Additional constraints for plant protection
- Price impacts on European agricultural markets-

October 2008

by

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for

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1 Introduction

The Council Directive (91/414/EEC) of 15 July 1991 regulates the placing of plant protection products on the market. This directive is due to be reformed and some proposals concerning the approval routine for pesticides have been made. Several studies (e.g. ADAS 2008 or Nomisma 2008) analyse the impacts of reduced plant protection on agricultural markets. Driven by strong yield reduction for crops ADAS (2008) obtained a considerable reduction in farmer's gross margins at constant prices. The assumption of constant prices, however, is crucial. Although ADAS (2008) only covers UK markets, it is still unlikely that projected shortfalls in production of a major EU crop producer like the UK (about 8% of EU25 supply of crop products in 2002) would not have an impact on prices. Therefore this study specifically addresses the link between additional constraints on plant protection and prices for agricultural commodities. This is even more important since this study does not focus on single countries but on the EU25 in total.

Three scenarios reflecting three revision proposals of Council Directive (91/414/EEC) have been defined, closely related to those analysed in ADAS (2008) and each reflecting a different degree of yield reductions for agricultural products. Those yield reductions have been based on existing studies and have been completed for the whole crop sector relying on expert assessments compiled by the European Crop Protection Association (ECPA).

The quantitative analyses of this study have been performed with the CAPRI (**C**ommon **A**gricultural **P**olicy **R**egionalised **I**mpact) modelling system[1]. The model is a well-known instrument to quantitatively assess the impacts of changes in political, socio-economical or environmental drivers on the agricultural sector. The core of the model is a set of behavioural functions representing farmers, the processing industry, and consumers of agricultural goods. In view of repercussions on international agricultural markets it covers the whole world but being more detailed for European agriculture.

The report is structured as following. In section 2 the analysed scenarios are described. Section 3 deals with the obtained results. In section 4 the limitations of this study are briefly

[1] The full model documentation can be found at http://www.ilr1.uni-bonn.de/agpo/rsrch/capri/Final_Report_Model_Description.pdf, In this study we use the model release of Summer 2007. More details also in section 6.2.

discussed and section 5 summarises the main findings. The appendix in section 6 gives some national results for illustration and a brief technical review of CAPRI.

2 Scenario description

2.1 Reference Scenario

The reference scenario, referred to as baseline in the following, serves as a comparison point for the impact analysis. This means that impacts will be displayed as differences between the scenario under investigation and the baseline, simulated for year 2013. The baseline includes policies as decided by 2004 approximately: The CAP reform of 2003 with implementation of decoupling and payment scheme options (single farm payments, regional uniform payments or hybrid forms) as chosen by different EU Member States, modulation of direct payments, capping of export subsidies and EU preferential trade preferences with e.g. Morocco, Turkey, the other Mediterranean countries, Chile, the least developed countries (EBA initiative: duty and quota free access) as well as African, Caribbean and Pacific countries under the Cotonou agreements. It comprises specific and ad-valorem tariffs as currently applied by the different WTO members. Based on the policy specification in 2004 it does not yet include more recent policy changes at the EU level such as the so called Mediterranean reform of 2004 and subsequent reforms of the sugar, wine, and fruit & vegetable sectors. Furthermore, there are no adjustments included to reflect booming markets for bio energy and the current CAP Health check proposals, including an expiry of milk quotas. The exact specification of the baseline has to be clarified for transparency. Nonetheless, it is unlikely that key findings of this study would have to be revised in a significant way if the analyses were repeated to reflect the most recent policy framework, including the CAP health check of 2008.

The modelling system comprises a tool for projection purposes which simultaneously merges trend analysis with projection results from other studies and imposes a larger set of consistency restrictions on the final projections. For the regions represented by the regional supply models the restrictions cover land balances, closed market balances, feed restriction of animals, fat and protein balances for dairy processing plus the impact of policy instruments as quotas and set-aside restrictions. Bounds are introduced for specific developments, such as herd size increases for pigs and poultry to capture the effect of agri-environmental legislation.

Major developments in EU25 underlying the reference run are in-line with the DG-AGRI Baseline 2007. For the rest of the world, FAO's @2030 exercise and results from FAPRI were used (Bruinsma 2003, FAPRI 2005).

2.2 Constrained plant protection scenarios

Three revision proposals of Council Directive (91/414/EEC) have been defined in three scenarios, closely related to those analysed in ADAS (2008) and each reflecting a different degree of yield reductions for agricultural products.

Scenario 1: *Commission Exclusion*, referring to the exclusion of certain plant protection products or chemicals according to the EU Commission criteria in Directive 91/414/EEC

Scenario 2: *Parliament Exclusion,* Exclusion of products according to Parliament criteria.

Scenario 3: *Parliament Substitution,* Substitution of products according to the EU Parliament criteria.

