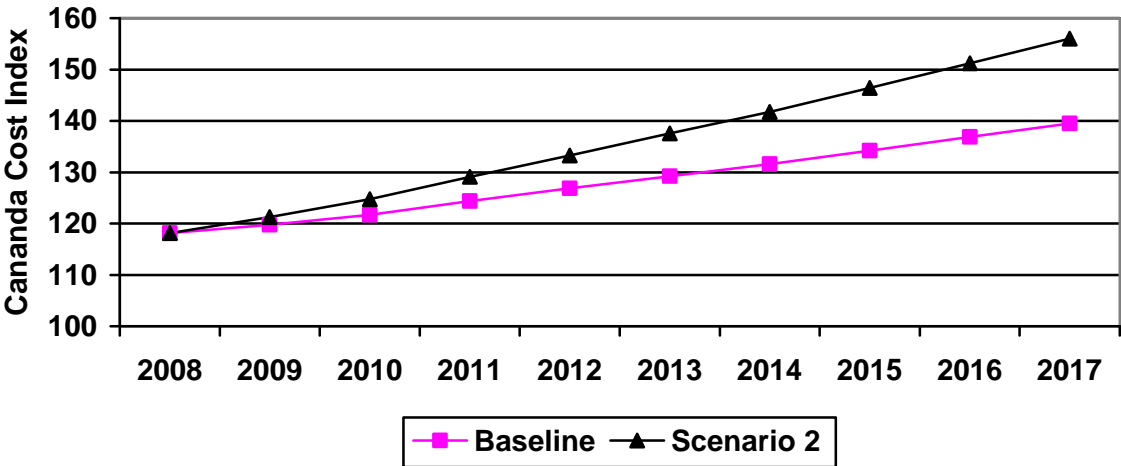
Source: WEMAC Model (2009)

Figure 24: Australian input cost projection under the baseline and scenario 2



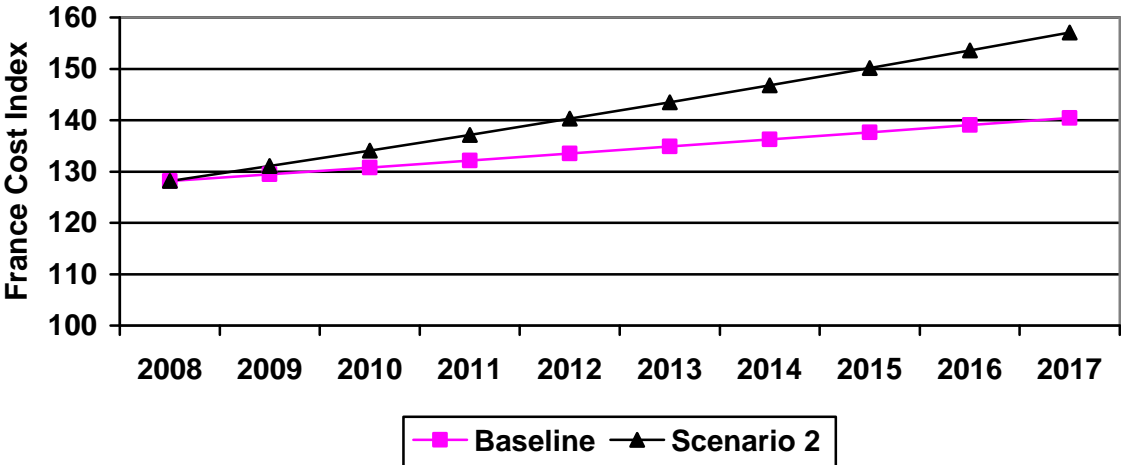
Source: WEMAC Model (2009)

Figure 25: Canadian input cost projection under the baseline and scenario 2



Source: WEMAC Model (2009)

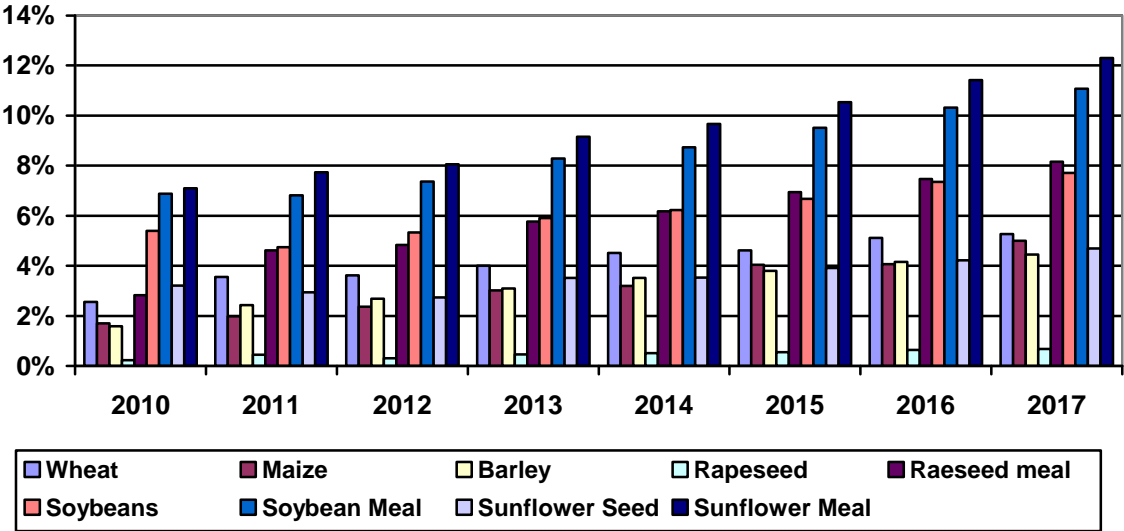
Figure 26: French input cost projection under the baseline and scenario 2



