Legume Futures

Legume-supported cropping systems for Europe

Project Newsletter 4 **20 September 2012**

Legume Futures at the ESA Congress in Helsinki

In line with the project plan, Legume Futures contributed to the organisation of the 12th Congress of the European Society for Agronomy in Helsinki in August. This Newsletter summarises the Congress presentations relevant to the development of legume-supported cropping systems. Fifteen Legume Futures scientists presented research results in seven talks and 11 posters.

This Newsletter reports on all contributions to the conference relevant to legume-supported cropping systems, not just those from Legume Futures. The abstracts of all presentations can be viewed here.

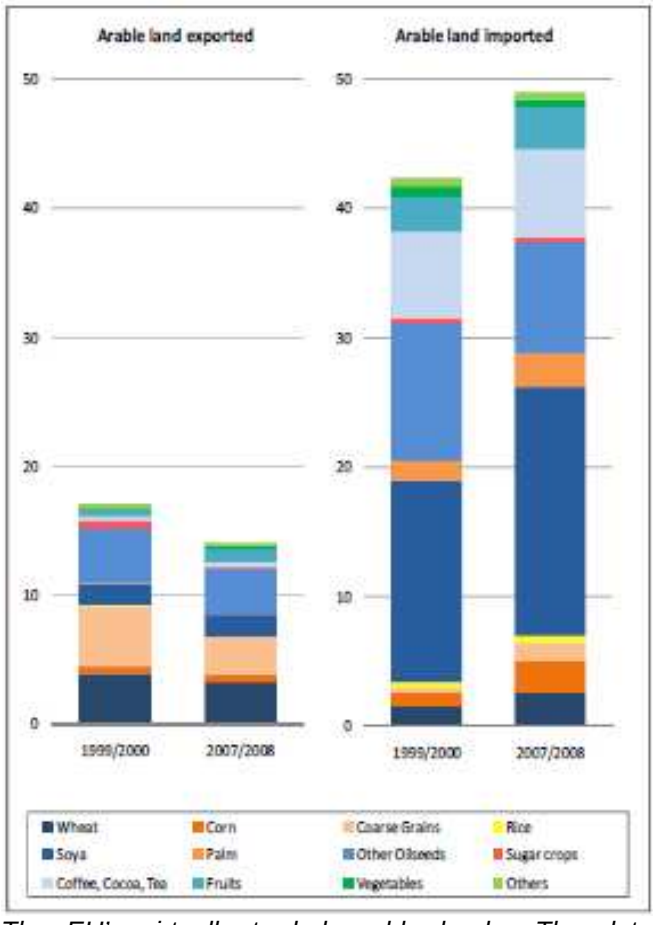
Contact: Fred Stoddard

Legumes in Europe – the broad view

In the keynote presentation, Christine Watson (SAC) set out some important wider considerations and challenges for developing legumes in Europe. European agriculture over the last 30 years has exploited an apparent comparative advantage in producing carbohydrate-rich crops (cereals) while the demand for high quality plant protein to meet growing demand from the pig and poultry sectors in particular has increased and is now met mostly by soy grown in South America. The result is that European food systems are now dependent on a net virtual land import of about 35 million ha due mainly to the import of soy. The EU soy import amounts to the equivalent of 23% of global soy production.

Grain legumes occupy 2% of the agricultural land in Europe, compared with about 8% in Canada and Australia. Therefore, while Europe is actually heavily dependent on legume crops and is a major in world trade, the public benefits of growing legume crops in Europe are missed. Depending on the farming situation, these public benefits may include reduced greenhouse gas emissions from cropping systems, reduced pesticide use, and biodiversity benefits arising from diversification of crop type in the landscape.

Optimising legume-supported cropping systems requires investment in knowledge, technology and know-how. In particular, developing new cropping systems needs the support of crop genetic improvement and related technologies. Legumes are the primary source of reactive nitrogen in organic farming systems. In developing legume supported cropping systems, the understanding and know-how arising from research targeted at the organic sector over the last 20 years by the EU and EU member states is a very relevant and valuable resource.



The EU's virtually traded arable land. The data graphed are the export of crop commodities expressed in terms of arable land used in production. From von Wirzke and Noleppa (2010).

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Legume as main crops

Legumes as conventional single-species main crops are grown in rotation and most of the research on these crops reported in Helsinki addressed rotational or environmental effects.

Moritz Reckling from ZALF in Germany examined rotation options available to farmers using computer-based methods. Farms with well structured sandy-clay soils have a wide range of rotation and legume crop options. In contrast, rotation options on sandy soils are restricted. In general, including legumes in cropping systems requires long rotations. In the context of conventional arable farming, three to four legumes species well adapted to each region are available in all the European regions the studied.