The exact definition of the criteria is given in ADAS (2008). Each criterion corresponds to a certain substitution or exclusion of plant protection products or their ingredients. At the bottom line the possibility to protect plants against pests is successively decreasing from scenarios 1 to 3 and therewith yields for crops are decreasing as well. Yields of high and low intensity processes for each crop are an exogenous parameter in the CAPRI model and consequently the parameter to be changed. The expected yield reductions corresponding to those scenarios are analysed in ADAS (2008) for wheat, potatoes and brassicas in the United Kingdom. Since this analysis is targeted at the entire EU25 and the whole agricultural sector, 'yield reduction coefficients', giving the percentage yield reduction in each scenario, were needed for all crops in all regions. Based on the ADAS results and expert knowledge (ECPA), a set of plausible yield reduction coefficients was derived and then applied to all regions of the EU25 (Table 1). For all cereals we took over the ADAS results for wheat, given that they follow similar patterns. For potatoes there was a one to one mapping, while brassicas have been mapped to other vegetables. All other crops received a comparable low yield reduction. Gras land is assumed to be insensitive to changing the plant protection constraints and therefore yields were kept constant.

Costs for agricultural inputs are also part of the parameters which are exogenous in CAPRI. Reduced plant protection also implies cost savings. As a simple but transparent assumption costs for plant protection have been reduced by the same percentage as yields.

The scenario analysis is carried out for 2013, because the CAPRI Version used for this study (mid 2007) has been frequently tested on this simulation year. The reform proposals of Council Directive (91/414/EEC), however, are aimed to be completely implemented by 2016. In 2013 some of the crucial substances in plant protection products will still be on the market. This analysis implicitly assumes that the reform is fully implemented by 2013, a simplification but it is again unlikely that the basic findings of this study would change if the projection year were shifted to 2016 (which would require more resources than available at the time of preparing the study).

Table 1 Yield reduction coefficients per CAPRI product

	Scenario 1	Scenario 2	Scenario 3
Soft wheat	26%	44%	62%
Durum wheat	26%	44%	62%
Rye	26%	44%	62%
Barley	26%	44%	62%
Oats	26%	44%	62%
Corn	26%	44%	62%
Other cereals	26%	44%	62%
Rape	10%	20%	30%
Sunflowers	10%	20%	30%
Soya beans	10%	20%	30%
Rice	10%	20%	30%
Olives	10%	20%	30%
Potatoes	22%	35%	53%
Sugar beets	10%	20%	30%
Tomatoes	10%	20%	30%
Other vegetables	25%	45%	77%
Apples, Pears, Peaches	10%	20%	30%
Other fruits	10%	20%	30%
Citrus fruits	10%	20%	30%
Table olives	10%	20%	30%
Fodder Maize	26%	44%	62%
Root fodder crops	10%	20%	30%
Other fodder	10%	20%	30%
Gras	0%	0%	0%
Other oils	10%	20%	30%
Other industrial crops	10%	20%	30%
Nurseries	10%	20%	30%
Flowers	10%	20%	30%
Other crops	10%	20%	30%
Paddy rice	10%	20%	30%
Pulses	10%	20%	30%
Tobacco	10%	20%	30%
Textiles	10%	20%	30%
Table grapes	10%	20%	30%
Table wine	10%	20%	30%

Source: ADAS (2008) and own calculations

3 Results

As expected, the analysed scenarios lead to strong effects on European and international agricultural markets. In this section we first focus on the price effects on wheat and potato markets and draw a more global picture on agriculture in section 3.2.

3.1 Wheat and potato markets

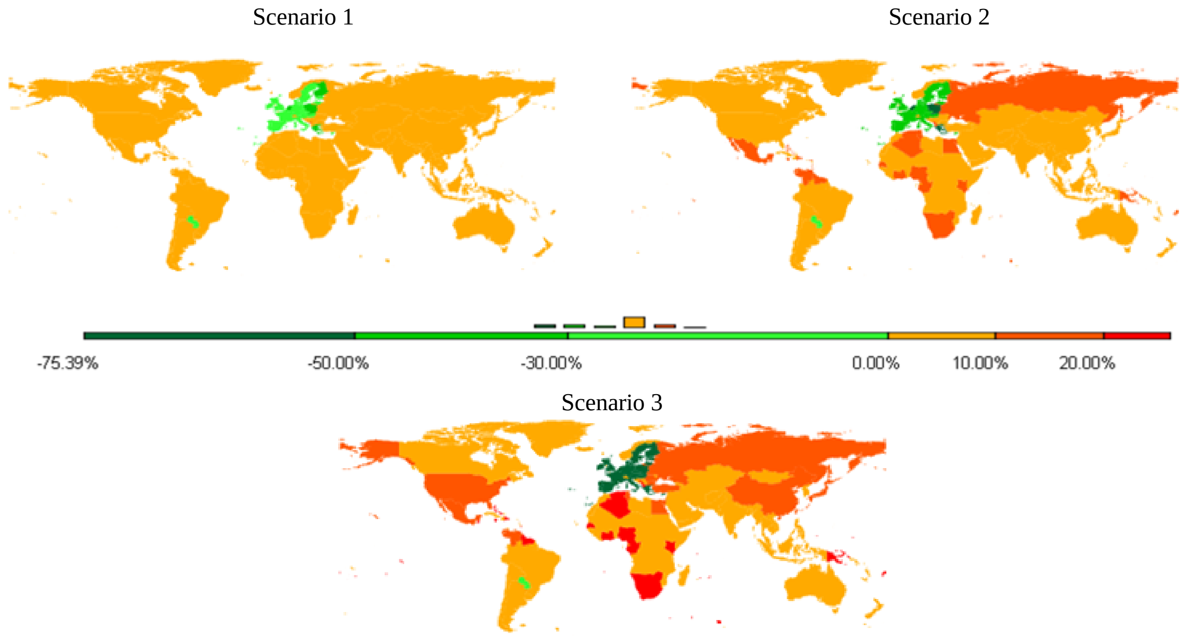
The analysed scenarios have one aspect in common namely that supply of all agricultural products in Europe is decreasing. In Scenario 1, the commission exclusion scenario (yields in Europe reduced by 10% to 26%) we observe a decrease of wheat production in Europe of 28% or 36 Mt[2] because in addition to the yield reduction effects, area cropped with wheat is also reduced. On the global level, wheat production is only reduced by about 2% or 15 Mt. Consequently, extra-EU25 countries are partly compensating the production shortfall in Europe with an increase in production of about 21 Mt. Moving to the other two scenarios, EU wheat supply is decreasing by 46% (60 Mt) in scenario2 and 68% (87 Mt) in Scenario 3. The aggregate of all extra-EU25 countries increases wheat supply by 7% (35 Mt) and 10% (50 Mt) respectively in scenarios 2 and 3. Some EU production is thus reallocated to non EU countries.

