New Paradigms for Crop and Soil Management
Welcome

The Biosciences Knowledge Transfer Network (BKTN) welcomes you to this workshop, which has been developed by the Plant Sector and is being organised in partnership with the Environmental Sustainability KTN.

As a society, we face some key challenges this century with increased demands for food and feed from a growing world population aligned to growing demand for agricultural feedstocks for biorefining applications. The agriculture sector will need to increase crop productivity in the coming decades to meet these demands and today’s workshop will assess how this can be achieved through improved crop and soil management, set in a context of climate change, limited natural resources, increasing energy costs and pressure to reduce emissions from the sector.

The BKTN has the objective to accelerate the conversion of bioscience knowledge into innovative agricultural, food and industrial bioscience products and processes through knowledge transfer and networking activities. The BKTN act as an interface between the UK research-base and industry to provide them with the knowledge and funding opportunities they need to take new products and processes to market.

I hope you enjoy the workshop today and look forward to working with you to develop new innovative solutions to improve crop and soil management for the future.

Tom Jenkins
Assistant Director and Plant Sector Lead, Biosciences KTN
Background

There is a need to improve agricultural productivity in the coming century to help ensure food supplies for a global population predicted to reach 9 billion by 2050, equating to an increase of at least 50% compared to current production. This second ‘green revolution’ must occur set in a context of climate change, industrialisation in emerging economies and the challenge of reducing greenhouse gas emissions from agriculture. Understanding the relationships between plants and ecosystems will be increasingly important to develop sustainable crop management practices and in particular the move from managing soil using chemical inputs to the increasing use of biologically-based improvement strategies is a rapidly emerging challenge. While some of this change in soil management can be addressed by technology alone, understanding the linkages from basic and applied research, to practice in the field and acceptance by users of crop products is essential in driving this new paradigm of sustainability forward.

Workshop objectives

The Biosciences KTN is establishing a forum to enhance knowledge exchange in the area of soil and crop interactions through formation of an Interest Group in Plant and Soil Interactions. The workshop will be one of the activities taken forward by the Interest Group to establish consortia between the private and public sectors to help drive new innovation in plant and soil science to growers. We will consider recent advances in applied soil science with a focus on crop production. The workshop will bring together stakeholders from industry, funding bodies, policy-makers and scientists to identify opportunities to increase crop productivity and sustainability through improved soil management practices. The workshop outputs will also be summarised and published in a report which can be circulated to relevant UK and EU policy makers. We will also look to identify priority theme areas which can be used to develop a framework for potential new joint funding initiatives relevant to crop and soil interactions between the public and private sectors.
# New Paradigms for Crop and Soil Management

## Welcome and Overview of Workshop

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## Session 1 – New Paradigms for Soil Management – Chair: Paul Hallet, SCRI

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<td>David Manning, University of Newcastle</td>
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<td>Tapping and preserving nutrients in soil</td>
<td>Andy Whitmore, Rothamsted Research</td>
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## Session 2 – Identifying the challenges to uptake – Chair: Chris Tapsell, KWS-UK Ltd

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<td>21st century soil management: what are the challenges for soil scientists?</td>
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## Session 3 – Understanding the commercial drivers and supply chains – Chair: Robert Edwards, FERA

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<td>Nicola Campbell, NFU</td>
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<td>14.35</td>
<td>New Perspectives for the UK Cider Industry: where next for Orchards and the Cider supply chain</td>
<td>Richard Heathcote, Bulmers/Heineken UK</td>
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<td>15.00</td>
<td>Controlled Traffic Farming – a blank canvas for crop production</td>
<td>Dave Tinker, Controlled Traffic Europe</td>
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## Session 4 – Opportunities for Innovation – Chair: Timothy Hall, DG Research & Innovation, EC

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<td>Ray Elliott, Syngenta</td>
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<td>Targeting soil pathogens – opportunities and challenges for plant biotechnology</td>
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<td>Doing more with less: reconciling food security with water availability</td>
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## Conclusions and next steps

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<td>Conclusions and next steps</td>
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Chair: Paul Hallett, Scottish Crop Research Institute (SCRI)

Paul Hallett leads the Plant-Soil Interface Group at SCRI. He has over 15 years experience examining the interaction between physical and biological processes in soil, with a specific focus on plant roots. Paul has a degree in agricultural sciences, specialising in soil science, from the University of Guelph, Canada and a PhD in the mechanics of particulate systems from the University of Birmingham. He has authored more than 60 scientific publications and secured funding from EPSRC, BBSRC, EU, DEFRA, Royal Society, WRAP and RERAD. His projects have brought together multi-disciplinary teams including biologists, plant scientists, agronomists, geotechnical engineers, and end-users. Paul is a Council Member of the British Society of Soil Science and an Associate Editor for European Journal of Soil Science and Vadose Zone Journal.

