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Impact of a combined meat tax and vegetable protein subsidy on European agriculture

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Abstract

Cropping and forage systems containing legumes would make European agriculture more environmentally sustainable. In this paper we focus on the impact of a combined meat tax and subsidy on vegetable protein. The policy is implemented in such a way that 2.5% of meat consumption is substituted for by vegetable proteins, in particular pulses. Increased production of legumes would have considerable environmental benefits, to which can be added the benefits of less meat production – considering that livestock production produces large amounts of greenhouse gases as well as pollution due to ammonia emissions and leaching of nutrients into the groundwater. Moreover, increased consumption of vegetable protein and less meat protein consumption would make diets healthier.

The policy shock is simulated with the model CAPRI, which is a partial equilibrium model for the European agricultural sector. The model consists of a supply module and a market module. The supply module comprises around 280 regional farm models (one farm model for each NUTS2 region in the EU27, Norway, Western Balkans and Turkey) covering about 50 crop and animal activities for each of the regions and including about 50 inputs and outputs. The data come from Eurostat's Economic Accounts for Agriculture, with average 2007, 2008 and 2009 as the base year. The trade module is a comparative static global multi-commodity model, covering 47 primary and secondary agricultural products and modelling trade between 60 countries grouped in 28 trade blocks. Among these agricultural products are two legume categories: pulses and soybeans (which are actually pulses, but usually classified as oilseeds). Apart from marketable agricultural outputs, it contains a specific sub-component that models the feed market.

The tax on meat consumption and production is implemented in such a way that the margin between producer and consumer price of meat products increases, such that consumption will decrease by the target percentage. Next a subsidy is applied to the same margin in pulses, until their consumption rises by an amount equivalent to 2% of meat consumption (pulses contain more protein than meat, so the protein content of food remains the same).

This leads to a decrease of consumer prices of legumes go down while the price paid to producers goes up, and the reverse happens for meat products. CAPRI projects a decrease of meat consumption by 2.5%, whereas human consumption of pulses goes up by 865,000 tonnes or 72%. However, not all of this change in consumption means a parallel change in production: net exports of meat increase and so do net imports of pulses; moreover, less pulses are used for animal feed. On balance, production of meat decreases by 1.5% and domestic production of pulses increases by 2.9%. However, since the production of soybeans does not increase (due to the decrease in meat production), overall production of grain legumes increases less than that of pulses alone.

1. Introduction: the rationale for a legume policy

A European food policy is inconceivable without some attention to the role of legumes. Firstly, as major providers of vegetable proteins, these crops are an essential part of our diet if we are to reduce our dependence on animal products. Secondly, even for livestock production legumes are needed as a protein supplement in animal feed. Thirdly, through their capacity to bind nitrogen from the air, they reduce the need for chemical fertilizers (Bues et al., 2013); since the manufacturing of nitrogen fertilizer involves the use of large quantities of energy, a reduction in its use means lower CO₂ emissions. Legumes also have the capacity to improve soil conditions and mitigate greenhouse gas emissions in other ways, albeit depending on how the crop is managed (Williams et al., 2014). A major drawback of cultivating legumes is the increased leaching of nitrates from crop residues – depending on how these residues are handled.

The importance of legumes does not by itself warrant a policy. However, while the consumption of legumes in Europe is actually increasing, production is on a long-term downward trend. Consumption of legumes is overwhelmingly in the form of animal feed, most of which is soy, imported from North and South America. From a situation where legumes were integrated into the agricultural system as a food crop and as a nitrogen provider to the soil, we have shifted to eating meat rather than beans, and to importing large quantities of beans for feeding our livestock. This leads on the one hand to an increased need for nitrogen fertilizer on our own soils – and probably to less healthy soils – and on the other hand to an increased clearance of tropical forest and other natural areas in exporting countries. Lower consumption of animal products (particularly meat) and increased production of legumes in Europe for both human and animal nutrition would have considerable environmental and health benefits, as well as raising the degree of food self-sufficiency in Europe.

Reversing an undesirable trend is obviously a policy task. The question is what policy could achieve this and what the impacts of such a policy are likely to be. In this paper we explore this question by simulating one possible policy: taxing meat consumption and subsidizing the consumption of grain legumes.

We do this with the aid of an economic model for the agricultural sector, called CAPRI. The following section contains a description of this model and of the data populating it. Next we present the results, and discuss to what extent these answer our research question. The final section draws conclusions from the research and points to relevant further research.