In Figure 1, we show a world map for each scenario highlighting the relative production changes compared to the baseline. Green shaded areas go along with production decreases while in red ones increasing production is observed. All EU25 regions are shaded green with the intensity of the green increasing from scenario 1 to 3. Nearly all extra-EU25 countries show an increasing wheat supply, with stronger increases for example in the USA, Mexico, the aggregate of Russia, Belarus and Ukraine as well as South Africa, China or Australia. The dominating countries in absolute additional wheat supply are China, the aggregate of Russia, Belarus and Ukraine followed by the United States.[3]

[2] Million tons

[3] The green shaded country in South America is Paraguay where wheat production is decreasing due to corn, the dominating crop there, becoming more competitive compared to wheat.

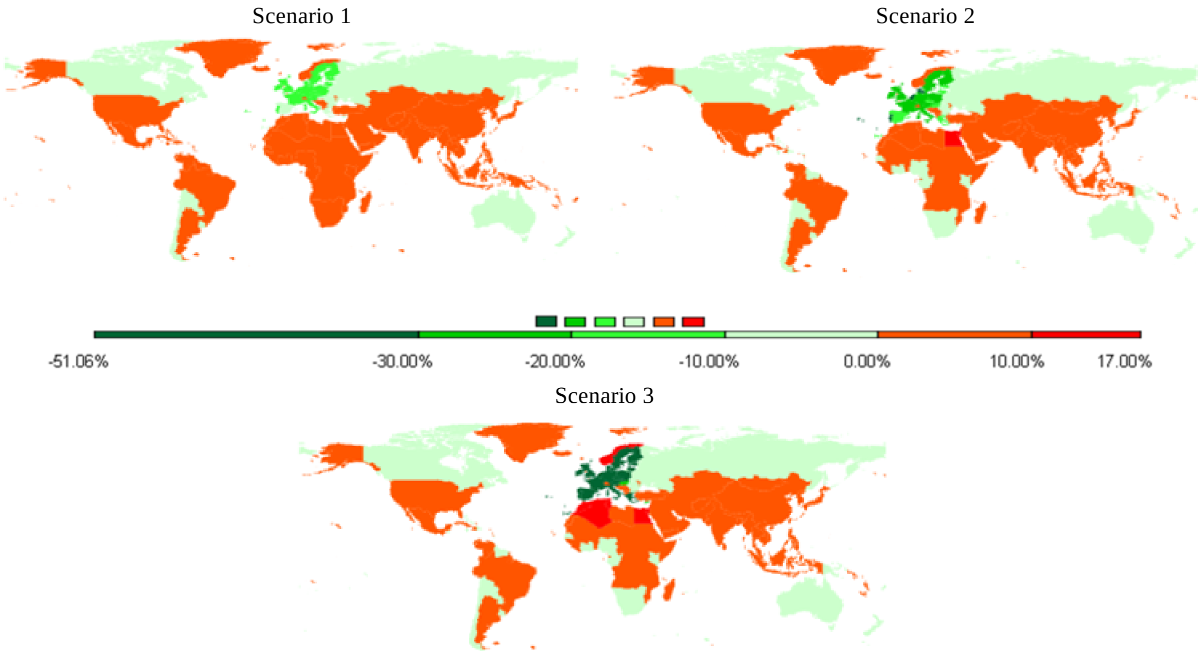
Figure 1 World wheat supply changes



Source: CAPRI modelling system

In case of potatoes we observe a similar picture but with some differences. Potato supply is considerably decreasing as well. Still the simulated reductions of production of 15% (8 Mt), 26% (13 Mt) and 44% (23 Mt) in scenarios 1 to 3 are clearly smaller than the driving yield reduction effects (22%, 35%, 53%) indicating that potato production gains in terms of competitiveness and areas are somewhat increased. Again we would expect other countries to partly compensate the EU supply shortfall, which is visualised in Figure 2. In contrast to the wheat market we see, that there are quite a number of countries, where potato supply is also reduced even though not as much as in Europe. Obviously, potato production becomes less attractive in those countries. Overall it appears that the global production shortfall is very similar to the losses in Europe, meaning that potato use is decreasing all over the world. In the rest of the world this is not due to yield effects but a consequence of changed competitiveness: If cereal markets are more affected from scenarios 1 to 3 their prices on international markets will rise stronger than potato prices such that non EU producers may find it profitable to reduce potato acreage at the expense of other crops, for example cereals.