Source: WEMAC Model (2009)

The immediate consequence of the increase in crude oil prices, and input costs analysed in scenario 2, is an increase in the price of all the modelled commodities. Increases in the prices of the oilseeds are generally higher than increases in the prices of cereals. The increase in oil prices creates additional non feed demand for oilseeds as an energy feedstock. In addition there is an increase in the prices of meals, which reflects substitution away from conventional cereals in the feed market in favour of these meals. The projected change in world prices under scenario 2 relative to the baseline are presented in Figure 27.

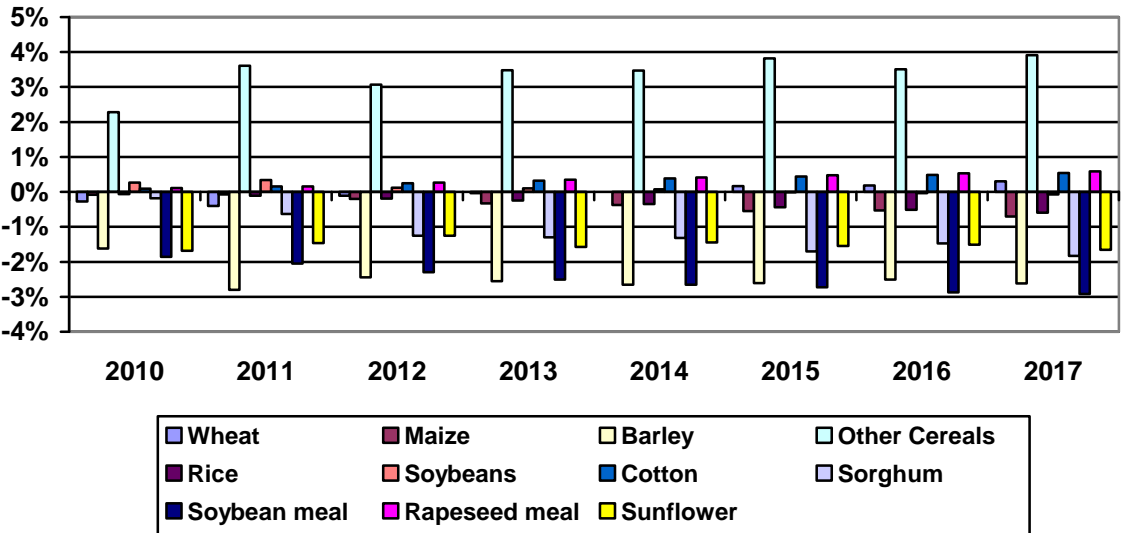
Figure 27: Percent change in world prices under scenario 2 relative to the baseline



Source: WEMAC Model (2009)

Figure 28 presents changes in US production of cereals, oilseeds and oilseed meals under scenario 2 relative to the baseline. In general the direction of the change in production is negative. A notable exception is in respect of other cereals where production increases under scenario 2 relative to the baseline. In particular the production of sunflower seed and soybean meal both decrease. Other changes are small in magnitude.

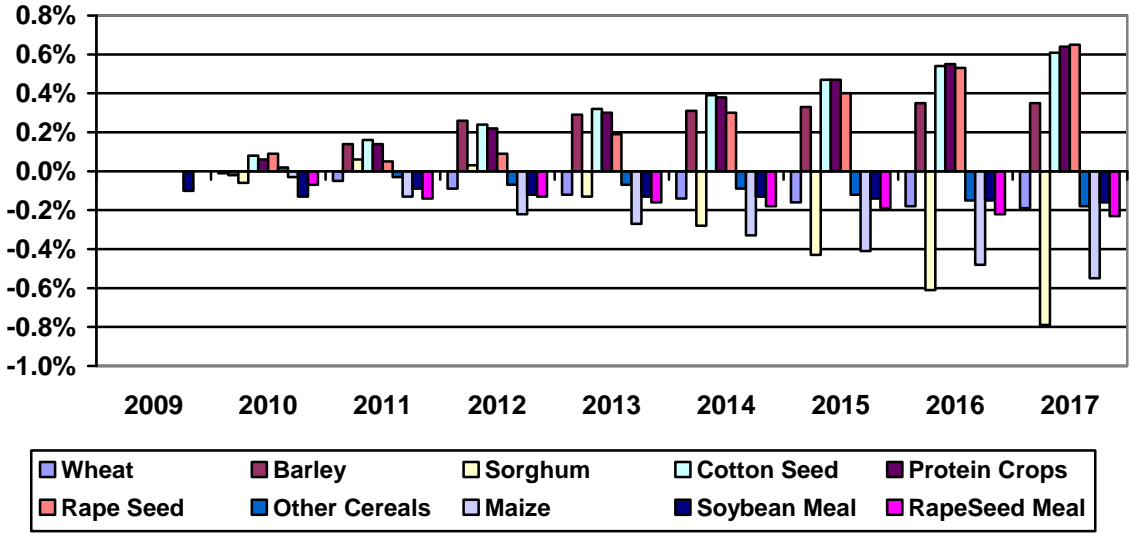
Figure 28: Percent change in US Production under scenario 2 relative to baseline