2. Method and data: the CAPRI model

CAPRI stands for Common Agricultural Policy Regional Impact. The model was developed from the late 1990s onwards, primarily by a team at the University of

Bonn (Germany) with funding from the EU. It is now applied and developed further by a network of researchers across Europe – even outside EU countries. The main rationale of the model is to forecast the consequences of changes in the EU Common Agricultural Policy: effects on the farm economy, on overall welfare, public expenditure, markets for food and agricultural inputs, land use, and on the environment. These effects are modelled at the level of regions within countries.

CAPRI is a partial equilibrium model for the agricultural sector. It contains a supply module and a market module, interlinked within the model. The supply module of CAPRI comprises around 280 regional farm models (one farm model for each NUTS2 region in the EU27, Norway, Western Balkans and Turkey) covering about 50 crop and animal activities for each of the regions and including about 50 inputs and outputs¹. The market module is a comparative static global multi-commodity model. It covers 47 primary and secondary agricultural products and models trade between 60 countries grouped in 28 trade blocks. Among these agricultural products are two legume categories: pulses and soybeans (which are actually pulses too, but usually classified as oilseeds). Apart from marketable agricultural outputs, it contains a specific sub-component that models the feed market (Britz & Witzke 2014).

The data fed into the model are at different spatial levels: EU and the other 40 groups of countries making up the global market, national level for some data, and regional level for other data. The primary source is the REGIO dataset within the database of Eurostat, the European statistical agency. This set contains data at NUTS2 spatial level (NUTS is a system of territorial divisions within European countries, meant to harmonize these divisions for statistical comparison). Gaps in the REGIO dataset are filled in by additional sources, assumptions and econometric procedures (ibid.). Data at national level are derived from Eurostat's Economic Accounts for Agriculture.

For the simulation discussed in this paper, data for 2009 were used to construct a baseline scenario for 2020. In that scenario current policies remain unchanged. This scenario is shocked by the proposed policy. In the policy scenario, a tax on meat is set up (additional to existing taxation) with the target to reduce meat consumption by 2.5% in all EU member states except Croatia (which was not yet included in the CAPRI database at the time of the analysis). The meat tax raises the margin between producer price and consumer price until the demand for meat at national level is reduced by the target percentage – as steered by the price elasticity for meat in CAPRI. Furthermore, a subsidy, funded by the meat tax revenue, is instituted to reduce the same margin for pulses until their

¹ A further disaggregation to ten farm types for each region (in total 2,450 farm-regional models, EU27) is also possible. This feature of CAPRI is however not used for the application in this paper.

consumption rises by an amount equivalent to 2% of meat consumption. Pulses contain more protein than meat, so the reduction of protein intake from meat is fully compensated by the additional consumption of pulses.

3. Results

The immediate effect of the combined tax and subsidy is on the prices of meat and pulses, of course. This is shown in Table 1: consumer prices of pulses go down while the price paid to producers goes up, and the reverse happens for meat products. We can see that the subsidy on pulses has to be quite large, equal to about 50% of the average margin: since pulses represent only a small proportion of our protein intake, the target of substituting for 2% of meat consumption means a very considerable increase in the consumption of pulses. In figures: the 2.5% decrease in meat consumption means an absolute decrease of 1.1 million tonnes. To compensate for the protein content of this meat, consumption of pulses must go up by 860,000 tonnes – an increase of 72%.

Table 1. Price effects of the meat tax scenario

Reference scenario (2020)			Change under meat tax scenario			
	Producer price	Consumer price	Producer price	Consumer price	Producer price	Consumer price
	€/t		Absolute difference with reference (€/t)		Percentage difference with reference	
Pulses	278	2518	14	-855	4.9%	-34.0%
Beef	3408	6798	-84	159	-2.5%	2.3%
Pork meat	1592	4436	-55	157	-3.4%	3.5%
Sheep and goat meat	5388	5747	-51	138	-0.9%	2.4%
Poultry meat	1578	4668	-16	94	-1.0%	2.0%

In order to achieve the required decrease in meat consumption, the proposed meat tax must amount to 7% of the margin between producer and consumer price, on average. This will lead to a consumer price rise of 2.0-3.5%, depending on the type of meat – different kinds of meat have different price elasticities, and consumers may shift to cheaper kinds of meat. Although the policy is aimed at altering consumer prices, the prices obtained by producers change too: the increased demand for pulses means a higher producer price, and conversely the drop in demand for meat leads to lower producer prices there. The effects on

producer prices of meat also have different elasticities, as a result of different cost structures.