Figure 2 World Potato supply changes



Source: CAPRI modelling system

Table 2 gives an overview on the market balance positions for wheat and potatoes in the EU25. As already discussed, supply reductions are considerable for both products over all scenarios. With increasing prices, demand is also decreasing, but less than domestic supply, the origin of the disturbance. As domestic demand is decreasing less than domestic supply there would be reduced export activities and increased imports.

A remarkable result is that the EU turns into a wheat net importer in the Parliament exclusion (2) and substitution (3) scenarios. In case of potatoes, the EU is already a net importer in the baseline and this position is reinforced through the scenarios. It is also visible that potato demand reacts more elastic to the new price environment than wheat. One of the reasons is that consumer margins are clearly higher for cereals than for potatoes such that a given price reduction of, say, 20% at the producer level could result in a decline of consumer prices of potatoes of 4% for example whereas consumer prices for cereals only fall by 2% (exact numbers are country specific).

Table 2 EU25 market balance positions (1000 t)

	Baseline			
	Production	Demand	Import	Export
Wheat	128564	111986	10068	26645
Potatoes	52051	53091	1407	367

	Scenario1				Scenario 2				Scenario 3			
	Production	Demand	Import	Export	Production	Demand	Import	Export	Production	Demand	Import	Export
Wheat	92682	103766	25747	14663	68815	97605	35801	7010	41585	90065	51436	2957
	-28%	*-7%*	*156%*	*-45%*	*-46%*	*-13%*	*256%*	*-74%*	*-68%*	*-20%*	*411%*	*-89%*
Potatoes	44029	46889	3025	165	38607	42896	4397	108	29279	36779	7554	54
	-15%	*-12%*	*115%*	*-55%*	*-26%*	*-19%*	*213%*	*-70%*	*-44%*	*-31%*	*437%*	*-85%*

Source: CAPRI modelling system

The described changes of the market balances for wheat and potatoes go along with considerable changes of prices. From Table 3 we can read that in the Commission exclusion scenario (1) the prices for both products increase by about 20%. In the parliament exclusion scenario (2) potato prices would increase by 33% while wheat prices increase stronger (40%). In the last scenario, parliament substitution, assuming the strongest yield decrease for agricultural crops, potato prices would increase by about 60% while wheat prices would be by about 70 % higher. These are quite considerable increases but not surprising given the production shortfall in the EU and the importance of the EU on international markets. These price increases are also in line with recently observed price increases. In 2007 for example, world wheat supply was about 20 Mt lower than in 2005 and the corresponding price increase was above 100%. Given that supply is not elastic within a marketing season, and that several other elements not covered in CAPRI also contribute to the recently observed price changes (biofuel demand, speculation), it is quite reasonable that the resulting price increases are somewhat lower in our model results. Furthermore, we use long term elasticities so that supply and demand can adjust to a new equilibrium and short term shortages of production are not accounted for.

The price increases for potatoes turn out to be generally lower than for wheat although in scenario 1 they are very close. This has several reasons. Firstly, yield reductions are assumed to be lower for potatoes and consequently production shortfalls as well so that less price pressure occurs. Secondly, the importance of the EU on international potato markets is less significant than for wheat. Finally, a higher responsiveness of potato demand works in the same direction.

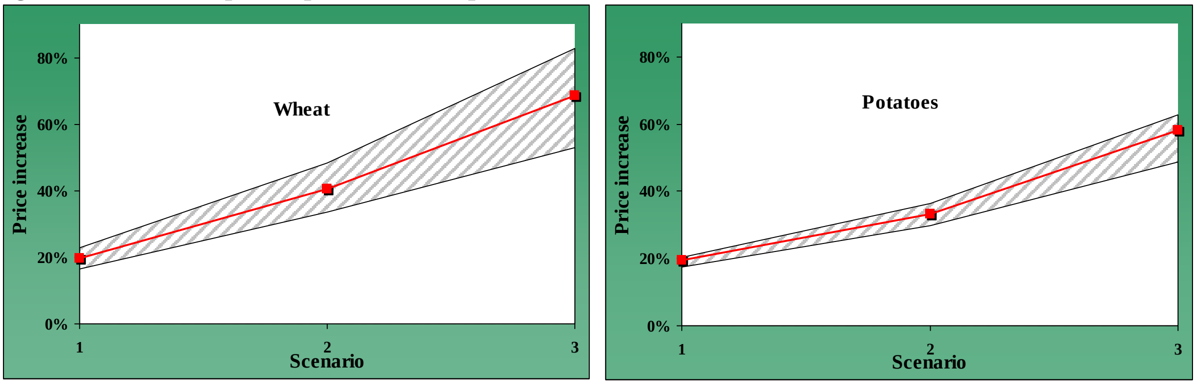
Table 3 EU25 market prices (€/t)