Source: WEMAC Model (2009)

Figure 28 presents changes in Australian production under scenario 2 relative to the baseline. The impact of the increase in production costs on the level of production in Australia is minimal.

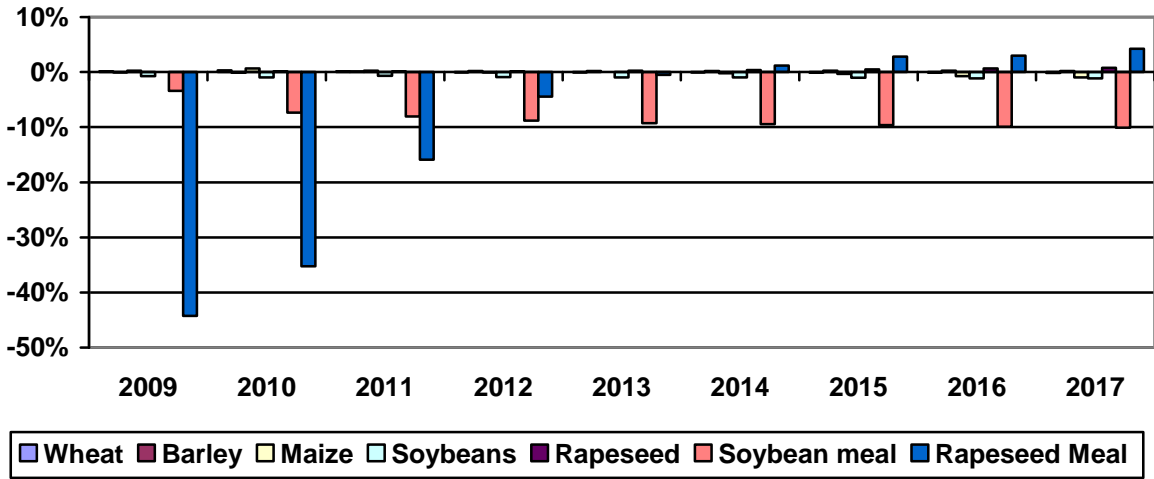
Figure 29: Percent change in Australian Production under scenario 2 relative to baseline



Source: WEMAC Model (2009)

The impact of scenario 2 on net exports from Australia is presented in Figure 30. While there would appear to be dramatic fall in Australian net exports of rapeseed in the initial years of the scenario, this is due to the small baseline level.

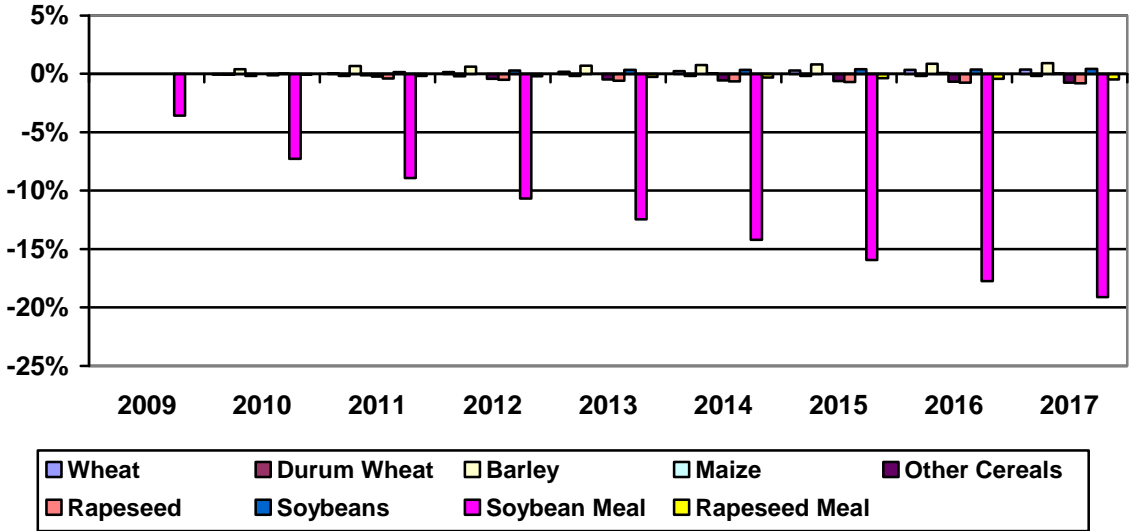
Figure 30: Percent change in Australian Net Exports under scenario 2 relative to baseline



Source: WEMAC Model (2009)

The main impact of scenario 2 in Canada is a pronounced decrease in soybean meal production which is due to increased exports of soybeans. The change in Canadian production is set out in Figure 31.

