All-Party Parliamentary Group on Science & Technology in Agriculture

Notes of a meeting held on Monday 14 September 2015,
Committee Room 17, Palace of Westminster

Water security in agriculture – how can science help?

Present:

Members
Mark Spencer MP
Earl of Selborne
Rebecca Pow MP

Stakeholders
Graham Jellis, AFCP; Martin Emmett, AHDB Horticulture; Maureen Friday, WFU; Agatha Agudelo, Sakata Seed Iberica; Dr Philip Burgess, AHDB Potatoes; Dr Katrina Hayter, Fera; Robin Upton, Suffolk Farms; Charles Tassell, Kent County Show; Charlotte Williams, Tesco; Jack Ward, British Growers; Henry Leveson-Gower, Defra; John Bingham, retired wheat breeder; Alan Turner, Kent County Council; Paul Dracott, East Malling Research; Mark Else, East Malling Research; Mark Pettigrew, PepsiCo; Lucy Gilchrist, PepsiCo; Paul Hammett, NFU; Nathanial Matthews, CGIAR; Simon Griffiths, John Innes Centre; George Rothschild, IWMI; Daniel Pearsall, Group Co-ordinator

Guest Speakers
Martin Collison, Collison & Associates Ltd
Paul Smith, Incinerator Replacement Technology Ltd
Dr Jerry Knox, Cranfield University
Prof Chris Atkinson, Natural Resources Institute, University of Greenwich
Dr David Firman, NIAB CUF Potato Agronomy Unit

1. Welcome & Introduction
Mark Spencer (MS) welcomed Members and stakeholders and briefly introduced the theme for the meeting, focusing on the importance of water as a vital resource for agriculture, and the contribution of UK agri-science in both improving water use efficiency and reducing the impact of embedded water in imported foodstuffs. He also noted that agricultural water use was an issue often raised by constituents facing summer hose-pipe bans in their gardens while water guns continued to be used in neighbouring farmers' fields.

2. Guest speakers
[Please note that speakers' slide presentations are available to download via the meetings section of the All-Party Group web-site at www.appg-agscience.org.uk]

Martin Collison, Director, Collison & Associates
Martin Collison (MC) set the background to the challenge of water security, noting that while domestic water consumption in the UK was around 150 litres per person per day and had been increasing at 1% per year for the last 80 or 90 years, the water use embedded in imported foodstuffs was around 3400 litres per person per day, 20 times higher than household use.

Flagged up as one of the most significant food security challenges in the Foresight work led by Sir John Beddington, MC stressed that water was a major constraint in the global drive to produce more food, with 60% of the earth's land surface either too wet or too dry for farming. Major zones across the globe were now classed as water scarce, yet the UK was producing less of its own food and importing more, often from these water stressed areas. Since the UK was not short of water and had the potential to increase domestic production, the large water footprint imposed on other parts of the world was difficult to defend from both an economic and moral perspective, suggested MC.

The UK's benign, temperate climate supports water efficient agricultural production, with UK water use per tonne of potatoes at 29% of the global average, and around one third of the average for grain crops. Importing foods which could be grown in the UK was therefore adding to water stress elsewhere, with 62% of all water used to produce UK food supplies embedded in imported products, and 68% of food imports sourced from water stressed areas of the world. The impact of climate change would further challenge the sustainability of this situation, with greater extremes of weather and temperature predicted to occur with increased frequency, he added.

UK farming would also need to prepare for projections of warmer, wetter winters and warmer, drier summers which may influence the type of crops grown, particularly vegetable and salad crop production in the east.

MC noted that the UK livestock sector uses almost as much water as crops, highlighting the fact that the issue of water security is not confined to crop production. Overall, however, agriculture accounts for only 1.4% of total UK water consumption, with the food chain using a further 1.5 – 2%. In other parts of the world, the equivalent figures were as high as 70-75%.

MC also pointed out that areas of the UK in which crop production was more dependent on irrigated water use, primarily the south and south east, were also the most densely populated and forecast to see the highest growth in housing. This was also the driest part of the UK, raising concerns about competition for water and prompting a need for smart new thinking in terms of water capture and storage, and more efficient usage, to manage available water supplies.

