15 Developing Legume Cropping: Looking Forward

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Europe is self-sufficient in most agricultural commodities that it can produce. It is even a net exporter of cereals. This remarkable productivity can be attributed to specialization in high-yielding cereals and oilseeds supported by synthetic nitrogen fertilizer, and large imports of soy from North and South America. However, this productivity comes at a cost for the environment linked to imbalances in European cropping systems. By 2010, when the Legume Futures project was initiated, awareness of these imbalances in our agricultural and food systems was already the subject of discussion in the mainstream agricultural policy community.

This book is the work of 58 authors from across Europe and beyond. Most have received support from the European Union (EU) for research and innovation activities that aim to support legume production. Almost all have received some form of public support. The total support certainly runs to several tens of millions of Euros. In addition to Legume Futures, the EU has invested in LEGATO, LEGRESIST, EUROLEGUME and ABSTRESS, among others. National governments have invested in projects such as CLIMATE CAFÉ, MEDILEG, REFORMA, COBRA and NORFAB. There are many other projects and more regional initiatives to support the production of legume crops in Europe.

This is all applied research. Its primary purpose is to improve the performance of farming and food systems and thereby provide benefits for people and the environment. This purpose is served when research results are used to deliver new practices, technologies, products, support organizational and institutional change, and to support evidence-based policy making. If successful, the research that the authors of this book are now doing or have recently completed will be making an impact on our farms and in our food systems in the next decade and beyond. Will we in 10 years be able to celebrate real impact from that research? Will we be able to

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proudly point to positive change commensurate with the investment our research represents and say we had a part in that?

Such change is not about promoting legumes. Legumes are neither good nor bad. Success for our research is about informing the effective rebalancing of farming and food in Europe using legumes. It is also about global change. In South America, cropping systems with more than 50% soy are common, so their cropping sequences are too simple. Europe is the second largest importer of soy from that region, including from cropping systems that few of us would regard as sustainable. At the same time, enabled by imports of soy, farmers in Europe have reduced legume production to the point that most European cropping systems do not use any legumes at all, so the system is imbalanced at field, farm, regional and global scales. But is change really needed?

Europe is more self-sufficient in protein than is commonly implied. While Europe imports about 70% of the protein-rich material used for feed supplementation, it is actually about 70% self-sufficient in tradable plant protein when all grain and arable forage protein sources are considered. This self-sufficiency estimate increases further when we take the protein from grassland into consideration. Many economists would argue that instead of regarding specialization and imports as a problem, we should celebrate them as a consequence of rational and effective exploitation of comparative advantage. European farmers are as good as or better than farmers in legume-exporting countries at growing legumes, but they are especially good at growing cereals. Agricultural land is scarce in Europe and the cost of land is high. High land rents in particular force farmers to allocate land to crops which are particularly productive in Europe, in most cases cereal crops. A textbook example of Ricardo's law of comparative advantage is clearly at work.

Can we expect change if the current situation reflects rational economic decision making by farmers and wider economic advantage that the use of comparative advantage brings? We can speculate on a number of fundamental changes that determine the likelihood of a rebalancing of agriculture supported by legumes grown in Europe. Reference to Ricardo's law in this context assumes that cropping systems are really optimized from a farm economic viewpoint. But is this the case? Chapter 13 in this volume reflects on the complexity of making assessments of the economic performance of cropping systems and shows that the real (farm-level) economic performance of legumes is higher than conventional gross margin analysis indicates. This means that the potential for economically competitive legume production is probably not fully exploited. However, even accepting that the farm-level economic performance of legume crops is often underestimated, there is consensus that there is a lack of compelling economic grounds for growing legumes for many farmers, especially where cereals and oilseeds grow particularly well. For this to change, we need a number of fundamental changes in framework conditions.