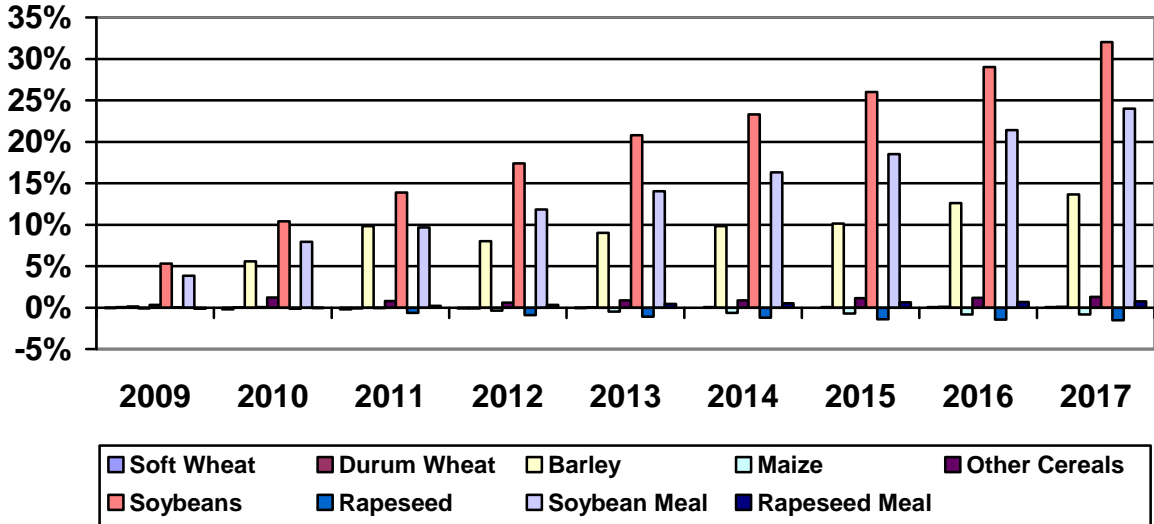
Figure 31: Percent change in Canadian Production under scenario 2 relative to baseline



Source: WEMAC Model (2009)

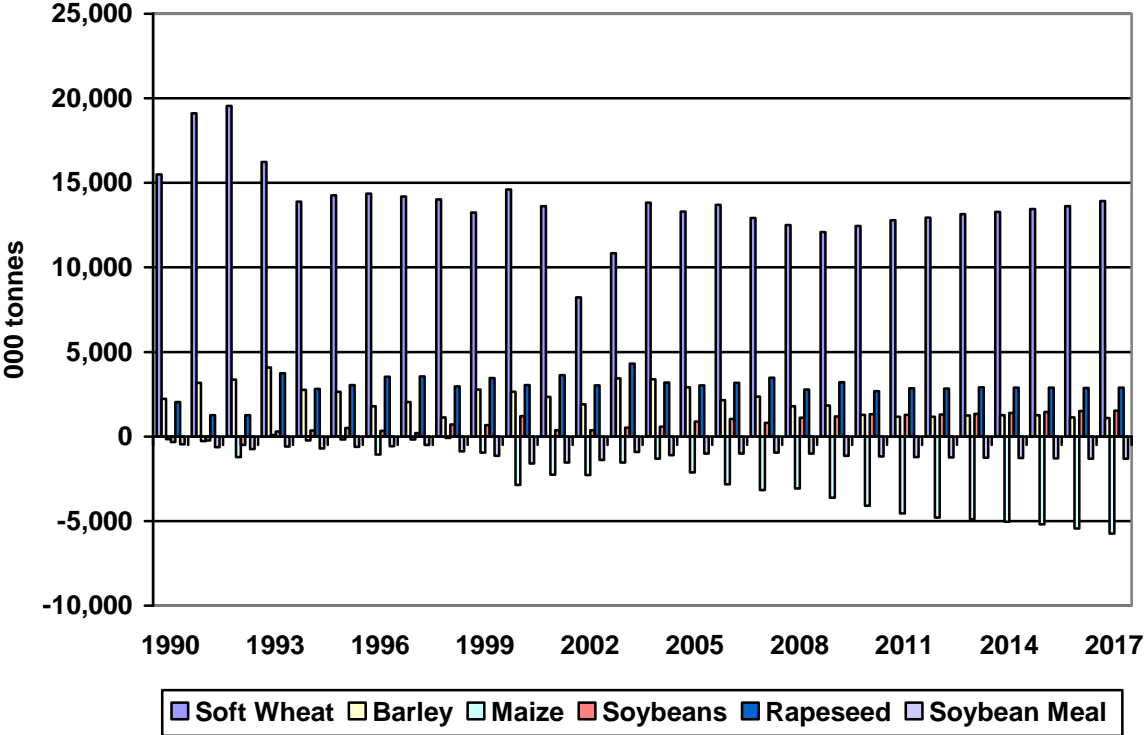
In Figure 32 the projected change in Canadian net exports under scenario 2 relative to the baseline are presented. The scenario has minimal impact on wheat net trade, while net exports of barley, maize and soybean meal increase considerably over time relative to the baseline. Nevertheless, with the exception of wheat, rapeseed and soybeans, Canadian net exports still decrease over time in absolute terms under Scenario 2 (see Figure 33).