	Baseline	Scenario 1	Scenario 2	Scenario 3
Wheat	111	133	156	187
		20%	*40%*	*69%*
Potatoes	104	125	139	165
		19%	*33%*	*58%*

Source: CAPRI modelling system

However, model results depend on its parameterisation. Most parameters used inside CAPRI are based on econometric analyses and are therefore quite robust. Recent studies (e.g. Weissleder et al, 2008) have shown that the model reacts quite sensitive to the assumptions on how consumers substitute between imported and domestic produced goods. Therefore we carried out a sensitivity analysis repeating the 3 simulations first with an increase of those substitution parameters by 30% and then with a decrease by 30% in order to provide a price range in between price increases are likely to be found. The results are visualised in Figure 3. The red line gives the result of the standard model run according to Table 3. The borders of the shaded area give the results of the other two variations. The lower line corresponds to a more flexible substitution between foreign and domestic goods, while the upper one assumes less substitutability, giving higher price impacts on EU markets therefore.

Figure 3 Wheat and potato price increase per Scenario for EU 25 relative to Reference



Source: CAPRI modelling system

It is obvious that the price impacts are stronger for wheat, and that they increase for both products with increasing yield reductions.

3.2 Effects on Agriculture in Europe

Although this study focuses on wheat and potato markets it is useful to analyse the effects on the agricultural sector in total as well. Since different crops are affected quite differently by the analysed scenarios, their relative competitiveness is also changed. This leads to re-allocation effects of crops.

Table 4 Changes in crop areas or animal herds in EU25 (1000 ha or 1000 heads)

	Baseline	Scenario 1	Scenario 2	Scenario 3
Cereals	51187	-458.86	-1581.56	-4622.7
Oilseeds	6759	-33.81	57.59	357.61
Other arable crops	7351	121.41	233.47	532.03
Vegetables and Permanent crops	13585	350.87	838.7	1799.56
Fodder activities	73241	232.94	734.06	2141.71
Set aside and fallow land	12832	-212.54	-282.27	-208.21
All cattle activities	91191	-2015.98	-3590.55	-6561.66
Beef meat activities	30143	-1068.29	-1816.15	-3412.2
Other animals	398915	-6864.09	-8131.66	-7341.84

Source: CAPRI modelling system

As visible from Table 4 areas with cereals are reduced over all scenarios, mainly reflecting reduced wheat areas. Cereal area is mainly taken up by 'other arable crops' (with potatoes dominating here) and vegetables and permanent crops. Fodder areas are also increasing significantly, while some areas from the fallow land category would return to production because with decreasing yields, marginal areas gain in competitiveness. In the animal sector we see decreasing herd sizes without exception. This is because feed, including fodder and tradable feedstuffs is becoming more expensive, considerably increasing input costs for animal activities. Grassland, usually the most important component of the fodder aggregate, would face an intensification (grass being unaffected by yield reductions), whereas total grassland area is fixed by assumption.

Re-allocation of crops is driven by changes in profitability which combines in turn the effects of changes in three variables: Product prices, yields and input costs. Since product prices are generally increasing (Table 5) and input costs are decreasing (Table 6) changes in profitability depend on whether these two effects compensate the yield losses per hectare (Table 1). The indicator that summarises those three effects is the 'gross margin' (revenues less allocated cost) per ha, which is visualised in Table 7.

Table 5 Price changes for product aggregates in the EU25 (€/t and %)

	Baseline	Scenario 1	Scenario 2	Scenario 3
	Value (€/ha)	% change to Baseline		
Cereals	103	23%	44%	73%
Oilseeds	173	11%	22%	36%
Other arable field crops	110	19%	32%	57%
Vegetables and Permanent crops	634	22%	51%	104%
Meat	1786	6%	12%	24%
Other Animal products	1174	4%	8%	16%
Dairy products	1168	1%	2%	4%

Source: CAPRI modelling system

Table 6 Changes in total input costs for activity aggregates in the EU25 (€/ha and %)

	Baseline	Scenario 1	Scenario 2	Scenario 3
	Value (€/ha)	% change to Baseline		
Cereals	581	-18%	-30%	-41%
Oilseeds	559	-6%	-13%	-20%
Other arable crops	1440	-6%	-12%	-20%
Vegetables and Permanent crops	2401	-6%	-11%	-15%
Fodder activities	324	-2%	-5%	-7%
Set aside and fallow land	181	2%	4%	6%
All cattle activities	636	12%	23%	36%
Beef meat activities	637	11%	22%	34%
Other animals	119	10%	18%	28%

Source: CAPRI modelling system

Given the assumptions underlying the three scenarios, gross margins per hectare would increase for most crop activities, meaning that rising prices combined with cost reduction could indeed compensate yield losses in terms of profitability. The highest relative increase can be found for fodder production activities (low initial value, no yield losses for grass), while the highest absolute increases would be observed in the vegetables and permanent crop aggregate. The latter is due to the assumption that extra-EU trade of vegetables is less flexible than for example in the case of wheat so that prices increase stronger.

