

The environmental effects of protein crops : implications for policy

Donal Murphy-Bokern, Kroge-Ehrendorf, Lohne, Germany

Tom Kuhlmann, Wageningen University, The Netherlands

Fred L. Stoddard, Kristina Lindström, University of Helsinki, Finland

Christine Watson, Kairsty Topp, Scotland's Rural College, United Kingdom

Peter Zander, Sara Preißel, Andrea Bues, Moritz Reckling, Leibniz Centre for Agricultural Landscape Research, Germany

Summary

This presentation reports on a study conducted for the European Parliament to assess the potential environmental effects of an increase in the cultivation of protein crops in the EU and to formulate a set of policy measures that could be applied under the new Common Agricultural Policy (CAP) to gain environmental benefits from increased cultivation of protein crops by EU farmers. It was conducted in early 2013 during an intense phase of the political debate about the future of the CAP. The study played a role in the development of the CAP reform package now being finalised.

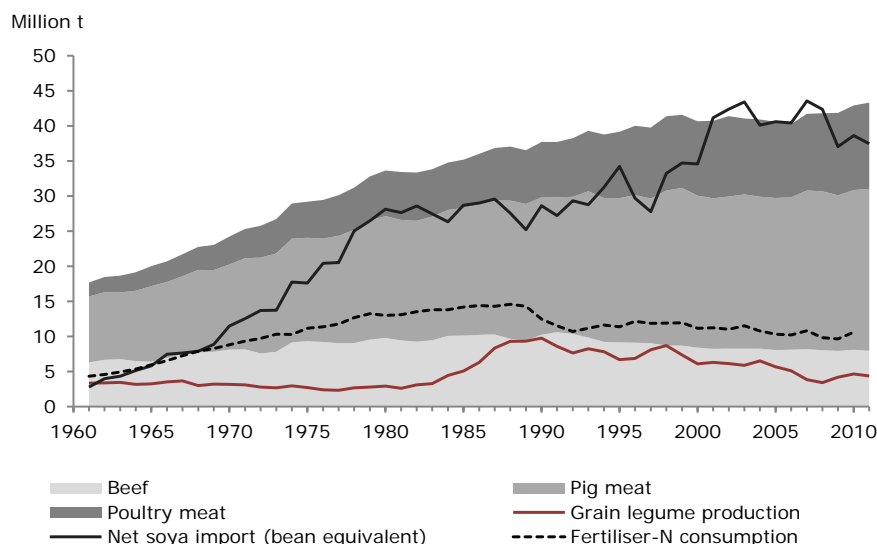
Compared with other major agricultural regions of the world, Europe is characterised by a lower share of legumes in cropping systems. This is because land is preferentially allocated to cereals in most of Europe's cropping regions because cereals grow particularly well in Europe generally. The demand for plant protein which current cropping cannot fully meet comes from a livestock sector scaled to meet the EU's high demand for meat. Our assessment concludes that increasing the production of protein crops would be an important contribution to the sustainable development of European agricultural and food systems. The direct farm and regional level environmental benefits combined with the indirect benefits arising from the better balance of EU agriculture and trade justify public intervention. We recommend that policy makers focus on the public benefits of increased legume cropping in the context of a wider re-balancing of European agricultural and food systems. This requires an integrated approach to policy development, which sees legumes expansion as a component of a wider effort to develop a more sustainable agriculture and food system.

The reform of the common agricultural policy that is now taking shape includes two measures specific to protein crops: the consideration of nitrogen-fixing crops as part of the Ecological Focus Areas and limited provision for national coupled support for protein crops. In addition, protein crops are the subject of the first focus group advising the EU European Innovation Partnership on agriculture and food. Parallel to these policy measures, there are indications that the financial return to the use of legumes in farming systems is reaching parity with that of the dominant legume-free cropping systems. The immediate impact of these policy measures will depend on details which are marginal to the main reform debate. The proposals are modest and any 'watering-down' of them in the final decisions could seriously compromise their impact on legume cropping.

The role of legumes in European agriculture

Legumes play a vital role in European agriculture, but most of the legumes used are grown outside Europe. The EU imports 70% of its requirement for high-protein crop raw material, mostly as soya from South America. This accounted for about 14% of the world-wide production of soya bean from about 15 M ha of arable land outside the EU in 2011. Over the 50 year period 1961-2011, the production of beef, pig and poultry meat in the EU-27 has increased from 17 to 43 million t, with a particularly large increase in pig and poultry meat (Figure 1). While demand for livestock feed increased, our production of protein crops has decreased (Figure 2). Protein crops are now grown on only 1.8% of arable land in the EU, compared with 4.7% in 1961. In contrast, they are grown on about 8% of arable land in Australia and Canada. The direct human consumption of pulses has also declined. It is estimated that only 11-15% of pea and 9-14% of faba bean grown are now used for human consumption.