Figure 32: Percent change in Canadian Net Exports under scenario 2 relative to baseline



Source: WEMAC Model (2009)

Figure 33: Canadian Net Exports of Crops under the scenario



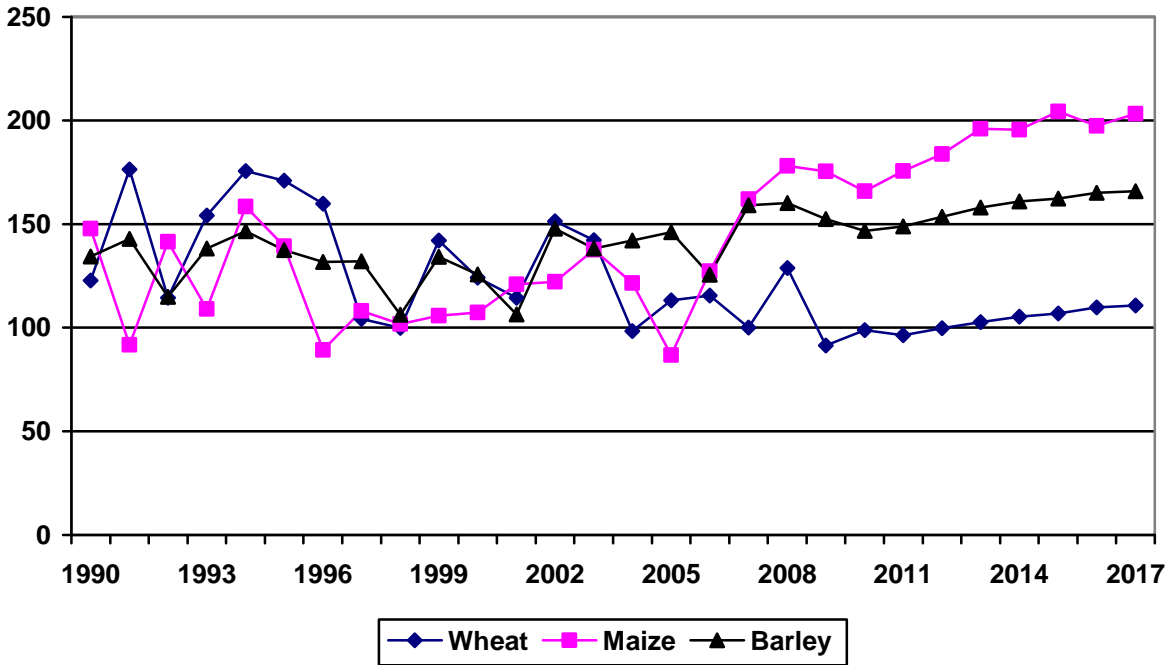
Source: WEMAC Model (2009)

3. Change in crop yields

3.1. Unexpected weather event for wheat in Australia for 2008 (Scenario 3.1)

We assume a 1.15t/ha decrease in the Australian wheat yield in 2008. Yields of other crops in Australia are unchanged. This is a one year only shock that is not sustained into the future. Under the scenario yields recover to normal levels in 2009. The short term price impact on wheat markets is dramatic since the resultant fall in Australian production has a significant impact on global wheat production and trade. World wheat prices are projected to increase considerably due to the absence under the baseline of global stocks. Selected world cereal prices, under scenario 3.1 are presented in Figure 34.

