

15th October 2014: Taking a global view



Aims

This was the first meeting in the series, and the aim of it was to help lay the foundation for the rest of the year by taking a global view of the connections between food security, biodiversity and bioenergy. The three witnesses also used their research and interests to think about some of the research pathways that will help us to prepare for and address these future challenges.

Witnesses

Ariel Brunner, the Head of EU Policy at BirdLife International travelled over from Brussels. He joined **Tina Barsby**, the CEO of the National Institute of Agricultural Botany (NIAB) in Cambridge and **Paul Dupree**, Professor of Biochemistry in the Department of Biochemistry.

Research gaps

Tina Barsby talked about ways in which research is driven by the market, particularly how/what crops get on to the market. She argued that there is a **tension and a gap between the commercial value of supply and the public demand for crop varieties**. Balancing populations demands for energy and food security will increasingly demand local solutions for local people so she very interested in participatory plant breeding and how to farmers in the collection and preservation of genetic diversity. Many of these new crops are developed for commercial purposes so she calls for more research into ways to transfer technology developed for commercial gain into non-commercial areas. She highlighted 'orphan crops' such as sweet potatoes, cassava, bananas which reproduce vegetatively and are locally important but where relatively little work has been done.

In his introduction, Ariel outlined some of the **tensions between agriculture and biodiversity**, between asking questions about both of these at global compared to local scales and between the perceptions and needs of the developed and the developing world. He argued that although there is a real interest in sustainable farming and in sustainable intensification, more research is needed into what these mean in practice and what impact they would have on biodiversity and ecosystem services.

Paul argued that there is huge potential for creating biofuels from the sugars in plant cell walls. For example, it is now feasible to convert these sugars into ethanol and it is becoming more economically viable. He recommended research focused on the **opportunities for renewables using waste materials**. New methods to produce these fuels would part of this. However, he wondered what the effects of developing these technologies could be on land use and on the land itself, particularly if those waste materials, such as straw, are currently ploughed back into the soil to improve its condition.

Wicked problems and questions generated by the open discussion included:

There were strikingly different views about the role that technological advances such as genetic modification (GM) could play in offering 'solutions'. Some saw genetics as the solution to problems of food security and environmental degradation (i.e., we can just use genetic tools to breed better crops that use fewer chemical inputs); whereas others saw GM as one of the major threats to both of these (i.e., the success in creating high-yielding crops has narrowed our diet to a few crops which are inbred and require uniform environmental conditions and high inputs). Technological fixes are never as straightforward as is initially imagined but we were left asking the question: how can we reconcile these very different views about the role of technological solutions in the future of agriculture?

What sustainable farming is and what it means in practice for biodiversity and the environment as well as for the crops themselves was first raised here and kept coming up throughout the year.

Are we complicit in optimising a food production system that needs fundamental change or should we all continue on a path that makes 'baby steps' that we hope will collectively shift us in the right direction? In other words, how do we find questions that are narrow enough to allow real research but that answer the bigger problems that clearly cannot be addressed through the sum of small improvements?

Food security today is a local, not a global issue, so how can we bring scale into this discussion and develop holistic sustainable farming scenarios for specific locales?

Witnesses

Dr Tina Barsby	Chief Executive The National Institute of Agricultural Botany (NIAB), Cambridge
Ariel Brunner	Head of EU Policy, BirdLife International, based in Brussels
Professor Paul Dupree	Professor of Biochemistry, Department of Biochemistry, University of Cambridge

Biographies

Dr Tina Barsby

Dr Barsby was appointed Chief Executive and Director of NIAB in September 2008, becoming the first female Chief Executive in the Institute's 90-year history. A plant geneticist, Dr Barsby has extensive experience in plant biotechnology and applied plant science, spanning both academic and commercial research in the agricultural crop sector, including 18 years with Groupe Limagrain.



She has extensive scientific experience in biotechnology and seed development, especially in wheat and oilseed rape, and has been involved in various cross-sector activities bringing together scientists and breeders.

Tina has a first degree in Agricultural Botany from the University of Wales at Bangor, and a PhD from the University of Nottingham. She spent a postdoctoral period at Kansas State University, and worked at Allelix Inc., Ontario, Canada for several years before returning to the UK in 1989.

e-mail: tina.barsby@niab.com

Ariel Brunner

Based in Brussels, Ariel Brunner is Head of EU Policy at the environmental NGO BirdLife International. In recent years, he has led BirdLife's work on reform of the European Union common agriculture policy, better implementation of the EU rural development policy and advocating the sustainability of biofuels and bio-energy policies. Before moving to Brussels he followed the implementation of EU nature conservation legislation in Italy and was instrumental in the designation of the country's special protection areas network (sites protected under the EU Wild Birds Directive).