programme for this session

10.00  David Manning  The shift from chemical to biologically based crop production
       University of Newcastle

10.25  Andy Whitmore  Tapping and preserving nutrients in soil
       Rothamsted Research

10.50  Tiina Roose  Rhizosphere Modelling
       University of Southampton

11.15  Coffee
biography | David Manning is Professor of Soil Science at Newcastle University. A geologist by training, he has research interests in the interaction between biological systems and geological materials. These interests enable him to address key problems, including the capture of atmospheric CO$_2$ through the formation of soil carbonate minerals, and the use of silicate minerals as sources of plant nutrition. He has over 100 publications, including a textbook on industrial minerals. He has received the Mineralogical Society’s Schlumberger Medal and was recently a Mineralogical Society Distinguished Lecturer. He is a member of Council of the Geological Society of London, and was a Director of Mineral Solutions Ltd for its 10 year life.

abstract | The shift from chemical to biologically based crop production

When there was less pressure on resources, the price of mineral-based chemical fertilizers was sufficiently low that they were the obvious materials to use to build soil fertility. Recently, however, prices have risen, and the need for fertilizer inputs has also risen as populations have grown. In 2008, fertilizer prices peaked. For N and P fertilizers, prices tracked the oil price (reflecting the large proportion of energy involved in their manufacture), and returned to pre-peak levels. For K (with lower energy inputs), prices rose to as much as $1000/tonne K$_2$O, and did not return to previous levels. Focusing on K, nutrient balance studies have shown that world production of K fertilizers needs to double to balance current offtake, and as an example of need FAO figures show that 47 out of 57 African countries import insignificant quantities of fertilizer. Here 1.5% of the world’s potash production is expected to support 15% of the global population.

The recent takeover battle for Potash Corporation demonstrates the economic importance of K as a globally-traded commodity. With high prices and with demand from wealthy nations sufficient to keep prices high, there is a growing need to consider alternatives that might not be so effective but are accessible to the poorest farmers for whom conventional K is now too expensive. There exists a diverse range of silicate rock materials that contain K, but existing trials generally have been disappointing. One reason why appears to be failure to consider the mineralogy of the materials, and specifically to determine mineral dissolution rates in soil systems rather than total K contents, as it is these that control availability.
biography | Andy Whitmore trained as a chemist, but joined Tom Addiscott’s group at Rothamsted Research (RRes) in 1981 to work on modelling the nitrogen cycle in arable cropping systems. He moved to IB-DLO in the Netherlands in 1991 to join the department of soil fertility and plant nutrition before returning to the UK in 1999 to head up the soil physics group at Silsoe Research Institute. In 2001 Andy accepted a joint appointment between SRI and RRes and on the closure of SRI in 2004 moved with his group full time to RRes. Andy is also a visiting professor at Cranfield University.

abstract | Tapping and preserving nutrients in soil

This talk will focus on managing the paradox that while many nutrients can be stabilised in soil, crops need to be able to access these nutrients in order to grow. Availability also makes nutrients vulnerable to loss, however. Using the nitrogen cycle as the main focus, the talk will provide an introduction to the issues deriving from the need to make N available to plants without increasing the risk of environmental pollution. In addition, some modern technological fixes for the issues raised will be presented.
biography | Tiina Roose is a Royal Society University Research Fellow working on modelling biological systems at the School of Engineering Sciences, University of Southampton. Her first degree was in Systems and Control Engineering from Tallinn Technical University, Estonia. She completed a DPhil on ‘Mathematical Model for Plant Nutrient Uptake’ at Oxford in 2000 under the supervision of Professor Andrew C. Fowler. She then spent 2 years as a postdoctoral research fellow at the Steele Laboratory for Tumour Biology at the Harvard Medical School/Massachusetts General Hospital working on the tissue mechanics of biological systems with particular emphasis on tissue growth and remodelling related problems. The Steele Lab at HMS/MGH was part of the Harvard-MIT Health Science and Technology (HST) program which in order to foster fast interactions between engineers and medics had all the PDRAs part of Harvard Medical School faculty and all the PhD students were registered at the MIT graduate school. The work in Boston involved personally undertaking in-vitro and in-vivo experiments including measurements of the mechanical properties of collagen gels and solid tumours. In 2003 she returned to Oxford to take up a postdoctoral position with Professors Jon Chapman and Philip Maini at the Oxford Centre for Industrial and Applied Mathematics. In 2004 she was appointed Royal Society University Research Fellow, which she held first in Oxford and from Oct 2009 in Southampton.