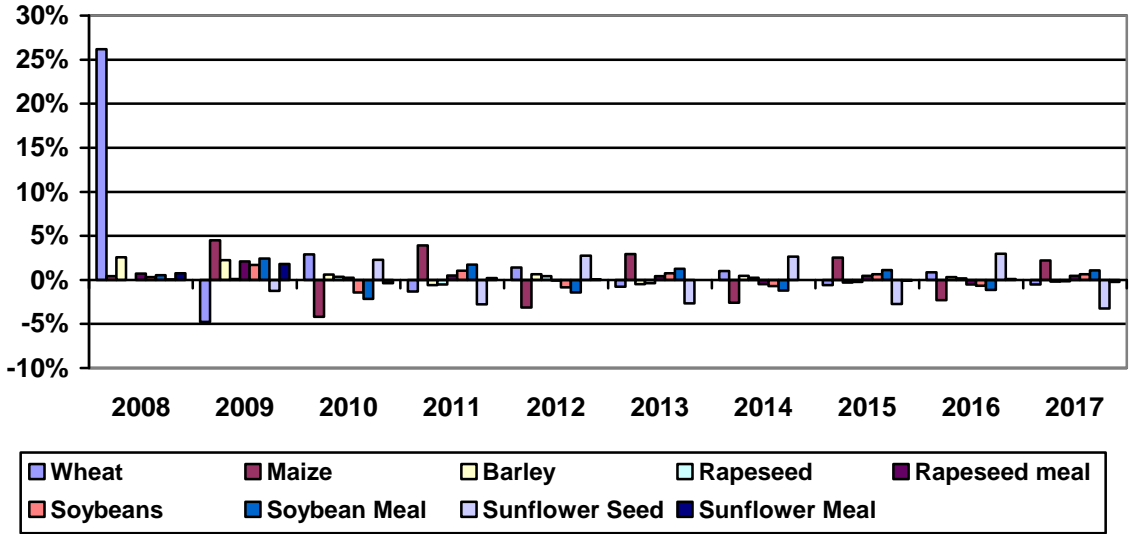
Figure 34: Historical and projected world cereal prices under scenario 3.1



Source: WEMAC Model (2009)

The percentage change in world prices relative to the baseline are presented in Figure 35.

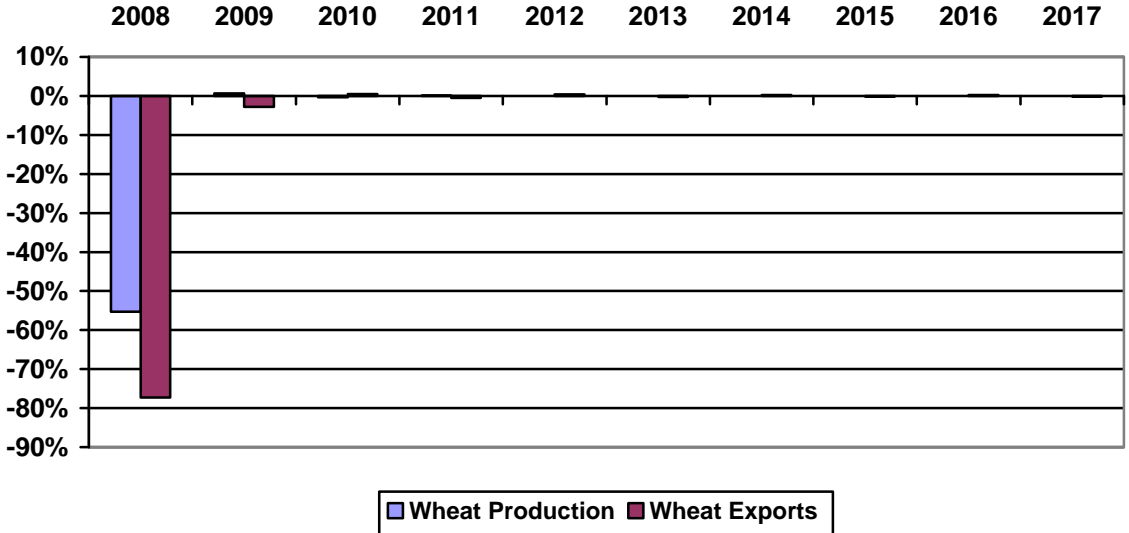
Figure 35: Percent change in world prices under scenario 3.1 relative to the baseline



Source: WEMAC Model (2009)

The impact of the wheat yield shock on Australian wheat production and exports is shown in Figure 36. There is no great increase in the exports of other countries, so the volume of wheat traded globally declines sharply and as a result world prices increase

Figure 36: Percent change in Australian Production and Exports under scenario 3.1 relative to the baseline