The first is that the technical performance of legume crops needs to improve compared with competing crops. In practical terms, this means that the net output of legume crops needs to grow faster than the net output of competing crops. There is some good evidence that this is possible. Cereal crop yields are stagnating even though breeding continues to increase yield potential (Brisson *et al.*, 2010). Climate change may be at least partly responsible, but negative agronomic factors related to the lack of diversity in modern cropping systems are also likely to play a role. This conclusion is supported by practical observation with increasing problems with weeds and diseases in cereal crops in particular. This means that modern cereal-based systems are approaching and exceeding resource and environmental limits that restrain their performance. If the performance of cereals stagnates or even declines, and performance of legumes continues to increase, we will over time see the comparative advantage of cereals over legumes decline. With this, the number of situations where legumes are competitive due to agronomic reasons will increase. This scenario is supported by investment in plant breeding and improving cropping systems in particular.

The second and related possibility is the costs of producing crops that compete with legumes increases disproportionally. Humphreys *et al*. in Chapter 9, this volume, provide an example of how the price of fertilizer nitrogen influences the profitability of introducing white clover into grass-based farming. In an excellent example of combining biological and economic research, they identified a tipping point in the ratio of fertilizer nitrogen price and the farm-gate price of milk in Ireland. When the ratio of the cost of 1 kg of nitrogen to the price of 1 kg of milk exceeds about 3, grass–white clover-based production tends to be no longer economically disadvantaged. The price of synthetic nitrogen is particularly relevant to perennial systems where the recovery of biologically fixed nitrogen in the system over years is high. Perennial forage crops require large amounts of nitrogen, which can be effectively provided by introducing legumes. The scope for this effect in arable systems is somewhat lower, although clearly the attractiveness of more diverse cropping sequences increases as the cost of maintaining intensive cereal production using synthetic fertilizer nitrogen and plant protection products increases.

The third possibility is the basic value of the crop produce increases relative to that of other crops. Schätzl and Halama (2013) in Bavaria have estimated that if the farm price of soy is more than about twice that of wheat, soy is competitive with wheat in that region. This ratio depends ultimately on the base price of protein compared with starch, set mostly by the world prices for wheat, maize and soy. Long runs of commodity price data (available from Index Mundi) show that the ratio of soy to wheat prices was consistently below 1.5 between 1990 and 2009. The last 3 years (up to mid-2016) are characterized by relatively high soy prices. From Schätzl and Halama (2013), we can expect that these soy prices are high enough to make soy competitive against wheat in many parts of Europe. Reports from farms confirm this. The currently rapid growth in the demand for soy from China is an underlying driver for high soy prices. Using analysis of scenarios, Pilorge and Muel (2016) indicated that the current high prices for plant protein are here to stay, but their scenarios do not highlight the effects of further globalization and increased free trade. From their work, it is reasonable to conclude that protein remains valuable compared with carbohydrate and oil, and that this increases the potential for legumes in Europe with protein yield per hectare being a key determinant of success. Such a development will impact most on the value of produce with the highest protein concentration (soy and lupin). The high starch content of pea and faba beans means that the upward pressure on the value of their protein is buffered by the downward pressure on the relative value of the starch. However, the overall effect is that pea, faba bean and other pulses will become more competitive when protein prices rise.

The fourth possibility is that the market rewards the higher environmental performance of value chains that use legumes. There is definitely growing interest within agriculture and food in higher process quality, manifest in the rapid growth in corporate social responsibility schemes in the sector (Murphy-Bokern and Kleeman, 2015). However, for legume production in Europe to sustainably and substantially benefit from such market premiums, it must be clear that legume crops support improved environmental performance that the consumer can recognize and reward. As we can see in Chapters 3 and 4, this volume, and from Bues *et al*. (2013), there is consensus that diversifying our cropping systems using legumes will bring environmental benefits, but these benefits are modest and probably not sufficient to drive large premiums.