An analysis of data on the nitrogen balance of crops in field plot experiments on a crop and year basis was reported by Pete Iannetta from the JHI in Scotland. The study concludes that in the absence of fertiliser nitrogen, the dry matter and nitrogen yield of legume-supported cropping sequences peaks when legumes account for 50% of the cropping. Legumes have no consistent effect on the nitrogen balance of crop sequences.

Turning to the environmental impacts, Susannah Cass of Trinity College Dublin provided a preliminary report of assessments of flora and fauna in legume crops. The research, which focused on the regions studied by Moritz Reckling, has already shown that legume crops support high levels of soil fauna.

Trial plots of soybean in Sweden. Photo: Fredrik Fogelberg

Fredrik Fogelberg from the JTI in reported on the development of the soybean crop in Sweden. His trials showed that soybeans bred in other countries but well adapted to Swedish conditions yielded 1.8 – 2.4 t/ha. The quality of the beans is high. This research highlights the potential for exploiting variability in soy in relation to responses to day length to develop varieties adapted to a wide range of European conditions, as has been achieved in maize.

Catch cropping

Eric Justes from INRA in France reported that the inclusion of legumes as main crops in cereal and sunflower-based rotations reduced soil carbon and nitrogen reserves. This effect was prevented by using catch crops – mustard, vetches, oats and rape. These results show the importance of growing high yielding crops, whatever the genus, to soil carbon stocks. In another paper, Dr Justes reported that legumes as catch-crops were less effective in reducing nitrate leaching in autumn in situations where main crops left large residues of mineral nitrogen.

Clara Lizarazo examined the effect of lupins on the supply of phosphorus to crops. She has examined the well known effect of lupins in mobilising P reserves that are inaccessible to other crops. By mobilising these reserves in lupins enhance the supply of P to the whole cropping sequence. This is very relevant in the debate about increasing scarcity of phosphorus fertiliser. In relation to that, Martin van Ittersum from Wageningen reported that large reserves of P have built up in soils in developed economies on a continental scale and that mobilisation of these reserves reduces the estimated global demand for fertiliser P by 50% compared to estimates that do not consider these reserves.

Intercropping

Inter-cropping was the subject of a large number of contributions. John Baddeley of the SAC defined intercropping as the simultaneous cultivation of two or more crops on the same area of land. It may increase yield compared with the crops grown separately or provide other benefits. In Dr Baddeley's report, the benefits were evident in low-input or organic systems when a multi-year assessment was made. Intercropping has clear benefits that extend well beyond the intercropping year where nitrogen supply is constrained. The yield level achieved over rotations using intercropping was comparable to that of the average of Scottish farms.

Elise Pelzer from INRA used multi-criteria assessment methodology to examine the effect of intercropping of wheat and peas. N fertilised intercrops produced slightly less wheat than the comparison sole crops but required only 40% of the nitrogen fertiliser. In unfertilised situations, intercrops out-yielded sole crops significantly with a Land Equivalent Ratio of 1.28. The paper does not report on multi-year effects.

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Intercrop of wheat and peas grown near Paris, France. Photo: Elise Pelzer

Eric Justes also reported that intercropping of beans or peas in durum wheat increased yield where nitrogen supply is restricted. Epie Kenedy from the University of Helsinki reported that legumes can be intercropped with Jerusalem artichoke as an energy crop reducing nitrogen fertiliser requirements.

Soybean-sunflower intercrops showed that there was scope for optimising intercrops through selection of component varieties so that inter-specific interactions are optimised.

There are situations where intercropping with legumes reduces yield. Reinhardt Neugschwandtner reported consistent yield reductions in oat/pea intercrops grown in Austria. From farm-based trials of legume-duram wheat intercrops grown in the Camargue region of France, Santiago Lopez-Ridaura reported that high LERs (greater than 1) were widely achieved in 2009-2010 under unfavourable weather conditions. The opposite occurred in the more suitable 2010-2011 season when most of the intercrops under-yielded. The results confirmed the commonly cited effect of intercrops reducing the risk of low yields under unfavourable conditions.

Intercropping in tree crops

Faba beans growing between olive trees in Morocco. Photo: Daoui Khalid.

Several papers examined the effects of intercropping legumes in tree crops – notably in olives and walnuts grown in the Mediterranean region.