Note that the changes in gross margins are not always evolving monotonically between scenarios. We see cereal gross margins increasing in scenario 1 and 2, while they decrease in scenario 3. This effect can partly be explained by the fact that cereals are an aggregate of single crops which are differently affected by the scenarios. For durum wheat and corn for example scenario 1 would yield the highest increases in gross margins whereas the lowest would follow from scenario 3, contrary to most other crops. But even for single crop activities like wheat and barley we observed a non-monotonic sequence of changes. This is simply because low and high yield losses do not cause proportional impacts on prices if the model is nonlinear and the range of yield variation is high.

Table 7 Changes in gross margins for activity aggregates in the EU25 (€/ha and %)

	Baseline	Scenario 1	Scenario 2	Scenario 3
	Value (€/ha)	% change to Baseline		
Cereals	308	12%	14%	4%
Oilseeds	340	9%	14%	19%
Other arable crops	1858	-5%	-14%	-25%
Vegetables and Permanent crops	5633	5%	9%	3%
Fodder activities	160	16%	28%	43%
Set aside and fallow land	37	13%	32%	64%
All cattle activities	370	-1%	-2%	-3%
Beef meat activities	97	-4%	-12%	-21%
Other animals	68	-2%	0%	8%

Source: CAPRI modelling system

Based on these results, it follows that European farmers on average may frequently benefit from reduced plant protection in terms of income effects. This may be a surprising but not at all unreasonable result. It is perfectly in line with a law by British statistician Gregory King (1648-1712) that the value of bad harvest is higher than a normal harvest (essentially due to inelastic demand). Furthermore, we observe already today that organic farms are often obtaining a similar income when compared to conventional farms, even though the price difference between organic products and conventional ones is much smaller than those obtained in this study.

Still the increase in agricultural income comes at the expense of the consumer and the processing industry that have to spend much more money on agricultural products. From the welfare analysis for the whole society in Table 8 it appears that the increase in agricultural producer surplus does not compensate the losses in consumer surplus by far. The profits of the processing industry are also reduced. The EU budged turns out to be positively affected, because of increasing tariff revenues induced by increased imports and savings of budget outlays due to less expenditure on subsidised exports and intervention.

Table 8 Welfare positions, absolute changes compared to the baseline (M€)

	Scenario 1	Scenario 2	Scenario 3
Consumer Surplus	-26160	-54313	-112410
Producer surplus	7421	13617	13932
Profits of the processing industry	-2699	-4611	-3930
Tariff revenues	2637	4704	6940
EU budget outlays	-573	-819	-1147
Partial welfare	-18227	-39784	-94322

Source: CAPRI modelling system

In total welfare is decreasing considerably with the consumer carrying the biggest part of this reduction. It is still a 'partial' welfare measure as it is not embedded in a model for the whole economy (a so-called CGE model) and therefore neglects some linkages with other sectors, and for example, employment effects. Furthermore any environmental benefits, presumably the main arguments for the envisaged changes in legislation, are not assessed in this study.

4 Limitations of the study

No adjustments to technologies

Strong yield reductions as assumed in the analysed scenarios imply changes in technologies as well. Some changes related to yields such as reduced input costs are accounted for by default mechanisms in CAPRI, but the assumed reduction of plant protection and yields might bring along other changes, such as non proportional changes in fertiliser application rates of different nutrients and other farm management practices that have been ignored for simplicity.

Environmental impacts

Neglect of further technological change also implies that this analysis cannot assess the environmental implications. Environmental benefits may result from avoiding undesirable losses of active components to the environment but changes in technologies may also mean that farmers are replacing some ingredients with others or envisage other adjustments with potential environmental impacts. These are not investigated in this study.

International trade behaviour

The market module in CAPRI is subject to several limitations. For example trade flows which already exist can more easily be extended than smaller ones. Trade flows which do not exist in the base year data cannot be introduced at all. Although the first assumption is realistic, huge changes in the EU market balance as obtained by the analysed scenarios are likely to change the trade patterns as well and might indeed create new trade flows that have not been observed in the past. Furthermore, we assume relatively inelastic substitution for some products like vegetables, which are not that easy to transport as for example cereals. This is realistic, but with EU prices increasing as much as simulated, foreign suppliers are likely to invent new strategies to export to European markets. Both points would lead to an overestimate of price effects so that price increases in reality might turn out somewhat lower.

Policy changes

National and international politicians are likely to react to strong changes in the price patterns. The EU for example might relax import tariffs to stimulate imports so prices would increase less. High food prices and decreasing supply quantities would redirect public attention to food scarcity and impacts on poor countries, as in the recent discussions about the merits of support for biofuels. If policy makers react with some 'supplementary' measures the scenarios investigated are still informing the policy debate, but the final outcome of decision making is unlikely to be simply some combination of our scenarios 1 to 3.

Booming biofuel sector and CAP evolution

As said before the recent booms of the biofuel sector are not included in our analysis. This boom was identified as one of the reasons for increasing prices in the last two years (OECD, 2008). Furthermore it has been mentioned in the introduction that some policy changes in recent years have not been incorporated in the baseline. While including this into the analysis will shift all prices to a different, presumably higher level, the relative changes through the scenarios are likely to stay similar.