However, not all of this change in consumption means a parallel change in production: the changes in demand for meat and pulses also have an impact on international trade. CAPRI forecasts that net exports of meat increase (the EU is a large net exporter of meat products) and so do net imports of pulses; moreover, less pulses are used for animal feed. As Table 2 shows, both production of meat and production of pulses within the EU change only marginally: the largest effect is on exports of meat and imports of pulses.

Table 2. Effect of meat tax scenario on market balances

Difference, 1000 tonnes						
	<i>pulses</i>	<i>beef</i>	<i>pork</i>	<i>mutton and goat meat</i>	<i>poultry meat</i>	<i>total meat</i>
Net production	67	-36	-562	-1	-95	-693
Human consumption	858	-69	-862	-9	-142	-1083
Feed use	-169					
Imports	518	-27	-29	-2	-9	-67
Exports	-105	7	271	7	39	323
Difference, percentages						
Net production	2.9	-0.5	-2.4	-0.1	-0.7	-1.5
Human consumption	72.4	-0.9	-4.0	-0.8	-1.1	-2.5
Feed use	-8.9					
Imports	37.4	-5.4	-3.0	-0.6	-1.6	-2.9
Exports	-17.4	1.6	9.8	5.6	3.5	7.3

The increase in production of pulses evidently also increases the area under these crops; this effect is important because of the aforementioned environmental benefits of growing legumes. However, the land-use effect of the meat tax policy on legumes is even smaller than the impact on production of pulses: as stated before, CAPRI contains pulses and soybeans as separate categories. Whereas the production of the former increases, the latter does not: the decrease in meat consumption keeps its area stable. The overall increase in area under legumes for the EU-27 (compared to the reference scenario) is only 25,000 hectares, representing a 1.7% increase as a percentage of the total arable land. The impact on land use varies by region, because each region has different comparative advantages for legumes, determined also by the relative production cost of competing crops. This is shown in Figure 1. Increases in legume cultivation can be seen primarily in northern zones: Scotland, Denmark, but also in Brittany and southern Greece; in many other regions it remains stable in comparison to the reference scenario.