abstract | Rhizosphere Modelling

In this talk I will present the latest developments on modelling plant-soil, i.e., rhizosphere, interactions. I will give a brief overview of how to translate data reliably across various different spatial scale and how to then use the models to investigate various different plant-soil interaction phenomena. My talk will primarily deal with the plant uptake of nutrients that are strongly bound in the soil, i.e., with phosphate and zinc.

On the single root scale I will specifically discuss how root hairs interact with dual porous soil particles and how organic acid exudation mediates uptake of zinc.

Following this I will briefly discuss the modelling of root system growth and how the nutrient and water uptake interact. In fact the models are now becoming so sophisticated that more in situ experimental observations of root growth are needed in order to detangle the feedback loops between the root growth and nutrient and water uptake. To this end I will briefly touch on the new multiscale X-ray CT scanning facility in Southampton that enables us to observe roots in undisturbed soil columns 30 cm of diameter and 1.5 m long at resolutions of 3 to 150 microns.
Chair: Chris Tapsell, KWS-UK Ltd

Chris Tapsell is Technical Director of the UK arm of KWS Ltd, an international independent seed company breeding agricultural crops for the temperate zones. With 30 years experience in the plant breeding industry (vegetables and cereals) and having worked for several multinational companies (Unilever, Monsanto and KWS), Professor Tapsell has extensive experience of plant breeding and agribusiness industries. He has worked overseas and managed teams in both the northern and southern hemispheres. With a keen interest in the entire supply chain from fundamental R&D to the consumer, Professor Tapsell is passionate about integrating effective supply chains and maximising innovation within them. Professor Tapsell has managed R&D projects from the industrial and public sector sides and now integrates UK R&D into the global activities of KWS Saat AG. He is a member of the BBSRC Sustainable Agriculture Strategy Panel and the TSB - Biosciences KTN Plant Sector Group, as well as a visiting Professor at Newcastle University. With KWS being very active in developing bioenergy crops, Professor Tapsell also represents the company in the major BBSRC Integrated Biorefinery Technologies Initiative.

programme for this session

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Richard J Godwin PhD, Dr(hc), FRepl, Hon FIAgrE, Hon FRASE, Fellow ASABE and Fellow RAS holds Professorships from Cranfield University, Czech University of Life Sciences and Harper Adams University Colleges respectively and in this capacity he supervises research programmes and provides academic leadership. He has had a long career as a researcher and educator in the field of agricultural engineering, soil and waste management and precision agriculture. His contributions have resulted in an improved fundamental understanding of soil - machine systems; the development of improved soil engaging tools and methods; and the transfer of principles to designers, extension advisors and farmers. The transfer of this through the development of training programmes in “Soil Management”, such as the BASIS programme, has helped in both improved crop production systems and the environment. He was lead author of the RASE report “The Current Status of Soil and Water Management in England” published in 2008; which reflected on the issues faced by UK Agriculture due to the lack of professionals with knowledge in agricultural practices. This had been brought about by the lack of funding for applied research itself, the negative impact of this on the career structure for the next generation of professionals and the retirement of experienced applied researchers, engineers and trainers. The report made a number of positive recommendations to help to overcome these issues, some to rebuild national capacity are long term and relatively expensive, others require little more than the will and drive to establish active “Soil and Water Management” groups both nationally and in local communities. Since the report Reaseheath College and Harper Adams University College have made investments to improve their capabilities by curricular enhancement and the employment of young professional staff respectively. Defra, Environment Agency and Natural England with RASE commissioned a second report “A Gap Analysis on the Future Requirements of Soil and Water Management” published in November 2010, which stressed the need for improved knowledge transfer and the lack of personnel with the ability to conduct the applied research, extension and training. It does applaud the value of the Environment Agency’s “Best Farming Guide” and calls for preceding workshops, demonstrations or 1:1 visits by advisors to get its point across quickly, effectively and show value. Currently the 5 day duration BASIS certified “Soil and Water Management” course taught at Harper Adams University College, Lincoln University and by private trainers continues to make a very significant contribution by training agronomists, farmers, consultants and government agency staff at the rate of c.100 per annum. Whilst this course earns 25 CPD points there is no requirement for registration as there is with fertiliser and agrochemical application.
biography | Brian is Head of "Soils & Nutrients" in ADAS, a past President of the Institute of Professional Soil Scientists, a Chartered Scientist and a visiting Professor at Cranfield University. Brian’s interests are focussed on the development of sustainable low-emission farming systems, which use organic manure and fertiliser nutrients to the benefit of crops and long-term soil fertility.

abstract | Working with farmers to improve soil management

UK farmers are under increasing pressure to produce more food while at the same time reducing the impact of agriculture on the environment. Good soil management is crucial to both these goals.

