

Harvesting Opportunities

Selected Abstracts from the Conference held at SNH Conference Centre, Battleby, Perthshire, on 24 February 2011

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SAC (Scottish Agriculture College)

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Introduction

J Stuart Swanston, SCRI, Invergowrie, Dundee

'Harvesting Opportunities' was the third in a series of biennial conferences organised by the Combinable and Energy Crops Sub-Committee of the Scottish Society for Crop Research and held at SNH, Battleby near Perth. The conference aimed at addressing the challenges and opportunities for arable farming in Scotland, but to do so in a global context. There are several reasons for this. Firstly, the challenge, outlined in a plenary lecture by Professor Peter Gregory, of increasing yield, in a warming climate, whilst reducing energy use and increasing resource-use efficiency is universal. Additionally, trade is an integral aspect of food security and Scotland has great capacity to produce raw materials and value-added products of high quality. However, as demonstrated by the presentation from Dr Keith Dawson, expertise is also an exportable attribute and major improvements have been effected in developing areas of Eastern Europe. Such technical developments may be one of the keys to unlocking yield potential as the world seeks to feed a growing population.

Better understanding and manipulation of natural systems and interactions will be essential, however, for sustainable yield enhancement. This selection of abstracts therefore includes contributions on current research in pathology, soil structure and nutrient uptake, which will continue at the new James Hutton Institute. These are aimed at creating a knowledge base to inform future, targeted plant breeding and agronomy. Natural interactions depend on biodiversity and this is another vital aspect of land-use research. Ensuring that benefits associated with set-aside are not compromised in the drive for greater productivity is a major issue addressed by Marie Pages-Gold of SNH.

Global Food Security: the challenge to Scotland's research community

Peter J Gregory, SCRI, Invergowrie, Dundee

The recent UK Foresight Report (2011) on "The Future of Food and Farming: Challenges and Choices for Global Sustainability" sets out five major challenges for the immediate future. It places considerable emphasis on the need to increase production sustainably by using resources more efficiently and by reducing waste, all in the context of a changing climate. As in the past 40 years, increased crop production in the future is projected to be achieved largely by increasing yields per unit area rather than by increasing the area of cropped land. This poses a considerable challenge: how to increase yield in a warming climate while simultaneously reducing energy consumption (allied to greenhouse gas emissions) and utilising resources such as water and phosphate more efficiently.

As with the rest of the UK, Scotland's food security depends on trade. Beef cattle, sheep, farmed salmon and some very expensive bio-ethanol are traded for many other foods. With a Scottish Government policy of substantially increasing food and drink exports from Scotland, how might research assist in meeting these multiple challenges?

A secure food system requires a product base (whether crops or animals) that is resilient to changes in climate, resistant to current and emerging diseases, produces more crop (meat) per unit of resource input, and meets consumer demands for safe, tasty and healthy food. This talk will explore the contribution that the Scottish research base might make to providing such products.

Friend or Foe? *Rhynchosporium* and other microbes on barley.

Adrian C Newton et al., SCRI, Invergowrie, Dundee.

Rhynchosporium is one of the most problematic diseases of barley, but it may be even more problematic than we think. We know it by the symptoms it produces, but it is also grows very extensively on green leaf tissue, even resistant varieties, producing spores and re-infecting. It is present on the harvested grain and completes its life cycle when it is sown for the next crop. Clean seed tends lead to higher yields, suggesting a detrimental effect of this symptomless growth of *Rhynchosporium secalis*, causal agent of the disease. Amount of *R. secalis* present on leaves as measured by the DNA present, shows some, but erratic correlation with disease. Epidemiological factors dominate whether the infections become symptomatic, particularly rain in April in the UK. A genomic location affecting whether it becomes symptomatic has also been mapped, leading to prospects for novel resistance breeding.

Barley can be affected by many other microbes that form no symptoms but affect plant health and yield. These include a root-infecting endophyte that enhances biotic and abiotic stress tolerance as well as yield. The leaf surfaces are covered with many species of bacteria and fungi, some of which interact with pathogens such as powdery mildew or *R. secalis* to either increase or decrease symptoms and thereby disease spread. Plants may even harbour animal and human pathogens, many being maintained in the soil. Populations on the plants vary throughout the season and are affected by leaf age, variety, location and soil management. Sustainable management of disease therefore needs to

exploit our increasing knowledge of the whole crop ecology rather than targeting the causal agent alone and inadvertently affecting non-target organisms.

Soil structure, biology and organic matter

Eric Paterson, The Macaulay Land Use Research Institute, Aberdeen

Currently, there are economic and environmental pressures to reduce the input of chemical fertilisers to soils in crop production systems. These pressures are concurrent with increased national and global emphasis on food security and the need to maximise agricultural productivity.