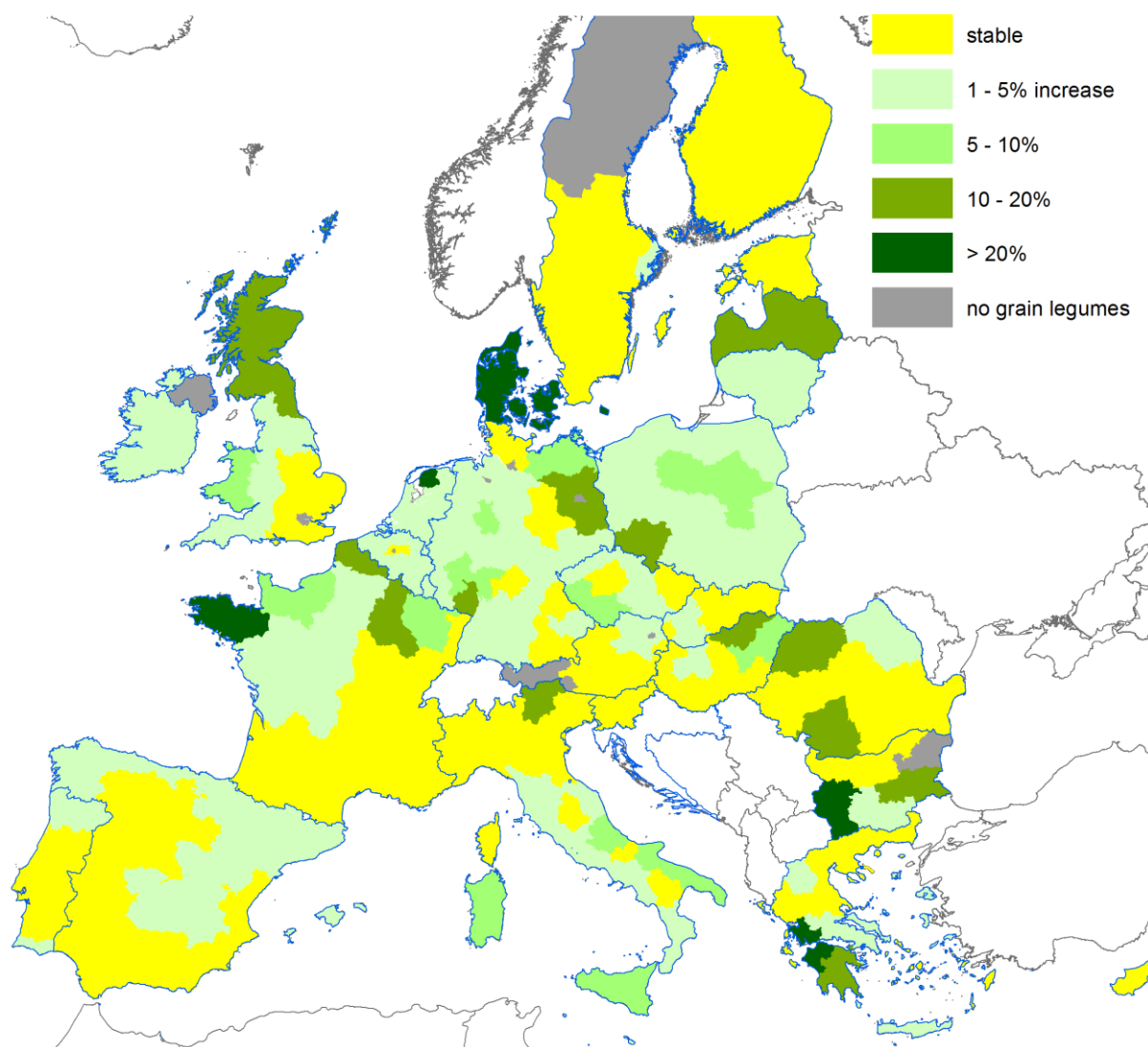


Figure 1. Change in cultivation of grain legumes under meat tax scenario

The largest effects in the livestock sector are in pork, where production decreases by 2.4%. As Figure 2 shows, Germany and Spain will be most affected.