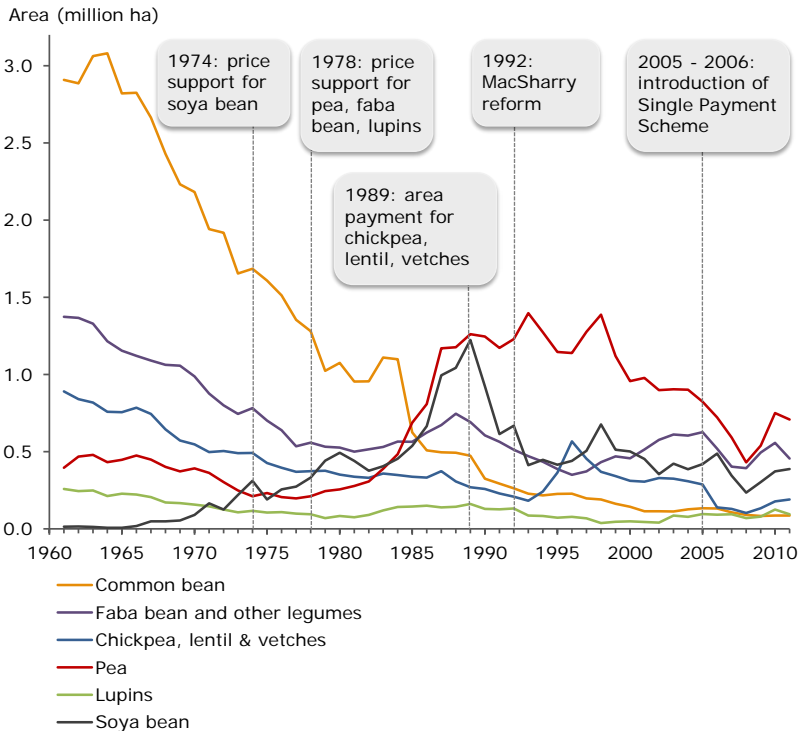
Figure 1: Changes in the production of meat and corresponding changes in fertiliser N use, protein crop production and net soya import for the EU-27 (1961 – 2011).



Source: Calculations based on data from FAOstat (2013)

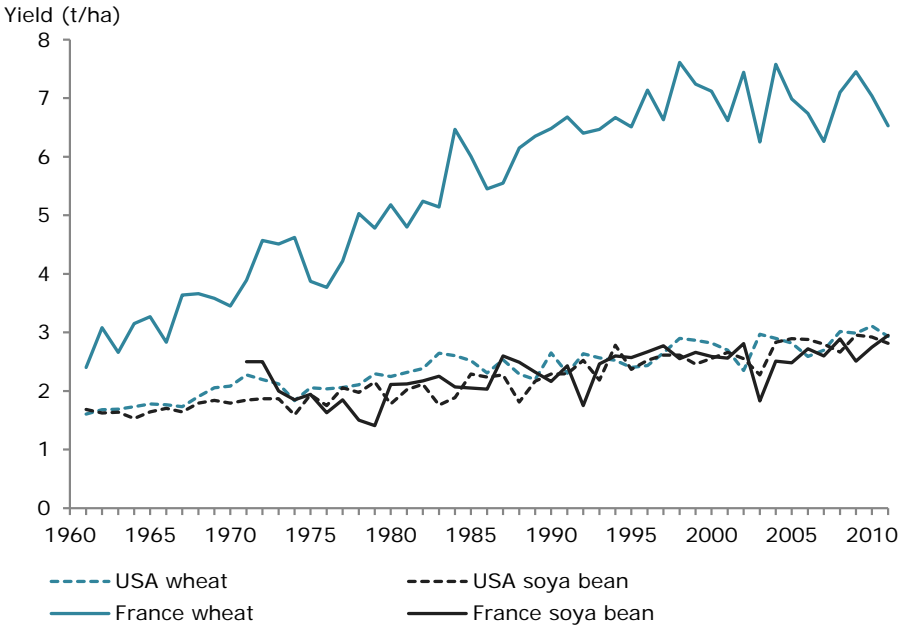
A major underlying driver behind the reduction in the proportion of arable land used for protein crops is the increased comparative advantage in the production of starch-rich cereals in Europe over the production of protein-rich grain legumes. Figure 3 shows the changes in the yield of wheat and soya bean in the EU (using France as an example) and the USA from 1961 to 2011. While US wheat yields are similar to US soya bean yields, wheat out-yields soya in Europe. Furthermore, wheat yields in Europe have increased steadily and are now double those of soya bean.