Meeting both of these, apparently opposing, objectives simultaneously presents a challenge. In natural ecosystems plant productivity is inextricably linked to nutrient cycling processes mediated by microbial communities. The decomposition of soil organic matter (SOM) by microbial communities mobilises carbon and nutrients into forms available for biological processes. The microbial biomass is a dynamic 'pool' for nutrients, meaning that nutrients held by the microbial biomass ultimately become available for plant uptake. In addition, plants influence the activity of soil microbial communities via release of organic compounds from roots.

These plant-released compounds provide a readily utilisable carbon and energy-source for microbial communities, fuelling a broad range of processes including decomposition of SOM. Consequently, the release of organic compounds from plant roots can increase the supply of nutrients from SOM to plant-available forms. This mechanism, that couples plant and microbial activity, is a strategy utilised by plants in natural ecosystems to maintain productivity.

For soils receiving high inputs of chemical fertilisers, the ability of crop plants to manipulate their nutrient supply from SOM has not been critical to their productivity, but if chemical inputs are to be reduced, exploitation of natural nutrient cycling processes will be increasingly important. Consequently, we are addressing whether there is scope to improve the traits of crop varieties that mediate mobilisation of nutrients from SOM. Such utilisation of SOM as a 'nutrient bank' requires that the stock of organic matter is maintained, so that it can continue to supply nutrients, but also so that benefits in relation to soil structure and biodiversity are protected.

One solution to maintaining SOM stocks (while also reducing chemical fertiliser inputs) is to utilise organic materials, such as municipal composts, as soil amendments. Potentially, such organic amendments would provide nutrients for crop growth, while also maintaining the SOM stocks required for sustainability of production and other ecosystem services. This research topic will be addressed at Balruddery, the SCRI experimental farm platform, where the importance of biological processes in establishing sustainable management practices will be investigated.

Gene x Environment: Impacts on Improving P acquisition by cereals

Tim George, SCRI, Invergowrie, Dundee

To enhance the sustainability of agriculture it is imperative that the use of P-fertilisers by temperate cereal crops be improved. This can be achieved both by agronomic and genetic approaches. While many studies have demonstrated genotypic variation in P-use efficiency in a number of cereal species the robustness of this genetic variation in contrasting environments is rarely considered. Here we describe an experiment in which we compare the P-nutrition of winter and spring barley genotypes from an association genetic-mapping population grown in a field trial with different cultivation treatments (conventional plough vs. minimum tillage) which had been established over a number of years. We demonstrate that, while there is significant variation between genotypes in their P nutrition, this variation is not comparable between cultivation treatments and only one winter barley genotype (cv. Gleam) has beneficial P-use efficiency traits in both cultivation systems. Analysis of the association genetic-mapping population demonstrated that there was a strong environmental component in the genotypic variation, with more significant associations of shoot P concentration with known SNP (Single Nucleotide Polymorphism) markers when the population was grown in minimum tillage treatments. These data suggest that it may be possible to identify genetic components to variation in P nutrition in barley, but that a large interaction with environmental variables may limit the usefulness of any genes or markers discovered for improving P-use efficiency to the conditions under which the screening was performed.

Agri-environmental advice for the wider countryside: awareness raising campaign on the environmental benefits of set-aside and how to replace them.

Marie Pagès-Gold, Scottish Natural Heritage, Inverness

Set-aside was introduced in the European Union in 1988 through the implementation of voluntary schemes and made compulsory at the reform of the Common Agricultural Policy in 1992 to help regulate agricultural production. In recent times, the economic rationale for limiting food surpluses effectively became irrelevant and the 2008 CAP Health Check introduced the ending of compulsory set-aside. Nonetheless, a side-effect of set-aside was their potential benefits for wildlife and the quality of the rural environment, in particular in intensive arable systems (Institute for European Environmental Policy, 2008).

In order to capture the benefits of set-aside for biodiversity and natural resources, Scottish Natural Heritage funded a 2-year awareness raising campaign for land managers across Scotland's main arable areas. Through a series of workshops, individual advice on farms and the production of a technical booklet, the campaign highlighted the importance of set-aside for arable biodiversity and promoted other positive management within and outside agri-environmental schemes. We will present the outcomes of this project, the challenges encountered and ways forward in promoting biodiversity conservation in the wider countryside.

Reference: Institute for European Environmental Policy (2008). The Environmental Benefits of Set-Aside in the EU. A summary of evidence: 18 pp.

Global Opportunities for Scottish Agriculture

Keith Dawson, Continental Farmers Group

The opportunities for Scottish expertise and technology in Global markets were highlighted by using three case studies of global development by Scottish companies or utilizing Scottish expertise.

The three case studies were based in Ukraine, Northern Sudan and Cuba and highlighted the wide range of opportunities available for the motivated Scot. Dr Dawson spoke first on the global situation and growth in food demand at three levels:

1. The growth in population from 2bn to 7bn in one lifetime
2. The increased requirement for protein in the diet, especially from those countries whose economies were developing rapidly eg China, India and Eastern Europe.
3. The switch from beef and sheep meat which utilize forage crops towards greater use of pork and chicken utilizing grain crops.