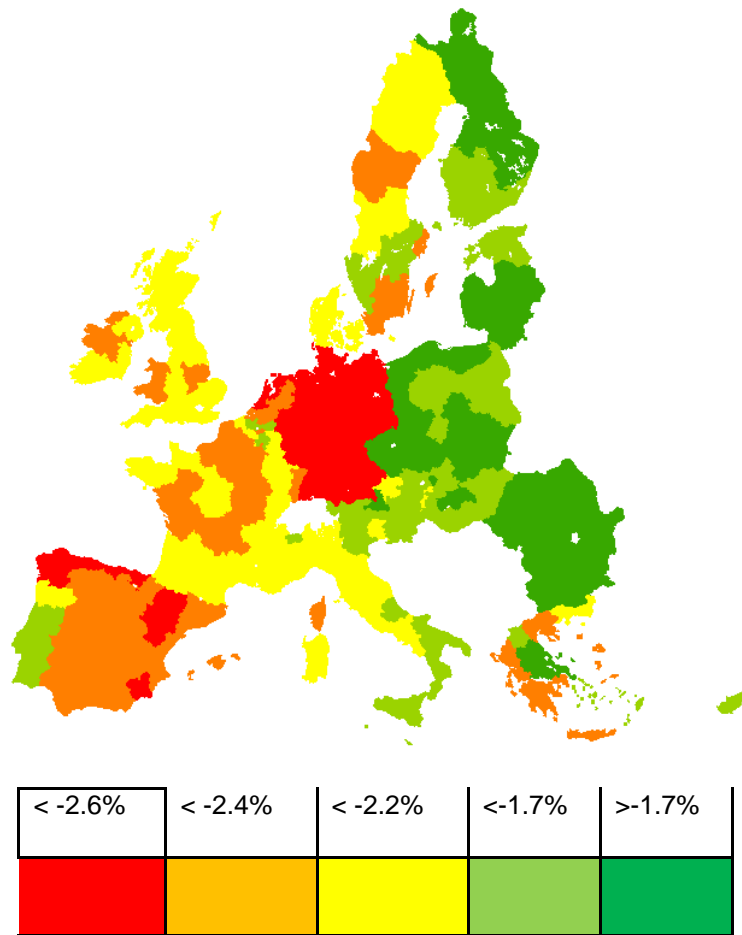


Figure 2. Effect of meat tax scenario on the production of fattening pigs

As the impact on both legume cultivation and on meat production is relatively small, so too is the environmental impact. Emissions of greenhouse gases from agriculture decrease by 0.4% overall (Table 3). This decrease is caused by four different effects of the policy: (1) the aforementioned lower use of nitrogen fertilizers when legumes are cultivated, leading to a reduction in carbon dioxide emissions; (2) lower nitrous oxide emissions from legume crops; (3) the decrease in livestock production, leading primarily to less methane emissions; and (4) agricultural land being taken out of production: fewer animals need less land for feed. The effect of this third factor can be seen in Table 3 by the difference between total emissions and emissions per hectare.

Table 3. Environmental effects of meat tax scenario

	Total	Amount per ha
Ammonia output	-0.67%	-0.62%
CH ₄ total emissions	-0.43%	-0.38%
N ₂ O total emissions	-0.36%	
Global warming potential	-0.39%	-0.34%

Apart from the impact on climate change, ammonia emissions will also be lower, mainly due to less livestock production. Then there is the effect on eutrophication, due to leaching of nitrate and phosphate into the groundwater. Nitrate leaching from legumes tends to be higher than from other crops, due to the high content of nitrogen in crop residues; on the other hand, lower livestock production leads to less phosphate and nitrate leaching. Under the scenario considered here, the latter effect will be larger.

CAPRI also calculates the impact on regional farm income. Overall that impact is negative: although arable farmers will gain somewhat from the increased demand for pulses (tempered by the lower demand for pulses from livestock feed manufacturers), livestock farmers will suffer. The regional pattern of this income effect is presented in Figure 3. The losses are highest in regions with a large share of livestock farms: Sweden, Denmark, the UK, Ireland and Germany. In the Netherlands, losses are limited because much of the livestock production there is in dairying. Net gains are found in only a few regions in southern Italy and in Greece, but on the whole it can be said that losses are less in eastern and southern parts of Europe and highest in the Northwest. These, of course, are net figures for all farms: losses for individual farm types such as pork and beef producers are higher.