Modern farmers have a number of useful tools at their disposal to firstly identify soil issues on the farm and then, where necessary, to alleviate them. The Soil Protection Review 2010 (which is part of Single Payment cross-compliance in England) focuses on reducing soil erosion, maintaining soil organic matter levels and avoiding/alleviating soil compaction. Additionally, visual assessment is a practical method that can be used to identify soil compaction in the field. There are three main visual tools available; the ‘Peerlkamp’ method, the Landcare ‘Visual Soil Assessment’ method and the Environment Agency’s ‘thinksoils’ booklet.

Working with farmers to improve soil management has never been more important, given the dual priorities of increased food production and environmental protection. The focus of farmer engagement activities should be on sustainable production, rather than solely avoiding soil degradation, and how maintaining or enhancing good soil structure and soil organic matter levels can help increase production, while also having environmental benefits i.e. best management practices that deliver ‘win-wins’. The use of some soil management practices, such as subsoiling to relieve compaction, is widespread. However, there is still a need to better integrate the identification of soil structural problems (through visual soil assessment etc.) with effective and timely soil management practices. Not enough farmers look below the soil surface to identify soil structural issues, resulting in cultivations and loosening operations being carried out on a routine basis, rather than addressing specific soil structural needs. Cultivating at the wrong time, wrong depth or when there is no specific need to improve soil structure wastes time and money. The improved on-farm uptake of best soil management practices can help to increase crop yields, as well as reducing the environmental impacts of farming.
biography | Dr. Sylvain Pellerin belongs to the managing team of the “Environment and Agronomy” department from INRA, France. He coordinates at a national level research actions dealing with carbon, nitrogen and phosphorus biogeochemical cycles in agriculture. Between 2003 and 2010 he was the head of the Joint Research Unit “Soil Plant transfer and cycle of nutrients and trace elements in agro-eco-systems”, INRA, Bordeaux, France. His scientific expertise is in the area of root system architecture, bioavailability of nutrients and trace elements in soils, modelling soil-plant transfer of nutrients and trace elements, and biogeochemical cycles of nutrients in agro-eco-systems. He has published 55 scientific papers in international journals. He teaches at Bordeaux University and at the Agricultural School from Bordeaux (Enitab). He coordinates a technological combined network for practical applications of research in the area of fertilisation.

abstract | 21st century soil management: what are the challenges for soil scientists?

The increasing demand for biomass production, both for food and non-food use, as well as environment and food safety issues, have highlighted some key soil functions that need a renewed attention from soil scientists. Soils are not only a support for primary biomass production, providing plants with water and nutrients. They are also a key compartment of major biochemical cycles (H₂O, C, N, P, trace elements), some of them being involved in major environmental (greenhouse gases emissions and climate change), sustainability (limited stock of P fertilizers) or food safety issues (food chain contamination). They contain a huge amount of living organisms, the diversity and functions of which are only poorly understood so far, although they partly control the previously mentioned biochemical cycles. Moreover, considering the relative time scales of soil formation and degradation, soils should be considered as a non renewable resource at a human time-scale while they are submitted to various threats such as erosion, compaction, loss of organic carbon content, reduction in biodiversity, salinisation, sealing.

The objective of this presentation is to review the main research challenges associated with some key soil functions and to present some on-going research actions. Future cropping systems are expected to combine high biomass productivity with lower mineral fertiliser inputs. This clearly questions the possible ways to increase the input of biologically fixed N or the mobilisation by roots of sparingly soluble nutrients like P. Plant products are expected to meet the requirements of increasingly severe regulations regarding the quality of food. This questions our ability to predict the soil-plant transfer of contaminants, and to suggest cropping systems and soil management practices, including generalised waste recycling, which reduce the risk of food chain contamination. The contribution of agricultural soils to net greenhouse gases emissions (C sequestration, N₂O and CH₄ emission) is still questionable, and has to be better assessed. Agricultural management practices which are likely to mitigate net emissions have to be proposed. Finally, the main threats which are likely to affect the soil resources over the long term should be identified, and conservative management strategies have to be proposed. The expected contribution of the French Soil monitoring Network to addressing this final objective will be presented.
Chair: Robert Edwards, Chief Scientist, FERA