There were tremendous challenges for all members of the agricultural family: researchers, suppliers, advisers and farmers.

Dr Dawson commented on the effect of higher food prices in countries where a high proportion of daily income is “consumed” by food. He did not expect such a powerful example of both the forces of connectivity and food as a percentage of disposable income in action to be so in evidence at this point in time with such significance. With what is now being called “The Facebook Revolution” in Egypt. On a recent visit there in October he had visited Tahrir Square and witnessed Egyptian agriculture and their teeming 80m population at first hand. Egypt is the world’s largest importer of wheat to feed this young population and the wheat export bans from Russia and Ukraine meant Egypt had to look elsewhere for supply. Instability and fear coupled with climatic events are now forcing wheat prices even higher!

In a mirror of the Solidarity Movement in Poland twenty years ago, which heralded the fall of Communism, it was food price rises which were a major factor in sparking the demonstrations in the Middle East. In the UK the average household spent less than 10% on food leaving income for other expenditure and luxuries such as satellite TV, second cars and foreign holidays. In poorer societies, where over 70% of income goes on food, an increase we grumble about is catastrophic and concentrates the mind via the belly. Further developments across the Gulf, North Africa and Middle East as a result of food prices, repression and global connectivity will increase pressure on commodity prices. It would be a brave US senator who voted against US biofuel security with current developments in the Straits of Hormuz-food and fuel security will drive strategy and stockpiling where economics allow! Dr Dawson asked the question whether biofuels were intrinsically a bad thing?

It would not be too much of an exaggeration to say that farmer productivity, and hence lower prices and even food availability, has provided not only the ability for Europeans to afford luxuries but also holds the key to global stability. Farmers are a Global Peacekeeping Force! Maybe we should all wear blue helmets?

Dr Dawson highlighted the development of three different case studies where Scottish investments were bearing fruit in Ukraine, Africa and Central America. With particular emphasis on the Ukraine as an exemplar he showed that Scottish agricultural entrepreneurs had identified an opportunity with land left fallow since the dissolution of Russian Collective farms twenty years ago. The system of land ownership had devolved into small individual holdings granted to villagers of 0.5-1.0ha but without sufficient capital

to cultivate the land and produce crops. There is an agricultural land sale moratorium in the Ukraine to avoid a landgrab, particularly by Russian oligarchs. This meant painstaking, lengthy negotiations with individuals and village councils to aggregate a holding of sufficient size to allow economies of scale for modern production.

Starting from 90ha of potatoes in 2006 CFG now had a landholding of 30,000ha using a proven model from their successful Polish business set up 18 years ago. This was a model with a crop rotation of potatoes, wheat, oilseed rape, sugar beet and maize. The model was one of High input:High hectareage in contrast to Australian/US/Russian models of Low input:High hectareage and a Western European model of High input:Low hectareages. There were no support payments and wheat and oilseed rape was produced and sold at lower prices than global prices. The production systems were based on an ICM/LEAF model with a fourfold mission statement of:

1. Growing high yields
2. Of a product quality that the market wants
3. At the lowest cost of production per tonne
4. With a high level of environmental and Social Responsibility

There had been significant difficulties along this impressive trajectory with significant challenges in land amalgamation, cultural differences, staff training and climate. He cited the importance of new technology, particularly improved genetics and highlighted the crucial role of genomics and SCRI in this sector. A textbook example of SNHs TIBRE approach in practice.

Dr Dawson highlighted the “Scottish Leapfrog Effect” jumping from horse drawn ploughs in the Ukraine to 400hp GPS controlled tractors pulling large cultivators or computer controlled one pass planters. This allowed both economies of scale and reductions in greenhouse gas emissions with significant organic matter return to the soils. The soils selected were of the highest quality and did not require stone or clod separation for potato cultivation. They were well drained and other criteria for selection of the area of operations were adequate summer rainfall, close proximity to EU and available large blocks of contiguous land. A lack of infrastructure and machinery had required significant investment in storage, transport and drying to improve marketing and premiums in an area largely devoid of any modern trappings. This had led to work and sales for Scottish companies both for construction and new and second hand machinery and seed potato sales. This had also led to CFG being a significant employer in an area of high rural unemployment and poverty. They were now used by the regional oblast government as a textbook example of FDI.

In addition to a detailed analysis of Ukraine Dr Dawson also highlighted the involvement of Scottish experts in a Saudi backed irrigation project in Northern Sudan abundant water from the Nile to irrigate 12,000ha of land not cultivated for a millennium. A third project with a heavy Scottish involvement was a project in Cuba looking at a combined AgriEnergy project utilizing remediated land as a source of feedstock for renewable energy plants and allowing cultivation for food crops with both domestic and export potential. This former agricultural sugar basket was now importing 85% of its domestic food requirements despite abundant agricultural land and a good climate.

Dr Dawson reminded the conference of the old Byzantine proverb “The man with a full stomach has many problems, but the man with an empty stomach has only one!”