Figure 2: Production areas of different protein crops in the EU-27 in relation to policy events (1961-2011).



Data source: FAOstat (2013)

Figure3: Yields of wheat and soya bean in the USA and France (1961 – 2011)



Data source: USDA National Agricultural Statistics Service (2013), and EUROSTAT (2013).

The unusually high yield advantage that cereals have over grain legumes in Europe is reflected in farm gross margin data (Table 1). Even when the benefit of legumes for subsequent crops is factored in, the average farm-level gross margin has been reported to be reduced by about 40 €/ha each year, but extreme reductions of up to 228 € as well as slight increases up to 67 €/ha are reported. However such data show that, in many cases, the economic disadvantage of including legumes in cropping systems is small. Against this background of small economic deficits at the farm level, recent changes in some of the economic drivers behind protein crop production may give an impetus to their cultivation. Soya prices have in recent years increased faster than wheat prices, and fertiliser prices have also increasing significantly. In addition, the premium for GM free soya has steadily increased. As a result, the competitive position of legumes has improved in the last decade. However, for the foreseeable future, legume crops will struggle to compete with cereal production for land in Europe and this means public policy remains an important factor. The rationale behind any public intervention is the environmental benefits that legume crops might bring.

Table 1: Gross margins of rotations with and without legumes

Case study, year	Annual gross margin incl. precrop effect (€/ha/yr)		
	Legume rotation	Rotation without legume	Deficit of legume rotation
Regional data, averaged 2000-2004¹			
Germany Saxony-Anhalt	278	281	-3
Germany lower Bavaria	142	167	-25
Denmark Fyn	193	213	-20
Switzerland Vaud	926	1107	-181
Spain Castilla y Leon	55	53	2
Spain Navarra light soil	331	330	1
Spain Navarra deep soil	354	347	7
France Barrois	243	243	0
France Picardie	425	428	-3
Regional data averaged 2001-2007²			
France Eure et Loir	737	738	-1
France Seine Maritime	833	839	-6
Germany Niedersachsen	745	792	-47
Spain Castilla-La Mancha	136	137	-1
UK East Anglia	813	852	-39
Average	477		-24
Range	53 to 1107		-181 to 7

Sources: Calculations based on data from:

¹ von Richthofen et al. (2006b) (Considered precrop effects: yield effect on 1st subsequent crop, fertiliser saving, pesticide saving, reduced tillage).

² LMC International (2009) (Considered precrop effects: Yield effect on 1st subsequent crop, N fertiliser saving)

Resource and environmental effects

Legume crops conserve resources because they require little or no nitrogen fertiliser. The nitrogen left behind in the residue of the protein crop helps boost the yield and reduce the need for nitrogen fertilisers in subsequent crops. The organic matter content and water-absorbing capacity of the soil is often increased thus increasing the yield of following crops, reducing erosion, and increasing the soil carbon content. Protein crops break the cycles of soil-borne diseases of cereals so less pesticide is needed in the following crop.

Protein crops also deliver environmental benefits from increased crop diversity and the impact of this on wider biodiversity. Linked to resource savings, reduced fossil fuel use translates into lower emissions of greenhouse gases and acidic substances. The evidence available so far indicates that nitrous oxide emissions from protein crops are minimal, although emissions can occur following the incorporation of residues. Reducing the quantity of imported soya also reduces pressure on international land-use change. Our review of life-cycle assessments confirms that replacing imported soya bean with European-grown protein crops reduces the resource use and environmental impacts of livestock products. We therefore concluded that the public benefits of protein crops justify public policy intervention.