Born in Israel, he holds an MSc in Environmental Sciences from Milan University and he speaks Italian, English, Spanish, French, as well as Hebrew.

e-mail: ariel.brunner@birdlife.org

Professor Paul Dupree

Professor Paul Dupree's research is focused on understanding the biosynthesis and function of polysaccharide components of the plant cell wall. He has made significant advances in the area of understanding and improving plant lignocellulosic biomass quality and quantity, research which underpins development of renewable materials, such as fuels from plants.



The Dupree Lab is one of the six research hubs in The BBSRC Sustainable Bioenergy Centre. This virtual centre is composed of academic and industrial partners, based at each of the Universities of Cambridge, Dundee, Nottingham and York and Rothamsted Research. Their contribution is the BSBE Cell Wall Sugars Programme - developing strategies to improve plants and enzymes for increased sugar release from biomass. The programme aims to better understand how sugars are locked into plant cell walls. By doing this they can select the right plants and the right enzymes to release the maximum amount of sugars for conversion to biofuels.

His research group collaborate with industrial partners to test their ideas and are also actively involved in increasing both energy awareness and public understanding of the opportunities and challenges biotechnology and bioenergy provide. They are also part of the Leverhulme Centre for Natural Material Innovation, a collaboration between the departments of Architecture, Biochemistry, Chemistry and DAMTP that aims to understand and improve wood properties for building construction.

e-mail: pd101@cam.ac.uk

Setting the scene

Ariel Brunner, the Head of EU Policy at BirdLife International travelled over from Brussels to help us to start to think about how biodiversity connects to the other elements of this topic. He joined Tina Barsby, the CEO of the National Institute of Agricultural Botany (NIAB) in Cambridge who focused on food security and agriculture and Paul Dupree, Professor of Biochemistry in the Department of Biochemistry who discussed his research into the development of sustainable biofuels that do not adversely affect the food chain.

Tina and Paul both recommended background papers to help to set the scene for their work and their areas of interest.

Tina sent us a book chapter that reviews the role that plant breeding and new agricultural technologies will play in feeding 9 billion people equitably, healthily and sustainably, particularly in Africa. She and Wayne Powell argue that in Sub-Saharan Africa, meeting this challenge will require both a deeper understanding of plant breeding methods and principles together with exposure and understanding of the needs of small holder farmers who dominate agricultural productivity. They also provide a critical appraisal of crop genomics and life sciences advances together with an analysis of the particular issues and opportunities related to plant breeding in this region.

Paul's paper focuses on xylan, one of the most abundant polysaccharides on Earth that will provide more than a third of the sugars when using plant dry matter such grass or hardwood feedstocks to produce biofuels (a method known as lignocellulosic biofuel production). Their results can be used in crop breeding programs to make non-edible plant material that requires less processing, less energy and fewer chemicals in order to convert it to biofuels or other renewable products.

There is also an article about Paul's paper on the university news website: [Biofuel from inedible plant material easier to produce](#)

Full references

Powell, W. & Barsby, T. (2013) Germplasm diversity and genetics to drive plant breeding for Africa. In: Successful Agricultural Innovation in Emerging Economies: New Genetic Technologies for Global Food Production (Ed. by D. J. Bennett & R. C. Jennings), pp. 82-94. Cambridge, UK: Cambridge University Press.

Mortimer, J. C., Miles, G. P., Brown, D. M., Zhang, Z., Segura, M. P., Weimar, T., Yu, X., Seffen, K. A., Stephens, E., Turner, S. R. & Dupree, P. (2010) Absence of branches from xylan in Arabidopsis gux mutants reveals potential for simplification of lignocellulosic biomass. Proceedings of the National Academy of Sciences, 107, 17409-17414.

- Tech transfer: How do we get the sorts of technology developed for commercial gain into non-commercial areas?
- From genes to companies & farmers: Under what political, legal, social conditions would genetic engineering of crops gain broader support, especially in the EU?
- What really matters/what are really the problems around land use?
- Food security today is a local, not a global issue – how can we bring scale into this discussion and develop holistic sustainable farming scenarios for specific locales?
- Compromise compromise compromise: in reaching agreements, providing policies and imposing regulations- and recognise/respecting the views of others.
- Recognition of global convergence on the lowest common denominator - in that internationalised markets are driving down commodity prices and human nature demands higher living standards for less; but balancing populations demands for energy and food security will increasingly demand local solutions for local people.
- Look for the opportunities for renewables such as waste materials - what are the effects of developing these technologies on land use and on soil?
- How do we find research questions that are narrow enough to allow real research and not just big philosophy, but that address the bigger problems out there, which clearly cannot be addressed just through the sum of small improvements?