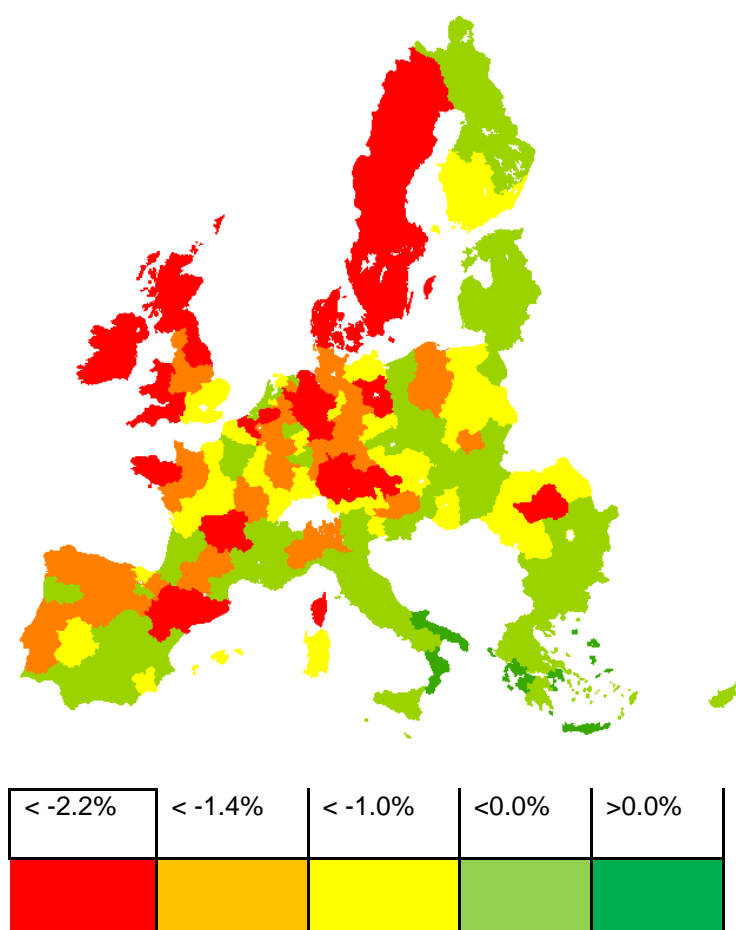


Figure 3. Effect of meat tax scenario on average farm income per region

4. Discussion and conclusions

Several different policies are conceivable that might promote the production of legume crops in Europe. For any such policy it would be important to evaluate its impact *ex ante*. The purpose of this paper is to show how this can be done for one of those possible policies. We have seen that a combined additional tax on meat and a subsidy on pulses for human consumption will have only a limited impact on the production of both meat and pulses, because increased exports of the former and higher imports of the latter will cushion most of the production effect. This demonstrates the usefulness of economic modelling, without which we could not quantify this impact.

The modest increase in legume cultivation is in respect to the counterfactual, i.e. the reference scenario for 2020. As the current trend is a decline in legume cultivation, estimated at 114,000 hectares for the EU-27 between 2009 and 2020, the projected increase under our policy scenario of 25,000 hectares is not sufficient to reverse that trend – only to mitigate it somewhat. Only a much more ambitious policy could achieve such a reversal.

However, what we could show in this paper is only part of the story of the effects of a legume policy. For one thing, the discussion in this paper has been entirely on grain legumes, i.e. legumes harvested for their seeds (peas), with or without their seedpods (e.g. string beans). Other legumes are important for forage: clover, alfalfa, vetches, etc. They have the same general benefits as grain legumes: high protein content, reduced need for nitrogen fertilizer. Their environmental impact is even better than that of grain legumes, as they lack the disadvantage of increased nitrate leaching. Data on forage legumes are sketchy, as they are often not cultivated in pure stands, but intersown in grass swards. Nor is it clear what the trends are in forage legumes, although the general impression is that they are in decline (Helming et al. 2014). Hence, a legume policy ought to pay some attention to forage legumes also – the EU Common Agricultural Policy currently does not speak about this issue.

Furthermore, CAPRI cannot accurately predict all benefits of legume cultivation. Apart from the effect on carbon dioxide emissions (due to the lower need for nitrogen fertilizer) and on nitrous oxide emissions (which are lower under biological fixation of nitrogen), there is also an effect on carbon storage in the soil, which is not accounted for in CAPRI. This not only acts as a mitigation for greenhouse gas emissions, but also improves soil structure, fertility and water retention capability (Bues et al. 2013, Williams et al. 2014, Kuhlman and Linderhof 2014). Legumes may also lead to a reduced need for phosphate fertilizer for succeeding crops, and to greater soil biodiversity, although this is more a result of crop rotation in which legumes are included than of legume cultivation per se; moreover, these effects also depend on crop management practices (Williams et al. 2014).

In addition to these benefits of legume production, increased consumption of vegetable protein and less meat protein consumption would make diets healthier (Rizkalla et al. 2003, Shi et al. 2004, Rochfort and Panozzo 2007). Additional environmental benefits of the meat tax policy (and these are included in our model) come from the reduction of meat production, slight though it may be. Livestock is responsible for 18% of total greenhouse gas emissions worldwide (FAO, 2006). With fixed technologies, the meat tax would reduce meat production and thereby reduce its impact on climate change, but also on impaired water quality from nutrient leaching (Galloway et al., 2008).

Against these benefits must be counted the costs of the policy. On the environmental side, there is one major drawback to legume cultivation: the increased leaching of nitrates into the soil and hence the groundwater, which is caused by the high nitrogen content of legume crop residues. Naturally, appropriate handling of these residues can mitigate that problem. The worst situation is where the legume is grown as a green manure crop, where all of the plant is ploughed into the soil. The best is where it is grown as a forage crop, where the residue is lowest.

There are also costs to the farm economy: although arable farms on the whole will benefit, livestock farms will see a decline in income, which will accelerate the tendency for farms to increase in average size, and hence small farms going out of business – an effect that CAPRI cannot measure, as each region is more or less treated as a single farm in the model.

Finally, of course, there is a cost to the taxpayer, who will pay more for meat. Weighing these costs and benefits is ultimately a political matter. The same goes for the question as to how feasible a European policy affecting people's diets is. There are other ways to promote legumes, for instance by financing research on cropping systems with legumes, therewith improving their competitive position vis-à-vis other crops such as cereals. However, that there is a need for promoting legumes in order to make European agriculture more sustainable can scarcely be in doubt.

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