5 Summary

In this study we analyse the effects of additional constraints for plant protection on agriculture focussing on price effects and in terms of products on wheat and potato markets. Three scenarios have been defined, reflecting different degrees of yield reduction for crops as a result of reduced plant protection. Those yield changes have been used as exogenous drivers in the agricultural sector model CAPRI in order to analyse their market impacts. The main findings are:

Wheat price increase strongly – EU becomes net importer

Wheat prices are increasing strongly from 20% in scenario 1 to about 70% in scenario 3. This goes along with strong production reductions which are partly compensated by increased imports and decreasing exports. In scenario 2 and 3 the EU turns into a net importer of wheat. On the global level wheat production is also reduced, but less than in the EU such that EU production is partly reallocated to other countries.

Potato prices increase but less strong than for wheat

Potato price are increasing less than those for wheat, but with 20% to 60% the impacts are still strong. On the global level potato supply also declines in many regions of the world. Outside the EU this is not due to yield effects but a consequence of losses in competitiveness triggered by increasing prices of other crops.

All other agricultural prises increase as well

Increasing prices can be observed for all agricultural products. Even animal products would become more expensive since increased input costs from more expensive feed tends to reduce herd sizes and thus increase prices.

Total welfare decreases considerably

Increasing output prices and decreasing input cost compensate for reduced yields in terms of agricultural income which would increase therefore from tighter plant protection policies. Total welfare, on the contrary, would decline, basically because large losses in consumer welfare dominate all other welfare impacts, including the agricultural income gains.

This study successfully closes the link between agronomic impacts of reduced plant protection and the economic impacts, especially the price response to reduced supply. We found that price effects induced by a reform of Council Directive (91/414/EEC) are not negligible at all and would have strong impacts on EU and international markets.

6 Appendixes

6.1 National results

For illustration, national results on supply, demand and price changes are given in this appendix. One will observe that relative price changes for countries that belong to one trading block in CAPRI (EU15 and EU10) are the same. This is due to the model assumption of a common trading market. Furthermore, Malta and Cyprus have been left out due to questionable statistics and their minor importance in terms of quantities supplied and demanded in Europe.

Table 9 National supply, demand and producer price changes for wheat

		Baseline			Scenario 1			Scenario 2			Scenario 3		
		Supply	Demand	Prices	Supply	Demand	Prices	Supply	Demand	Prices	Supply	Demand	Prices
		Value (1000 t)	Value(1000 t)	Value (€/t)	% change to Baseline			% change to Baseline			% change to Baseline		
EU 15	Belgium	1995	3771	108.28	-28%	-8%	20%	-46%	-14%	40%	-65%	-24%	69%
	Danmark	5289	4881	104.03	-28%	-3%	20%	-46%	-5%	40%	-66%	-10%	69%
	Germany	27923	18802	105.46	-27%	-8%	20%	-46%	-14%	40%	-65%	-21%	69%
	Austria	1462	948	102.9	-28%	-4%	20%	-46%	-6%	40%	-65%	-8%	69%
	Netherlands	1221	4133	102.04	-31%	-16%	20%	-53%	-30%	40%	-74%	-50%	69%
	France	37710	21009	105.54	-27%	-5%	20%	-45%	-10%	40%	-64%	-16%	69%
	Portugal	10	1676	122.86	-42%	-5%	20%	-67%	-7%	40%	-90%	-9%	69%
	Spain	4358	7788	131.64	-26%	-7%	20%	-44%	-12%	40%	-63%	-16%	69%
	Greece	79	1409	175.96	-25%	-6%	20%	-36%	-7%	40%	-52%	13%	69%
	Italy	2250	6593	148.39	-26%	-5%	20%	-43%	-7%	40%	-62%	-8%	69%
	Irland	1060	1529	89	-28%	-25%	20%	-47%	-41%	40%	-71%	-50%	69%
	Finland	790	985	100.42	-31%	-19%	20%	-50%	-33%	40%	-69%	-48%	69%
	Sweden	2694	1982	98.85	-29%	-17%	20%	-47%	-32%	40%	-67%	-51%	69%
	United Kingdom	15901	14429	109.15	-28%	-13%	20%	-47%	-22%	40%	-66%	-32%	69%
EU 10	Czech Republic	4796	2936	99.72	-28%	-10%	18%	-46%	-18%	38%	-65%	-31%	62%
	Estonia	199	245	80	-30%	-11%	18%	-49%	-23%	38%	-71%	-41%	62%
	Hungary	4535	2197	91.67	-29%	-5%	18%	-48%	-11%	38%	-69%	-22%	62%
	Lithuania	1480	952	89.33	-29%	-12%	18%	-47%	-20%	38%	-68%	-32%	62%
	Latvia	549	330	87.77	-29%	-9%	18%	-49%	-16%	38%	-70%	-32%	62%
	Poland	9610	9026	94.23	-32%	-13%	18%	-53%	-24%	38%	-74%	-39%	62%
	Slovenia	226	233	126.34	-28%	-3%	18%	-48%	-8%	38%	-69%	-19%	62%
	Slovak Republic	1435	1084	89.12	-32%	-4%	18%	-53%	-8%	38%	-76%	-15%	62%