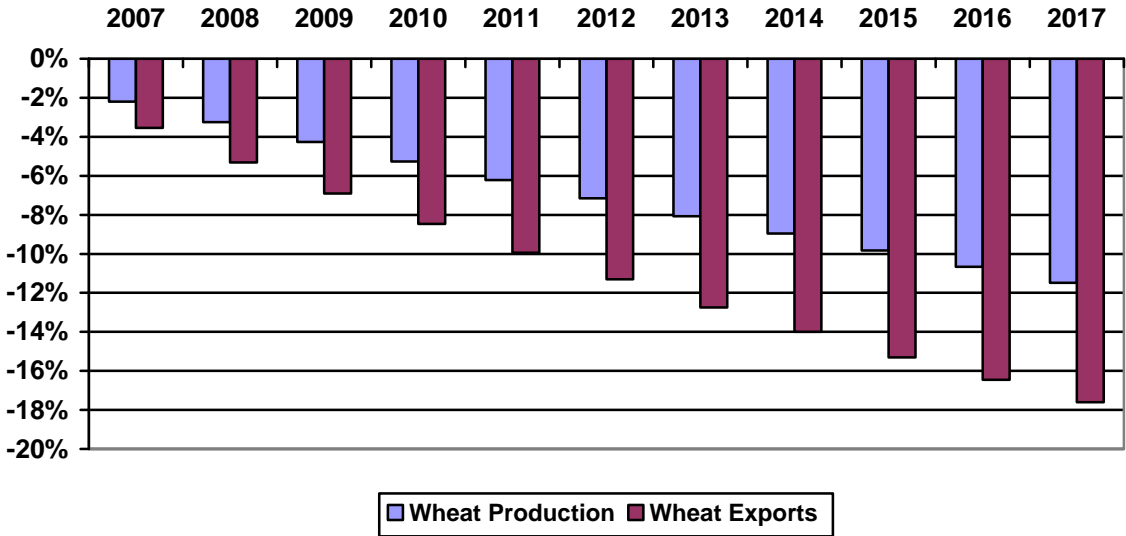


Source: WEMAC Model (2009)

3.2. Slowdown in technical progress (Scenario 3.2)

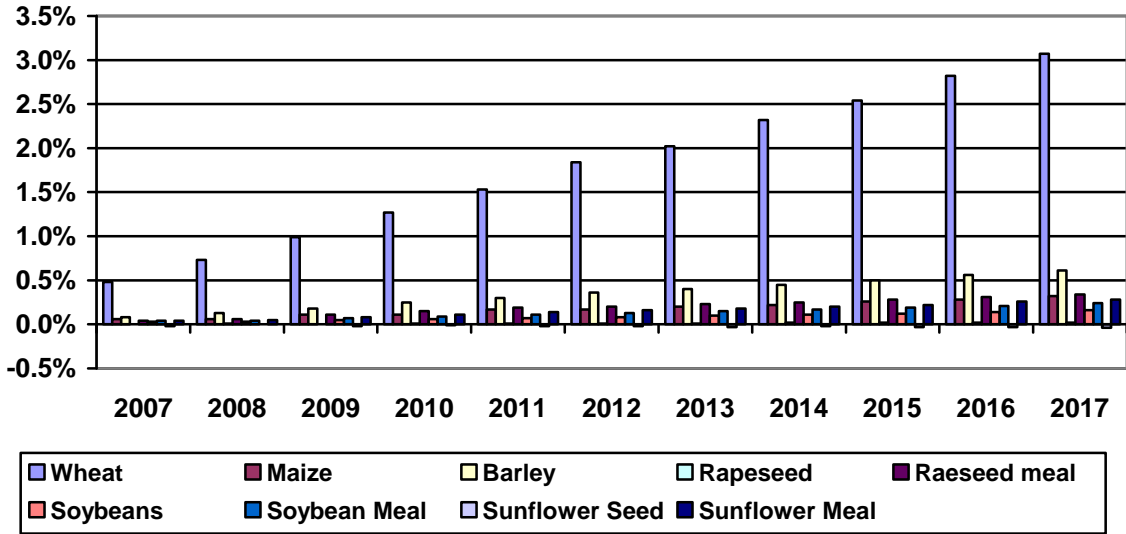
In this scenario we assume a slowdown in the exogenous rate of technical progress in the case of wheat production in Argentina, which leads to a lower growth rate in production than projected in the baseline. Consequently in this scenario, relative to the baseline, production and exports from Argentina are lower and this leads to higher world prices for wheat and more modest positive prices changes for all other crops. Figure 37 presents the change in Argentinean wheat production and wheat exports in this scenario relative to the baseline. Figure 38 below shows the change in the price of crops relative to the baseline.

Figure 37: Percent change in Argentinean Production and Exports under scenario 3.2 relative to the baseline



Source: WEMAC Model (2009)

Figure 38: Percent change in world prices under scenario 3.2 relative to the baseline



Source: WEMAC Model (2009)

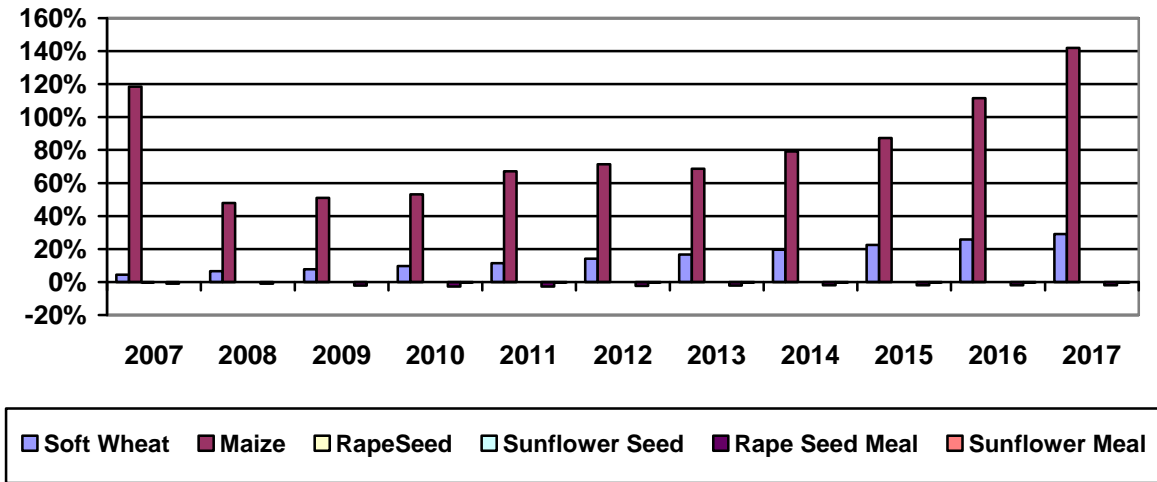
4. Change in biofuels in the EU-15 (Scenario 4)

In this scenario we assume a decrease in the demand for biofuel feedstock in the EU relative to the baseline.