Robert Edwards has 20 years of post-doctoral work experience of plant secondary metabolism and has worked in both the private and public sectors in the UK and USA. He joined Durham University in 1991, where he stayed until 2010. He was Head of Biological Sciences since 2008, and his research group was located in the new Centre of Bioactive Chemistry since 2005. In 2003, he was awarded a research development fellowship by the BBSRC to pursue his research interests in plant chemical biology, and since 2006 has been a Science Manager, with an interest in promoting applied research in plant biotechnology. In 2010, Robert has relocated his group to the University of York, where he is now a Professor of Crop Protection. He is also the new Chief Scientist at the Food and Environment Research Agency (FERA) since the end of 2010.

programme for this session

13.45 Murray Hart
DEFRA
Drivers affecting soil management and agronomy

14.10 Nicola Campbell
NFU
Assessment of utilities and added value of by-product streams as organic fertilisers

14.35 Richard Heathcote
Bulmers/Heineken UK
New Perspectives for the UK Cider Industry: where next for Orchards and the Cider supply chain

15.00 Dave Tinker
Controlled Traffic Europe
Controlled Traffic Farming – a blank canvas for crop production

15.25 Coffee
biography | Dr Murray Hart graduated from Wye College, University of London with an MSc in Conservation of Soil Fertility in 1989. He went on to study for a PhD in the Soil Science Department at Rothamsted Experimental Station, investigating pesticide side-effects on soil microbial biomass and activity, being awarded his doctorate in 1995. After a short period working for an agricultural consultancy in southern England, he moved to New Zealand, where he worked as a technical officer and then technical manager for a large fertiliser company, Summit-Quinphos (NZ) Ltd. His roles there included training fertiliser reps in soil science, nutrient cycling and fertiliser reactions in soil; conducting field research; project management; and later managing a small team producing nutrient loss risk management farm maps for farmer clientele.

In 2004, Dr Hart moved to Australia, where he became a Research Associate at the University of Western Sydney, investigating nutrient runoff from pastoral land in the Sydney drinking water catchment. His work here included field studies with rainfall simulators looking at dissolved and particulate phosphorus mobilisation, and setting up and managing an 11 km² nested catchment study in the southern highlands of New South Wales, investigating phosphorus, nitrogen and sediment mobilisation and transport from natural rainfall run-off events. In October 2009 Dr Hart returned to the UK to take up a position as a Senior Scientific Officer in the Nutrient Management Team at Defra, where he currently works advising policy colleagues on nutrient management related issues.

abstract | Drivers affecting soil management and agronomy

Agriculture today faces many challenges ranging from feeding a growing global population, reducing its contribution, and at the same time adapting, to climate change, contributing to food security and facing up to more local issues such as point and diffuse source water pollution, ammonia emissions and soil erosion. Farmers still face challenges around productivity, competitiveness and profitability and we all expect them to contribute to preserving and restoring habitats and protecting our countryside.

Governments have a vital role in ensuring that these issues are recognised and addressed. In England, Defra plays a key role for Government and works with a range of other public bodies and the agricultural industry to face up to and tackle these issues. This is partly through administering existing legislation at international, European and national level, influencing revisions of existing regulations and the development of new laws, monitoring compliance and managing the application and breaches of regulations, developing and funding agri-environment and other schemes and procuring fundamental scientific research to further our understanding of the underlying processes involved. However, the real challenges come in winning hearts and minds of those working in agriculture and convincing them of the benefits of adopting different practices with reduced environmental impacts whilst at the same time maintaining or improving profitability.

This presentation will give an overview of some of the main regulatory and other government-centric drivers that are influencing management of soils and crops in the UK now and into the future, and some of the initiatives Defra is taking to address the issues which arise.
biography | I am Environment Policy Adviser at the National Farmers Union, based at Headquarters in Warwickshire. My policy areas cover soil and waste – both those wastes produced by agricultural activity and those utilised by agriculture. I gained my PhD in 2009 at the University of Glasgow in the area of Environmental Chemistry and working on the use of composted materials and rockdust as soil fertility amendments.

abstract | Assessment of utilities and added value of by-product streams as organic fertilisers