Source: CAPRI modelling system

Table 10 National supply, demand and producer price changes for potatoes

		Baseline			Scenario 1			Scenario 2			Scenario 3		
		Supply	Demand	Prices	Supply	Demand	Prices	Supply	Demand	Prices	Supply	Demand	Prices
		Value (1000 t)	Value(1000 t)	Value (€/t)	% change to Baseline			% change to Baseline			% change to Baseline		
EU 15	Belgium	2806	1463	125.83	-17%	-6%	19%	-29%	-9%	32%	-48%	-15%	55%
	Danmark	1262	1187	81.63	-20%	-33%	19%	-33%	-45%	32%	-51%	-77%	55%
	Germany	10121	8198	83.11	-17%	-18%	19%	-28%	-29%	32%	-46%	-49%	55%
	Austria	528	564	60.81	-17%	-13%	19%	-29%	-22%	32%	-49%	-37%	55%
	Netherlands	7298	5223	91.85	-19%	-20%	19%	-31%	-33%	32%	-50%	-56%	55%
	France	6391	5300	127.01	-17%	-12%	19%	-27%	-21%	32%	-46%	-35%	55%
	Portugal	305	806	114.23	-18%	-5%	19%	-33%	-8%	32%	-55%	-14%	55%
	Spain	1499	3148	148.75	-7%	-5%	19%	-14%	-9%	32%	-32%	-16%	55%
	Greece	689	760	277.65	-10%	-6%	19%	-19%	-9%	32%	-35%	-8%	55%
	Italy	1443	2269	227.43	-13%	-6%	19%	-22%	-10%	32%	-40%	-18%	55%
	Irland	411	739	158.16	-14%	2%	19%	-25%	3%	32%	-45%	0%	55%
	Finland	586	555	69.18	-17%	-17%	19%	-29%	-28%	32%	-48%	-47%	55%
	Sweden	908	1081	123.55	-18%	-14%	19%	-29%	-23%	32%	-48%	-39%	55%
	United Kingdom	5419	6889	105.63	-18%	-5%	19%	-29%	-8%	32%	-49%	-6%	55%
EU 10	Czech Republic	855	864	103.72	-11%	-14%	23%	-19%	-24%	41%	-34%	-25%	73%
	Estonia	181	159	106.72	-11%	-2%	23%	-16%	-4%	41%	-34%	-5%	73%
	Hungary	605	625	148.2	-7%	-3%	23%	-12%	-5%	41%	-28%	-8%	73%
	Lithuania	1036	810	52.7	-12%	-10%	23%	-19%	-17%	40%	-33%	-27%	73%
	Latvia	530	406	74.79	-18%	-15%	23%	-28%	-26%	41%	-49%	-42%	73%
	Poland	13614	11291	49.27	-13%	-11%	23%	-20%	-18%	41%	-34%	-31%	73%
	Slovenia	158	176	123.33	-10%	-6%	23%	-18%	-12%	41%	-33%	-17%	73%
	Slovak Republic	344	341	110.3	-18%	-2%	23%	-29%	-3%	41%	-50%	-5%	73%

Source: CAPRI modelling system

6.2 The CAPRI modeling system

CAPRI is an agricultural sector model linking non-linear mathematical programming models for about 250 regions covering the whole of EU27, Norway and Western Balkan countries with a world wide global market model for agricultural products. In the current study, the model is applied for ex-ante analysis (currently year 2013) in a comparative static mode.

In the regional models, agricultural supply of 39 crop and 19 animal activities is modelled. These cover all agricultural activities according to the definition of national accounts in addition to feed and further input demand. The supply module allows for an explicit representation of the different (semi-decoupled) payment schemes of the CAP, differentiated across production activities and regions. The regional yield per activity is an important input to those supply models.

Price interactions between the EU27[4] countries and 24 other countries or country blocks are taken into account through the market module, a comparative static, spatial multi commodity model of the so-called Armington type for about 40 primary and secondary agricultural products. The module features flexible and regular systems of supply, human consumption, feed, and processing functions. Future changes as defined in legislation are implemented in the Baseline (Reference run for 2013).

Policy instruments for all regional aggregates in the market model include bilateral tariffs (specific and ad valorem) and price wedges, based on OECD's producer and consumer support estimates.

The supply and the market module are linked by an iterative procedure converging to market clearing prices and quantities. The model captures several dozen Tariff Rate Quotas (TRQs) worldwide, covering all important ones for EU's agricultural markets. TRQs in the model are either allocated to specific trading partners or open to any imports. Remaining flexible levies in cereal markets and safeguards for sugar and rice for the EU are captured by the model.

The EU entry price system, partially depending on trading partner and/or TRQ, is integrated in the model through a sigmoid function which is non-symmetric. This function represents the

[4] The EU25 itself is not one single trading block in the market model. It consists of the two trading blocks EU15 and EU10.

Entry Price System as applied by the EU in the fruit and vegetable sector in a rather realistic fashion, while still permitting numerical stability of the system.

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