In olives, cereals grown between trees reduce olive yield by up to 30% while faba beans have no effect on tree yield. Bean plant morphology and yield is strongly affected by position between the trees. In line with the work reported by Eric Justes, selection of bean varieties specifically for intercropping is beneficial. Aurelie Metay from Montpellier Supagro also reported benefits to intercropping trees (walnut) with chickpeas and in that case, the chickpea had the advantage of exploiting high levels of light before leaf emergence of the walnut.

Forage legumes

Aleksandar Mikić of the Institute of Field and Vegetable Crops and Branko Ćupina of the University of Novi Sad reported on innovative and extensive studies of intercropping annual legumes for forage. These are mixtures of legumes.

Intercropping faba bean with Hungarian vetch. Photo: Aleksandar Mikić

They show how mixtures of legumes allow species with contrasting phenology and structure to be combined using crop design concepts. Species with good standing ability such as beans and lupins are combined with climbing legumes such as vetches. The overall result is more efficient resource capture and reduced harvest losses of the climbing legumes.

Another way of legume intercropping is the use of field pea as companion crop in establishing perennial forage legumes such as lucerne, red clover or sainfoin. Here pea plays the role of bioherbicide in the earliest stages of the undersown perennial legume and contributes to the total forage yield in its first cut.

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Sustainable food consumption – implications for the nitrogen cycle, cropping systems and legumes

In a presentation reviewing five separate research projects conducted over 10 years, Donal Murphy-Bokern examined the implications of more sustainable food consumption for land use and crop production.

Halving EU's meat and dairy production in line with consumption change linked to health recommendations cuts reactive N losses from the food system by 40%, GHG emissions by 25-40% and reduces health risks. There are profound implications for land use, soy imports, and the environment.

Even though the reduction in the livestock component of the diet is compensated by increased consumption of plant-based foods, the overall effect is a reduction in the need for agricultural land. The EU's cropland requirement for food production drops by 25% opening up land use options. For developing legume-based cropping systems, the research indicates that such a change in diet will have only minor and marginal effects on the demand for legumes for direct human consumption compared with the role legumes play in livestock feed. A 50% reduction in livestock production reduces the demand for soy by 75%.

This research shows that the effects of on-farm and other technical mitigation measures pale into insignificance when compared with the effects of consumption-based production changes.

Legumes-supported cropping systems – a complex combination of innovation opportunities in all of Europe's agricultural regions.

Summing up the contributions in the two Congress sessions on legumes, Donal Murphy-Bokern and Jaume Lloveras reflected on the breadth of research findings reported.

Legumes are remarkable in the range of crop types included. They are therefore capable of adding diversity to all crop and forage systems in Europe, and to a huge range of markets – animal feeds, fresh horticultural produce, and processed food markets.

In line with the commitment in the Legume Futures project, the Congress was successful in bringing together a wide range of research results relevant to the development of legume-supported cropping systems. The meeting was successful too in subjecting the opportunities and challenges offered by legumes for society to critical and objective scrutiny.

Taken together, the research results reported present a complex picture from which it is difficult to extract general messages or themes for those at the sharp end of crop development: farmers, breeders and policy-makers.

The range of research results cover four types of legume crops: grain legumes, catch crops, intercrops, and forage crops.

The minor-crop status of legume crops in arable farming systems in all parts of Europe combined with their mass-flowering habit means that benefits of expansion for biodiversity can be confidently expected. However, there were no reports of grain legume crops competing economically with cereal crops in Europe under current prices for imported soy and nitrogen fertilisers. The lack of research results on the improvement and production of these crops reflects the current low level of investment in improving them.

The economic and agronomic position of forage legume crops seems to be better. We know from research in Ireland that white clover-supported grassland-grazing systems are economically competitive with pure perennial ryegrass and the economic position of clover strengthens as nitrogen fertiliser prices increase. The innovative research on mixtures of forage legumes (Mikic and Cupina) in Serbia reinforces the view that forage legumes are competitive.

Capturing rotational benefits is a factor in determining the competitive position of legumes. Competiveness is greatly increased by constraints on other supplies of nitrogen. Intercropping is clearly effective in these circumstances and benefits extend into subsequent crops. Eric Justes has clearly show with high quality data that non-legume catch crops help extract the full benefits of legumes in arable systems and that the higher biomass productivity of the non-legume catch crops contributes better to the soil carbon balance.

Overall, we know that legumes offer a wide range of agronomic and environmental benefits. What was clear from the Congress presentations is that the optimium exploitation of these will depend on investment in knowledge intensive farming systems with fuller assessment of the long-term effects on farms, especially in relation to nitrogen fertiliser savings. The development of successful systems for different parts of Europe requires a concerted approach from different natural and social science disciplines.

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