MC highlighted a role for science and innovation in three key areas:

- New ideas and technologies to improve water use efficiency;
- Innovation in water management, including novel ways to capture and store water, and greater cross-sectoral collaboration on water provision, flooding and catchment management;
- Regulatory and fiscal policy innovation to attract private sector investment in water management.

MC also noted that since Britain accounts for just 1% of global farm output, if UK innovation could take the lead in developing smart solutions to some of these issues it would open up a worldwide market for agri-tech exports.

In conclusion, MC highlighted the need for the UK to develop a long term water plan for agriculture to secure water supplies, reduce embedded water imports and attract investment in water use efficiency. Increasing interest in water from large global investors signalled a major opportunity to incentivise private sector investment and exploit opportunities for UK innovation in this area.

Paul Smith, Director, Business Development Director, Incinerator Replacement Technology Ltd
Paul Smith (PS) explained the development of a new soil improvement agent, providing an added-value alternative to burning animal by-products generated by the food industry which post-BSE could no longer be fed to livestock or used as fertiliser.

Known as 'Biomation', the technology involved combining nutrient-rich animal by-products with a carbon-based polymer to produce a water-absorbing hydrogel, encapsulating nutrition for plants and expanding to 20 times its mass when hydrated with water.

PS explained that this protein-based super absorber (PBSA) was unlike other super absorbers used in sanitary applications such as nappies, which were designed to absorb but not release up to 400 times their own volume in water. PBSA was not a rigid structure, allowing breakdown over the course of 12 months to provide a combination of organic material as fertiliser for the soil, carbon dioxide and water.

Experiments in sandy and loose structure soils with Delta T, a Cambridge University spin-out company, clearly showed that the PBSA improved retention of water at root level over a period of several days. Greenhouse trials at NIAB Innovation Farm with tomatoes planted in sandy soil and compost combined with 1% PBSA (equivalent to 150kg/ha) continued to thrive nine days after irrigation ceased while untreated plants died.

The role of PBSA in maintaining moisture levels, providing nutrients and encouraging soil microbial activity helped stimulate plant growth and trials had shown up to 300% yield increases under controlled environment tests. Replicating that performance in the field could alleviate many of the water security challenges facing global agriculture and, with 3.6bn ha of desert around the world increasing by 12m ha per year, offered the potential to open up major new sources of productive land.

PS described the background to the product's development, which had begun with a failed research project to investigate the potential to freeze-dry animal by-products as an alternative to incineration. This led on to investigating the use of a strong alkali which proved too expensive as a disposal method but when combined with a polymer to retain moisture resulted in the successful PBSA product. PS noted that the PBSA experience demonstrated that the route to innovation was not always a planned or linear process.

Next steps for the project were to scope out the potential to produce PBSA on an industrial scale, and to conduct small-scale field trials with broccoli in Spain.

Larger scale field trials were planned for next year using 25 tonnes of PBSA, and discussions were ongoing with Europe's largest animal by-product company and the Spanish division of a global seed company to take forward the product's development.

Dr Jerry Knox, Reader in Agricultural Water Management, Cranfield University
Jerry Knox (JK) opened by highlighting the international significance of water security – the World Economic Forum's recent assessment of 41 different technical, economic and geo-political risks identified water crises and food crises in the top five global risks in terms of their likelihood and magnitude of impact.

Indeed water and food had increased in prominence on the international agenda very rapidly over the past five years, driven mainly by the 2008/09 food price spike as well as concern about the volume of food being produced under both rain-fed and irrigated conditions in increasingly water stressed regions of the world, the diversion of resources to produce bioenergy crops, and the burgeoning demand for food from India and China.

The major water issues facing the UK were linked to this international agenda, with half of the fresh fruit and vegetables imported to the UK coming from North Africa, Southern Mediterranean, South East Asia, Southern Africa and Australia, in effect exporting drought to many of the most water-stressed regions of the world. UK healthy eating policies to promote fresh fruit and vegetable consumption, linked to year round consumer demand and a loss of focus on seasonality, were adding indirectly to this problem.

Furthermore, the UK consumes around 250 litres of water per capita per day in terms of perishable fruit and vegetables going to waste, highlighting the importance of efforts to reduce food waste.