More details

From genes to companies and farmers

- How do you involve farmers into the breeding process/participation?
- Under what political, legal, social, etc conditions would genetic engineering of crops gain broader support, especially in the EU?
- Participative plant breeding
- Corporate roles in developing and influencing agricultural technology

Technological solutions

- How do we get the sorts of technology developed for commercial gain into non-commercial areas? (vegetative + African market = double negative)
- I was struck overall by the difference in the speakers' expressions of faith in technological solutions. For example, it was clear from Tina Barsby's comments that she sees genetics as the solution to problems of both food security and environmental degradation (i.e., we can just use genetic tools to breed better crops that use fewer chemical inputs); but by comparison, Ariel Brunner seemed to categorize the achievements of genetics to date as one of the major threats to food security and a source of environmental degradation (i.e., the success in creating high-yielding crops has narrowed our diet to a few crops which are mostly inbred and which require uniform environmental conditions and high levels of chemical inputs).
- My own research on the histories of agricultural technologies and conservation biology leads me to sympathize more with Brunner than Barsby. In fact, I felt like his views of both technological realities and human nature were as sensible as any heard from those of us engaged in more academic pursuits. He was very clear and convincing in his explanation that technological fixes are never so straightforward as is initially imagined, with unanticipated ramifications all over the place, and also in his point that we cannot simply expect people to eat food that is more sustainable to produce and deliver (as is also evidenced every meeting in meals we eat...)

What really matters/what are really the problems around land use?

- Sustainable farming...what is it? ; relationship between sustainable farming and biodiversity and conservation? ; what are the elements of risk built into innovations such as high yielding crops
- Priorities for biodiversity conservation (in context of climate change) and potential accommodation with farming

Questions of scale

- Food security today is a local, not a global issue – how can we bring scale into this discussion and develop holistic sustainable farming scenarios for specific locales?

Policy

- Subsidies for specific crops may distort the market for crops, but they also have other aims, such as preserving specific rural lifestyles. How do we balance the food aims of policies against these broader cultural aims?
- Compromise compromise compromise - in reaching agreements, providing policies and imposing regulations- and recognise/respect the views of others. However, whether an ardent conservationist, GM proponent or climate change denier, present the evidence for risk and reward calmly and encourage a positive outcome. Stop moaning and have a positive attitude.
- Policy (Ariel Brunner) is subject to pressure groups even in the face of overwhelming evidence – the differing strengths of pressure groups (eg farmers) distort the direction of policy making

Markets and prices

- Recognition of global convergence on the lowest common denominator - in that internationalised markets are driving down commodity prices and human nature demands higher living standards for less; but balancing populations demands for energy and food security will increasingly demand local solutions for local people (my "Royston Vasey" scenario- League of Gentlemen)- be it local solar/energy generation including solar, wind and perennial biofuel crops or intensifying agricultural production and marketing
- (Tina Barsby) there are distortions in levels of research for different crops based on commercial returns for companies; seeds get precedence over vegetative crops – this is a Cinderella issue where knowledge that should benefit society is not gained because there is not a profit driver.

Next generation fuels and waste

- If we were to turn crop processing into a biochemical production process that could turn out many different products from the same raw crop stock (food, fuel, fibre for clothing, etc), what would/should the mix of products be and how would this be governed (if at all)?
- Look for the opportunities for renewables – for example, waste materials.
 - What are the effects of developing these technologies on land use (e.g. is less land used because fuel production is more efficient or is more used to grow biofuels because it's more profitable?) and on soil (e.g. the straw is being removed)?
 - What are the effects on greenhouse gasses?
 - Can it be economic without government incentive?
 - Could it be used as animal feed?
- Concentrating our efforts? Research (Paul Dupree) is focussed and narrow (for well understood reasons) leading to knowledge gain being the dominant rationale rather than increased understanding of a recognised problem. Paul said he would continue his research into lignocellulosic sugars even if it were shown to be leading up a blind alley. The consequence of this is that the scientists (academic researchers) are not the ones who decide what to research or what the implications are. So who is? There is an implication that the Research Councils have this role; are we satisfied they have a sufficiently broad remit? I am not sure I am.
- How to tackle such an apparent contradiction - education in both developed and developing world, and transparency in delivery and use of aid packages to encourage local resilience, but need for Cambridge to harness the power of those global drivers and use our collective expertise to make a difference
- I found interesting the comments on "this is all way too big and too complex so I better focus on my little research topic". It is very real, but also the real challenge. How do we find research questions that are narrow enough to allow real research and not just big philosophy, but that address the bigger problems out there, which clearly cannot be addressed just through the sum of small improvements? I found brilliant the example about the efficiency of lorries (technological improvements can scrap maybe another 1% but this is dwarfed by the logistical improvements on a system that runs lorries 85% empty half the time and 100% empty the other half of the time).

Background references from the witnesses– full list

Mortimer, J. C., Miles, G. P., Brown, D. M., Zhang, Z., Segura, M. P., Weimar, T., Yu, X., Seffen, K. A., Stephens, E., Turner, S. R. & Dupree, P. 2010. Absence of branches from xylan in *Arabidopsis gux* mutants reveals potential for simplification of lignocellulosic biomass. *Proceedings of the National Academy of Sciences of the United States of America*, **107**, 17409-17414.

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