Relevant policy measures

A range of measures including protection of the market (price support), coupled and decoupled direct subsidies, and agro-environmental schemes have been used to support protein crop production. Between 1958 and 1992 various price support schemes were available for soya bean, pea, faba bean and lupins (Figure 2). In 1989, area payments were introduced for chickpea, lentil and vetches. In the reform of 1992, price support was reduced and replaced with area payments. These payments varied according to crop type, with soya bean receiving less than other protein crops. In the 2003 reform, all area payments were included in the Single Payment Scheme. The 'protein premium', which was a top-up payment within the single payment scheme, was used until 2012 on a restricted area basis in 17 member states, including some of the main protein crop-growing countries. In addition, Lithuania, Poland, and Slovenia used specific measures available to the new member states to support protein crops. We conclude that policy measures used in the last twenty years have temporarily stimulated modest expansion in the legume cropping area showing that legume production is responsive to policy intervention.

Our study examined the options for policy intervention, particularly in the context of the current reform of the CAP. We presented six policy options for supporting protein crops that can be considered in the reform of the CAP. These options are based on thorough analysis of the on-farm and environmental benefits of legumes and the history of the CAP with respect to protein crops.

More stringent crop diversification measures

The current 'greening' proposals on crop diversification are not expected to result in significant changes in cropping patterns, and almost certainly will not significantly increase

the production of protein crops. Much more stringent crop diversification requirements are needed to have this effect. There is an agro-ecological case for tightening up diversification requirements to encourage more on-farm diversity in terms of crop plant families and plant genera. A flexible framework could for example particularly encourage cereal-based farms to use non-cereals in diversified cropping systems. In the context of diversification, however, there is little scientific or agro-ecological rationale to support a general requirement to produce legumes specifically. Such a requirement would conflict with WTO requirements.

Classification of legume-cropped areas as ecological focus areas

Our review provides only limited evidence from ecology to support a policy that would allow protein crop areas to qualify as Ecological Focus Areas (EFA). There is reasonable consensus that grain legumes are superior in terms of farm-level biodiversity compared with the major cereals and maize. But there is little evidence to show that protein crops could compare well with other EFA options in terms of biodiversity, which is their purpose.

However, the simplicity of the measure gives it the potential to provide a significant boost to protein crop production in the context of the current proposals. This could in turn stimulate synergistic private sector investment in crop improvement and technical progress, especially if supported by public research.

Voluntary coupled support schemes

The current proposals include the abolition of the special support under Article 68, but include provision for voluntary coupled support schemes in response to economic and social challenges in a particular area under Pillar 1. These two factors (“economic” and “social” challenges) could be enhanced by an environmental dimension that would provide a basis for supporting protein crops. The scope for this measure is limited by WTO considerations and coupled support schemes are expensive on a per hectare basis. This is a cost borne by those receiving decoupled payments. This option has the potential to allow regional and coupled support schemes to be developed where increasing protein crop production would be particularly beneficial. However, in these areas in particular the subsidy per hectare would need to be relatively high because of the dominance of cereals.

Promote legumes via agri-environment schemes

In the present Rural Development Programme (Pillar 2), measure 214 may support legume cultivation at the discretion of the Member State or regional authority. Such an approach has the advantage of not conflicting with other farm interests, but the potential in terms of area affected is limited. There is also the risk that the protein crops do not perform well in agri-environment terms compared with other options under this scheme. This option has the advantage of being based on a wide range of regulating and supporting ecosystem services provided by legumes. It is also flexible and reactive to regional needs and opportunities, as exemplified by the Entry Level Scheme working in the UK. However, the risks identified for the use of protein crops under the EFAs apply here.

Increase support for organic farming

The use of legume crops is a practical necessity in organic farming systems. There is no doubt that expansion in organic farming leads to wider use of legumes. However, as a means of increasing protein crop production, increasing support for organic farming is an expensive

option. This measure however has the merit of using established frameworks linked to distinct premium markets so that in effect consumers pay part of the cost. If the measure is used, it should be because of the other environmental and social effects of organic farming.

Investment into research, breeding, and technical progress

This review has identified two key features of protein crops: responsiveness to technical improvement and under-estimation of their on-farm benefits by farmers. Here investment in research and technical progress (which was an objective of the CAP when it was introduced in 1962) can play a role.

Strengthen climate protection policies

A protein crops policy can be seen as part of a climate protection policy, even though the benefits of protein crops go well beyond the reduction of greenhouse gas emissions and an increase in carbon sequestration in the soil. Crop production in general contributes directly to greenhouse gas emissions primarily through carbon dioxide emissions from fossil fuel use and nitrous oxide emissions from soils enriched with nitrogen. Measures to tackle these two gases could encourage the production of protein crops indirectly. Any policy that increases the cost of carbon emissions would make nitrogen fertiliser more expensive, and thus legumes more attractive. Measures that increase the price of fossil energy carriers will also make growing legumes more attractive to farmers.