While a small fraction of UK crop production relied on irrigation, JK considered that it was nonetheless important in terms of the rural economy and added value. Such production – predominantly concentrated in the east and south east - must cope with large inter-annual variations in agro-climate and at the same time deal with the impact of changing regulations on water availability and cost in meeting end-user demand for yield and quality. JK indicated that greater collaboration between Government, industry and other stakeholders was needed, particularly focused on demand hot-spots in parts of South Lincolnshire, North Norfolk, Suffolk and the West Midlands, to avoid adverse impacts on the rural economy.

JK noted that the Agri-Tech Strategy reflected increased recognition of the need to invest in scientific solutions to meet future food needs in the context of a changing climate and finite natural resources. It was critical to recognise that without water security there could be no food security, he said.

In terms of scientific innovation and its role in improving water security in agriculture, JK highlighted four key areas:

- Combining agri-informatics with improved soil sensor and application technologies to promote precision irrigation;

- Improving medium-term weather forecasting approaches to de-risk agricultural production systems and help farmers manage probability;

- Increasing the resilience of fresh produce supply chains to water-related risks, by identifying the hot-spots for UK supply and understanding how to mitigate those risks;

- Understanding the trade-offs between improving water use efficiency, energy consumption and greenhouse gas emissions.

JK concluded that while the policy focus in recent years had been on carbon, water issues were increasingly gaining traction and with food-related water consumption totalling 3400 litres per person per day it was important to get water into the daily psyche and to focus on sustainable outcomes for the long-term security and efficiency of water use.

Professor Chris Atkinson, Chair of Sustainable Agriculture and Climate Change, Natural Resources Institute, University of Greenwich

Exploring the role of plant breeding and crop genetics in developing more water-efficient farming systems, Professor Chris Atkinson (CA) acknowledged that there was still a long way to go to understand plant physiology and how plants respond to drought. A key challenge in developing drought tolerant crops for agriculture was the need to focus not only on plant survival, but also on maximising the quality and yield of the crops produced.

Plant breeding was a time-consuming process, and while advances in genomic science were undoubtedly opening up new opportunities to identify and describe the genetic factors involved, CA cautioned that there was still a need to understand more fully how these genes were expressed and how this related to the plant's function in response to water stress.

Breeding for drought tolerance also depended on having access to sufficient characterised genetic diversity, for example through germplasm collections, while biotechnology also enabled novel sources of diversity to be introduced from other species.

CA suggested that the shift from public to private sector plant breeding programmes could be a factor in limiting the focus on 'public good' objectives such as drought tolerance, and also in restricting access to genetic material.

Opportunities to improve prospects for breeding in this area included the development of automated, non-invasive tools to measure the performance of individual plants under drought conditions, the introduction of new agro-ecological approaches to understand how plants interact and 'fit' in their environment, and the use of new GIS and spectral technologies to analyse crop performance on a larger scale.

But CA highlighted the complexity of the genetic factors contributing to drought tolerance and their interaction with other traits such as heat tolerance, adding that it was not a simple question of more or deeper roots equals improved performance under water stress.

Other genetic possibilities to improve the water use efficiency of agricultural crops included avoiding drought, for example by developing earlier-maturing crops to optimise use of available soil moisture. More research was also needed to understand what was happening below ground in terms of crop physiology and development under drought conditions.

Offering a vision for the future, CA emphasised the need for greater integration of scientific disciplines, bringing together soil science, genomics, crop physiology and agro-ecology to promote improved understanding of drought tolerance, and to focus on the development of functional phenotypes linked to the physiological processes which influence a plant's response to drought, such as photosynthesis and stomatal conductance.

CA considered that current breeding approaches were not always appropriate, emphasising the importance of realistic, field-based evaluation and validation. He also stressed the need to interact with and learn from the global breeding community, and to support UK-based facilities and staff at crop research institutes with expertise in this area.

Dr David Firman, Head, NIAB CUF Potato Agronomy Unit

David Firman (DF) described the work carried out by his team at NIAB CUF in Cambridge to improve water use efficiency in potato production, which related particularly to the UK but also extended to more water stressed regions such as Iberia and parts of North America.

Data from the UK Irrigation Survey showed that potato production accounted for more than half of UK irrigated water use, primarily main crop but also early potatoes. It was important to recognise the role of irrigation not only in improving yields but also in maintaining quality, a key factor in reducing wastage.

In relation to yield, the difference between an irrigated and unirrigated potato crop could be more than a factor of two, while irrigation also played a key role controlling a number of physiological disorders and diseases.