4.1. Decrease in the amount of cereals used for biofuels in the EU

The scenario involves a 20% fall in the amount of cereals (soft wheat and maize) used for biofuel purposes in comparison with the assumptions used under the baseline scenario, for all countries in the EU-15. The impact of this scenario is to depress the demand for biofuels related crops in the EU, which in turn leads to lower levels of crop imports into the EU. As illustrated in Figure 39 this leads to a higher overall level of EU net exports, most notably in the case of maize and to a lesser degree soft wheat. However, it should be noted that the percentage change in maize net exports in the scenarios is calculated against a relatively small baseline level of maize net exports. In absolute terms, the additional maize net exports from the EU are not projected to lead to large changes in the global trade of maize. In contrast, the additional EU net exports of wheat that are projected under this scenario do lead to an appreciable increase in global wheat trade. These different impacts on world markets for maize and wheat of the change in biofuel demand are reflected in the different world price impacts. The greater importance of the EU to world wheat trade, when compared to maize, is reflected in the larger projected impact on international wheat prices of the biofuel scenario examined.

Figure 39: Percent change in EU Net Exports under scenario 4.1 relative to baseline

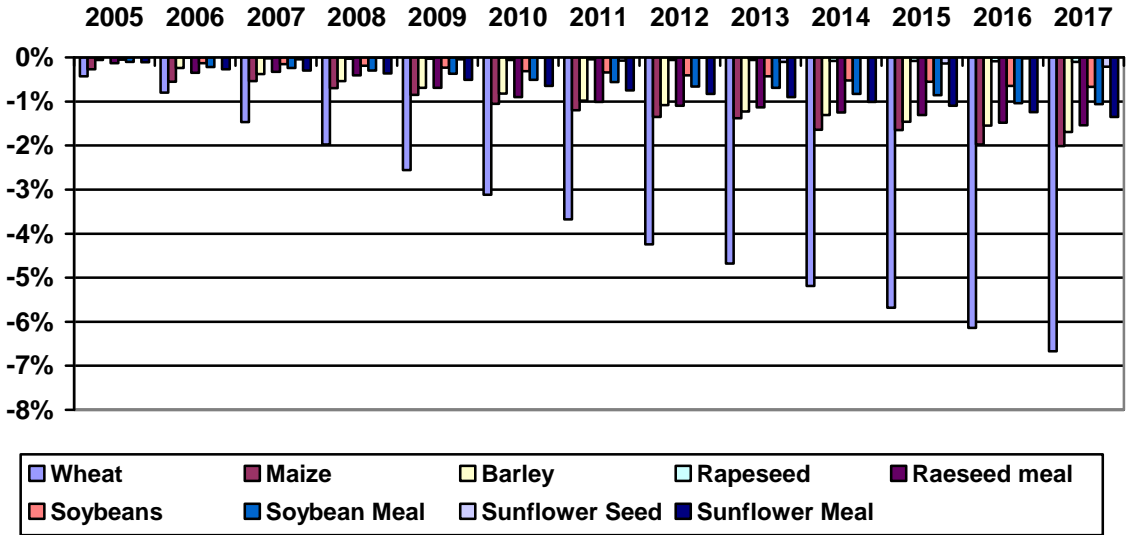


Source: WEMAC Model (2009)

The increase in EU net exports leads to an increase the availability of soft wheat and maize on the world market, relative to the baseline. In turn this reduces world prices relative to the baseline, more so in the case of soft wheat than in the case of maize given that the EU is a bigger

player on the world wheat market. The percentage changes in world prices in the scenario relative to the baseline are presented in Figure 40.

Figure 40: Percent change in world prices under scenario 4.1 relative to the baseline



Source: WEMAC Model (2009)

Conclusion

Here we have seen the capacity of the WEMAC model to handle a variety of different shocks. This demonstrates the versatility of the model and its usefulness to policy makers.

The choice of scenarios has been motivated to demonstrate the wide range capacity of the model to analyse a number of topical issues.

- The macroeconomic shocks examined are highly relevant in the context of the current global recession
- The technical change scenario is illustrative of the type of scenario that could be examined with regard to the adoption of genetically modified crop varieties.
- The yield shock scenario demonstrates how the impact of short run climatic shocks could be addressed in the model
- The biofuels scenario that was examined shows the impact which changes in environmental policy targets can have on crop markets.