The EU Landfill Directive requires the UK to reduce the amount of biodegradable waste it sends to landfill to 35% of waste produced in 1995 by 2020. Increasingly, local authorities and industry are looking for alternatives to waste disposal – recovery of waste to land makes economic and environmental sense in many cases. British agriculture makes use of many of the wastes and by-products produced by households and industry. However, the perceived risks posed by use of materials labelled as wastes can be a barrier to increased uptake. Quality of the material diverted for use on land is therefore a key challenge and has led to the introduction of quality standards and end-of-waste criteria, in the form of quality protocols and publicly available specifications, for some waste materials. Once a material achieves end-of-waste status it will no longer be regarded or regulated as a waste, which can greatly increase its acceptability for use in agriculture. This presentation will cover the types of wastes and products available to agriculture, the regulatory context and the issues and concerns currently surrounding their use.
Richard Heathcote graduated in Zoology & Biochemistry from Hull and then gained an MSc in Freshwater Hydrobiology from Cardiff. Richard has previously worked for Bass Brewers, Smiths Crisps and Thames Water in a variety of IT related roles before joining Bulmers in 1988 as an IT Project Manager, followed by a line management role as Production Planning Manager for Bulmers. Richard has now been at Bulmers/Heineken UK for over 20 years. Richard moved into Sustainable Development at Bulmers in 2001 and that role has now changed to be Heineken UK based. Richard looks after all sustainable development issues across Heineken UK, including Bulmers cider aspects, with a focus on climate change, responsible sourcing including sustainable orchards and by-product development. Richard also works closely with colleagues across the UK and Heineken Group on wider corporate responsibility matters.

Richard also chairs the UK’s National Association of Cidermakers Sustainable Futures committee and is a Board member of the UK’s Environmental Sustainability Knowledge Transfer Network.

Outside work Richard enjoys hill-walking, gardening, good food & beer and Celtic music.

New Perspectives for the UK Cider Industry: where next for Orchards and the Cider supply chain

This presentation will introduce the UK cider industry, and examine the challenges it now faces as the user of a long term (50yrs+) perennial crop. It will then go onto examine how responding to these challenges is bringing about a new era of research and innovation. The talk will describe the strategy being adopted and how this is being translated both into practical trials, and into collaborative commissioned academic research. The talk will also show how Heineken has recognised the need to maximise the use and value [of any agricultural] of its apple crop by ensuring efficient processing into cider and the wider valorisation of cider by-products.
biography | David Tinker, Chartered Engineer and Chartered Environmentalist, has had a varied career in applied research in agricultural engineering from tractor design to overseas development and meat processing. All along he has had frequent spells of soil tillage whether with tractors or oxen, and in paddy fields, on terraces or in UK farming systems. He has now settled down to a spell with European colleagues to disseminate CTF.

biography | Tim Chamen, Chartered Engineer and Chartered Environmentalist spent 25 years at Silsoe Research Institute where he worked on tillage tool development and the effects of machinery compaction on soil and crop responses. Since leaving Silsoe in 1996 he has worked independently, undertaking contracts for machinery manufacturers, the EU and others on soil/machine interactions and economics. Always maintaining the thread of avoiding compaction damage to soils, he set up Controlled Traffic Farming (CTF Europe) Ltd in 2007 in response to an increasing demand for advice. The company now has a large farmer and industry partnership in the UK and also works across Europe as a facilitator of controlled traffic farming systems.

abstract | Controlled Traffic Farming – a blank canvas for crop production

Controlled traffic farming (CTF) is a field traffic management tool that removes 80% or more of field traffic from the main cropping area. Without the negative effects of random soil compaction, this area can now be managed to optimise crop performance and soil function. Our challenge is to learn how to manage this relatively unique condition to achieve these goals. It is well known that increasingly heavy vehicles are compromising crop performance by restricting root growth and hence nutrient uptake, but what soil structure should we nurture to deliver full crop potential and how do we achieve it? Equally, we know that uncontrolled compaction at all levels compromises soil function. At the surface, even low contact pressures can reduce pore size and continuity, constraining oxygen supply and water infiltration, while increasing the risk of nitrous oxide emissions and negative methane fluxes. Deeper in the profile, hydraulic conductivity and soil porosity are also compromised, leading to further risk of water run-off and soil erosion. Our present annual crop production cycle is characterised by soil damage and repair, promoting significantly greater fuel use, unnecessary oxidation of organic matter and a diminution of soil fauna. CTF is a key means of achieving improvement, liberating soils from this annual cycle and addressing both crop production and environmental issues that deliver positively to the new paradigm for crop and soil management.