The Defra Irrigation Survey showed that most UK growers were not using any scientific method to schedule water irrigation, with only a minority of growers using approaches such as soil moisture measurement or tuber based calculations. This data alone suggested that there should be scope for improvements in the efficiency of water use in UK potato production.

DF suggested that while the guiding principles of irrigation management were relatively straightforward, improvements could only be made by measuring the key factors involved, such as rainfall, temperature, canopy size, wind-run, relative humidity and solar radiation, as well as soil type and drainage.

DF explained that NIAB CUF had been working on a number of projects to investigate these factors and their influence on water requirements, to improve advice to growers on when and how much to irrigate. This included a research partnership with PepsiCo as part of their 50 in 5 project to reduce water use embedded in their products by 50% over five years. By applying these principles and feeding information back to individual growers, year on year improvements could be made in water use efficiency.

DF emphasised the importance of data collection in improving the analysis and understanding of water use efficiency, highlighting the CanopyCheck smartphone app developed by NIAB CUF to measure ground cover, a key factor influencing evapotranspiration, simply by taking GPS-tagged images of the growing crop canopy. This process of data collection was increasingly supported by other imaging techniques such as the use of drones and satellites.

DF also stressed the importance of monitoring weather data in improving the efficiency of irrigation, including the fundamental requirement to measure rainfall and actual levels of irrigated water received by the growing crop on a field by field basis. For example, in-field rain gauges and automated telemetry had been used to show that crops were often not receiving the amount of water that growers thought they were applying.

Finally, DF described the importance of irrigation in controlling the incidence of common scab which in dry conditions could damage tubers leading to wastage by rendering them unmarketable. A NIAB CUF project carried out for AHDB had shown that irrigation could be scheduled and carried out quite differently to control common scab according to potato variety, and this research was already delivering significant savings in irrigated water use.

3. Questions and discussion

The following key points arose during discussion:

Retired wheat breeder John Bingham noted that the increase in wheat yields since the 1950s had greatly improved water use efficiency per unit of production, although the rate of improvement had slowed in recent years. The next step would be to use GM techniques to improve photosynthetic efficiency, although he expressed doubt about scope to change the timing of development stages such as flowering and grain fill.

In response to a point raised by Lord Selborne, views differed on the need for the UK to step up its international collaboration on water-related issues. Martin Collison argued that a much greater focus on collaboration was needed, not only in relation to the science and technology involved, but also in the management of water as a resource, looking for example to countries such as Israel which permitted the use of grey and recycled water for food crop production. Jerry Knox considered that the UK should be focusing more on alliances with countries facing similar water use challenges, while George Rothschild of the International

Water Management Institute (IMWI) suggested that the UK was collaborating effectively on a global basis on water-related issues, for example through the Institute for Hydrology and Ecology along with UK university departments and others, adding that a key challenge was not to treat water in isolation but as an integral part of the health/energy nexus.

Rebecca Pow MP congratulated the Group on assembling such a fascinating line-up of expert speakers, asking whether more should be done to push Government and other bodies to highlight the cost of embedded water in imported foodstuffs, and putting the case for more seasonal use and storage of home-grown crops as an alternative.

MC considered that the fresh produce supply chain was taking these issues seriously and that in the long-term the UK should looking to replace imports with home-grown production wherever possible, as well as seeking improved collaboration and strategic planning in the management of water supplies for agriculture.

Jerry Knox observed that in an ideal world, water stressed countries should be looking to import water-intensive products from countries such as the UK, although acknowledging that in practice this was unlikely to happen since blue water movement was a consequence not a driver of trade. A key challenge therefore was to identify and highlight the socio-economic and environmental impacts of producing water-intensive crops in water-stressed areas to meet demand from countries not short of water, particularly when much of the produce ultimately goes to waste.

Simon Griffiths of the John Innes Centre highlighted the importance of the 10 year Defra-sponsored Wheat Genetic Improvement Network (WGIN) in focusing on the way drought is handled in the UK wheat crop.

Meanwhile a recent survey of growers by East Malling Research had shown a two-fold difference in productivity between well-irrigated and poorly-irrigated crops, highlighting the importance of providing crop-specific advice and support to growers.

Concluding the meeting, Mark Spencer MP thanked speakers and attendees for their contribution to a stimulating and informative session.