Transition theory offers a fifth prospect for change. In addition to the individual fundamental factors, there is also the possibility of fundamental change based on a combination of small changes leading to breakthroughs at the system level. Voisin *et al*. (2014) argued that the development of legume production has been hindered by lock-in within incumbent structures and processes. For example, older trade agreements supported specialization of EU agriculture in cereal production and this has stimulated infrastructure investment in processing large amounts of imported soybean meal. Complementing this, Europe's natural ability to produce high-yielding cereal crops was reinforced by public and private investment in cereal breeding and supporting technologies. The resulting lock-in or dominance of the incumbent system is manifest for example in the market under-valuation of pea and faba bean in relation to their nutritional contribution in compound feeds (see Chapter 13, this volume). Compared with the dominant European cereal/imported soy system, the lack of a critical mass of production of alternative legumes in Europe reduces investment in technical support and leads to higher transaction costs. With such lock-in, a self-reinforcing dynamic supporting the dominant system works parallel to a self-reinforcing dynamic that discourages alternatives, for example in different levels of research investment. Voisin *et al*. (2014) argued that starting with combining niche high-value chains that give priority to a secure and high-quality supply within regionalized systems, new broader structures and processes can be established. The theory of transition (Geels, 2011) indicates that such new systems can emerge when the effects of several niche innovators coalesce. The innovators in these niche systems are free of the constraints in the dominant system and a wide range of technical and organizational innovations can play a role in each case. Eventually the success of these niche innovations influences the dominant system and changes it. An example of this is the influence that organic food processing has had on the development of 'clean label' processing in conventional food. Voisin *et al*. (2014) argued also that new innovative value chains can target high transaction costs in the conventional system, for example the high costs of controlling the quality of internationally traded commodity compared with the lower cost of controlling the quality of locally grown crop produce. The additional advantage of 'peace of mind' that comes from having direct access to crop produce of known origin can also play a significant role in commercial decisions. New value chains may synergize with each other and with the dominant system. In animal feeding, legume species not only complement cereals, they complement each other, offering a more diverse and resilient supply chain. In agricultural development contexts, the development of a high-value tradable crop such as soy can be used to spearhead improvement of farming more generally. This is particularly relevant in Eastern Europe where synergies based on improved cropping sequences that use legumes can increase the output of both legumes and non-legume crops. Growth of legume production in the east offers the opportunity of new east-to-west trade within Europe as an alternative to trans-Atlantic soy imports.

Lastly, the sixth approach to change is the use of public policy measures. Kuhlman *et al.* in Chapter 14, this volume, reflect on options making it clear that the development of policy instruments is not as easy as is often assumed in public debate. A range of policy instruments supporting legume production have been introduced in the last 2 years in the EU and there are early indications that the trend in the decline in the production of legumes has been reversed. However, as observed in debate recently in the European Parliament, there are trade-offs and political contraindications. There is particular caution about forfeiting the benefits of comparative advantage and the effect that using alternative protein sources might have on feed costs (assuming that alternatives are more expensive). Perhaps the dominant concern now is the challenge to European level measures in general, particularly measures under 'greening' that seek to influence farmers' decisions about the use of their land. In addition to the general 'greening' measures (crop diversification and the ecological focus areas), direct subsidy for protein crops (grain legumes and lucerne (alfalfa)) is provided by the Voluntary Coupled Support in 16 of the 28 EU countries. Payments range from €36/ha in Finland to €417/ha in Slovenia, but official statistics do not yet reflect the effects. Nevertheless, trade sources anecdotally report increased demand for seed for these crops and this generally provides short-term confidence in investment in related value chains.

The future, of course, depends on a combination of these six developments. A systematic use of value chain approaches will help combine and harness these approaches for sustained change at local level within the diverse farming and food systems across Europe. For this, the recently announced plan from the European Commission to invest in innovative research looking at the development of legume-supported value chains is very significant. Development to date provides a rich resource of practical know-how and insights embedded in farming and food businesses which can now be harnessed to improve systems supported by research-based experts. This 'multi-actor' approach complements the research we have had to date, which was largely about components of systems. The successful harnessing of this combined knowledge in value chains is the way forward if we are to be able to look back proudly at effective change in 10 years.

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