(Presentation to be given by David Tinker)
Chair: Tim Hall, DG Research & Innovation, European Commission

T.J. Hall obtained his PhD in plant pathology from Manchester University in 1976 and then worked as a research scientist in the Glasshouse Crops Research Institute, Littlehampton, UK before joining the Commission services in 1983. He became Head of Unit for Scientific and Technological Cooperation with Developing Countries in 1994, and has also headed units in the Quality of Life Directorate under the 5th Research Framework Programme (FP5) and in the Health Directorate under FP6. His current position (since October 2006) is Head of Unit for Agriculture, Forestry, Fisheries and Aquaculture Research with primary responsibilities for overseeing collaborative research and coordination activities related to “Sustainable production and management of biological resources from land, forest and aquatic environments” in FP7. He was also Interim Director for “Biotechnologies, Agriculture, Food” from September 2007 to June 2009.

programme for this session

15.40 Ray Elliott
   Syngenta
   Improving seed treatment to enhance
crop production

16.05 Anne Osbourn
   John Innes Centre
   Targeting soil pathogens – opportunities and
challenges for plant biotechnology

16.30 Ian Dodd
   University of Lancaster
   Doing more with less: reconciling food security
   with water availability

16.55 Coffee
biography | Ray Elliott is Senior Scientific Advisor at Syngenta, Bracknell. During his 26 years in the agrochemical industry, Ray has held a wide variety of scientific and managerial positions within research and development including in synthetic and process chemistry, environmental sciences and latterly analytical sciences. He has also managed large multi-disciplinary and multi-national projects in R&D. He has been an active member of a number of committees within BAA (British Agrochemical Association now known as the Crop Protection Association) and BBSRC (Biotechnology and Biological Sciences Research Council) and is currently a member of the Project Management Committee for the new LINK scheme on Renewable Materials; the Innovation, Science and Technology Committee of the CBI; and the Steering Committee of the Integrated Biorefinery Technologies Initiative (IBTI) set up by the Bioscience for Business Knowledge Transfer Network. He chairs the RSC Science, Education and Industry Board and has been a member of RSC Council since 2009. Ray Elliot takes an active interest in education at all levels, having had links with Cambridge University Chemistry Department for many years and been a Junior School Governor for 10 years. He is currently a Governor of East Berkshire College of Further Education.

abstract | Improving seed treatment to enhance crop production

As we know, seeds, as the carrier of the genetic potential for crop production and productivity, represent one of the most valuable resources on the globe. Many seed varieties confer to the plant some degree of disease or insect resistance, however almost all crops are threatened by a large number of pests and pathogens, as soon as they start to grow, and often need additional protection. Seed treatments are primarily chemical or biological substances applied to seeds or seedlings to help to protect the seeds and assure optimum emergence and performance of the crop. This is a very well-targeted method, which not only reduces attacks on the growing plant by insects and diseases, but also reduces the potential impact on the environment and on non-target organisms. Seed treatment provides a protective zone directly around the seed. As soon as the tender roots emerge, they absorb the systemic fungicide present to provide protection against seed-, soil- and wind-borne diseases. Similarly, insecticides create a protective zone around the seeds which prevents pests living in the soil from reaching the roots on which they normally feed. Systemic insecticides also protect the plant from attacks by sucking insects which often, in addition to their own ill effect, transmit dangerous viral diseases. Finally, the pelleting process makes the seeds more robust and uniform, so that they can be precision-sown with modern drilling machinery.
biography | Anne Osbourn leads the Institute Strategic Programme on Understanding and Exploiting Plant and Microbial Metabolism at the John Innes Centre. In early work on bacterial pathogens of plants she was the first to develop in vivo expression technology (IVET), an approach that has since proved to be very powerful in animal research. Anne has extensive experience of microbiological research (with both bacterial and fungal plant pathogens) and more recently initiated a programme on plant natural products – synthesis, function and mechanisms underpinning metabolic diversification. Her group works with crop and model plants, and uses a wide range of multidisciplinary approaches including genetics, genomics, computational biology, cell biology, protein and small molecule biochemistry. Anne is an author of over 85 peer-reviewed scientific publications and recently co-edited a comprehensive textbook on plant-derived natural products [Lanzotti V & Osbourn A. (2009) Plant-derived natural products – Synthesis, function and application. Springer, New York, USA]. She has also developed and co-ordinates the Science, Art and Writing (SAW) initiative, a cross-curricular science education programme for schools (www.sawtrust.org).

abstract | Targeting soil pathogens – opportunities and challenges for plant biotechnology