Use nutrient policies

There is a wide range of policies directly and indirectly relevant to the use of nutrients in agriculture. The best known is the Nitrates Directive, but there are others such as the Water Framework Directive and national regulations governing the use of nutrients. The Nitrates Directive has already indirectly raised the relative economic performance of clover-supported dairy systems in Ireland by putting a cap on stocking rates which encourages farmers to focus on costs instead of output. A tax specifically on the use of nitrogen in agriculture is also possible. The tax could be levied specifically on nitrogen in mineral fertilisers and on nitrogen surpluses in agriculture (e.g. the Dutch Mineral Accounting System, the Swedish tax on nitrogen in mineral fertiliser 1984-2010). Taxes on nitrogen surpluses are sound in principle but if implemented fully would consider nitrogen fixed by legumes as an input.

The environmental damage of nitrogen fertiliser has been estimated at 0.37 €/kg of N (equivalent in prices of 2013), including its effect on global warming, pollution and eutrophication. An equivalent price increase alone would hardly be sufficient to compensate the gross margin deficits of grain legumes in most production regions, but a policy that incorporates the environmental cost of the fertiliser would be an important component of an integrated policy approach that could significantly promote legume cultivation in Europe together with other measures.

Support producer initiatives

There are bottom-up as well as state-sponsored initiatives to promote the growing of legumes, which could be supported by the European Union. One such state-sponsored initiative is the Danube Soya Association aimed at growing soya bean in the Danube basin as an alternative to imported soya. It is supported by both EU members and non-member

states in the Danube basin. The German protein crop strategy describes measures to support knowledge dissemination among producers (i.e. crop-specific demonstration networks) as well as support to research and development. Bottom-up private sector initiatives include product certification schemes for animal production based on on-farm or regional feed production, such as those represented by the Neuland brand in Germany and the farmer association 'Mutterkuh' in Switzerland.

Outlook

Protein crops have multiple positive environmental and resource-conserving effects operating at field, farm, regional and global levels. These effects point to the need to recognise the potential of complementary policy measures and to foster efforts to enhance this complementarity. Such an integrated policy approach can be particularly robust if it focuses on the positive outcomes that protein crops can bring about for society. To make them complementary to one another, measures should be rooted in an understanding of the agroecological processes governing the benefits.

With the current low use of protein crops, the promotion of legumes through greening measures can be justified from a practical policy viewpoint. Combined with investment in research and development, this could stimulate private-sector investment in crop improvement and technical progress. This private investment in technical change is important because the current status of protein crops in Europe is determined largely by the yield advantage of carbohydrate-rich cereals. This is a consequence of climate over much of Europe which, despite its diversity, tends to favour high yields of cereals. This means that in the long term, a closing of the yield gap between protein crops and cereals, particularly in terms of protein yield, is an important strategic goal. There is also a need to improve the ability to capture for farmers the on-farm economic benefits of more diverse rotations that include legumes.

The Member States of the European Union are now at various stages in deciding how to respond at national level to the CAP reform decisions made so far. The most relevant measure is the consideration of nitrogen-fixing crops as contributing to the EFA requirement. Any 'watering-down' of this measure, either direct or indirect, will reduce the impact of reform on legume cropping.

Acknowledgements

We want to record our thanks to a number of individuals who helped us in our work. These include Prof. Alan Matthews (Trinity College, Dublin), Ms. Morvarid Bagherzadeh (OECD), Dr. Juergen Wilhelm (The Ministry of Agriculture in Lower Saxony, Germany), and Prof. Markku Ollikainen (University of Helsinki).

Mr. Guillaume Ragonnaud from Policy Department B of the European Parliament provided first-hand insight into the policy development process as it unfolded. His liaison with us was always helpful and supportive.

The study for the European Parliament was completed while most of us were participants in the Legume Futures research project and this helped us access information. Legume Futures (Legume-supported cropping systems for Europe) is funded by the European Union through the 7th Framework Programme under grant number 245216 CP-FP.

Reference:

Bues, A., Kuhlmann, T., Lindstrom, K., Murphy-Bokern, D., Preissel, S., Reckling, M., Stoddard, F.L., Topp, K., Watson, C. and Zander, P. (2013) The environmental role of protein crops in the new common agricultural policy. The European Parliament.