Soil-borne diseases are extremely difficult to control because of the inaccessibility of plant root systems and the complexity of the interactions between roots, soil, pathogens, and root-associated microbial communities. Control methods for soil pathogens commonly rely on chemicals or crop rotation. These methods are often unreliable, and are insufficient to provide effective disease control. Chemicals have to be applied in large doses, are less effective in the soil than when used for control of foliar pathogens, and raise concerns about environmental sustainability. The problems caused by soil-borne diseases are likely to be exacerbated by climate change since mild wet weather in winter and spring and drier summers will favour pathogen multiplication and symptom development, so making control by crop rotation less effective in the future. Furthermore, as the need for food production increases and cropping systems become even more intensive this will impose constraints on rotation. The introduction of genes that provide protection against soil-borne diseases into crop plants using non-GM and/or GM-based approaches offers the most robust and sustainable way forward for control of soil pathogens. Potential strategies for this will be discussed, along with their potential benefits and pitfalls.
biography | Ian Dodd is a Reader in Sustainable Agriculture at the Lancaster Environment Centre, and Associate Editor of Irrigation Science. He grew up on a temperate horticulture (grapes / pome-fruit / stonefruit / summer vegetables) research institute farm in southeast Queensland, Australia. After a Bachelor of Science at the University of Queensland, he gained a Commonwealth Scholarship to undertake his PhD at Lancaster University, UK. Since then, he has worked in Australia, Singapore, Spain, and the UK, and gained over 15 years research experience in plant physiology, specifically in the interactions of crop root systems with their physical, chemical and biological environment and the influence of these interactions on crop growth via altering plant root-to-shoot signalling. He has published over 40 papers in this area, many concentrating on the “science underpinning the application” and involving horticultural techniques such as rootzone cooling in tropical aeroponics production, rootstock-mediated crop improvement, partial rootzone drying and rhizosphere engineering. He has been involved in several national and European projects aiming to improve crop water use efficiency and currently leads WorkPackage I (Development and optimization of new precise irrigation techniques) of the EU SIRRIMED (Sustainable use of irrigation water in the Mediterranean Region) project.

abstract | Doing more with less: reconciling food security with water availability

Crop production is frequently (and sometimes catastrophically) constrained by insufficient water. Plants trade water (transpiration, E) for carbon (photosynthesis, A) and leaf or crop water use efficiency (WUE) can be defined as the instantaneous ratio of A to E, or time-integrated crop biomass to water use, respectively. Improving WUE seems an obvious target of plant breeding programs but is often associated with decreased crop yield under rain-fed environments. Supplementary irrigation can stabilise crop yield from year-to-year and conventionally has aimed to meet the crop’s full water requirements. However, changes in climate (rainfall patterns) and/or resource management (irrigation quotas) will mean that future crops, either unintentionally or deliberately, will receive deficit irrigation (less water than the crop’s full water requirements). A curvilinear relationship between irrigation and yield provides some opportunities to save water without limiting yield (where current practice is inefficient), but efficient irrigation management should aim to manage crops within the near-linear part of this relationship to minimize both yield penalties and irrigation inefficiencies. Measurements of plant and soil water status can help this aim. Complementary techniques to enhance “crop per drop” include partial rootzone drying irrigation and rhizosphere engineering. Partial rootzone drying relies on spatially heterogeneous irrigation (wetting only part of the rootzone) to exploit plant root-to-shoot chemical signalling mechanisms, and in 40% of cases produced more yield than conventional deficit irrigation (that wets the entire rootzone) when the same amounts of water were applied (Dodd 2009). Rhizosphere engineering aims to inoculate plants with naturally occurring soil-borne bacteria that produce or break down the same chemical signals used by plants (Dodd et al. 2010), thus attenuating yield limitation caused by deficit irrigation. Integrating genetic progress in plant breeding with management techniques will be essential for future crops.

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Dianna Bowles, OBE
Centre for Novel Agricultural Products (CNAP), University of York

Dianna has more than 30 years of research expertise in Plant Biochemistry. She is the former Director of the Centre for Novel Agricultural Products, winning a 2005 Queen’s Anniversary Prize for Higher and Further Education in Bio-renewables to benefit society. She was elected to EMBO, led EPOBIO and is on the steering group of the US-EC Taskforce in Biotechnology Research - Bioproducts from Plants, as well as being a member of the EU Industrial Biotechnology, and Plants for the Future Technology Platforms. She has worked widely with the EC, UK government departments and the BBSRC, including previous membership of a number of panels specialising in non-food crops. She is a Board Member of the Biosciences KTN and Chair of the Plant Sector Group.

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