BSPB
promoting innovation

Royal Society investigation into biological approaches to enhance food crop production

Submission by the British Society of Plant Breeders

The British Society of Plant Breeders is the representative body for the UK plant breeding industry. Formerly the Plant Royalty Bureau, BSPB was formed in 1966 after the UK Plant Varieties & Seeds Act 1964 established a legal framework for collecting seed royalties on protected crop varieties.

Acting on members' behalf, BSPB licenses, collects and distributes certified seed royalties and farm-saved seed payments on the following agricultural and horticultural crops: Cereals, Oilseeds, Potatoes, Pulses, Fruit and Herbage. The Society aims to promote investment in future crop improvement by optimising the return to plant breeders on their intellectual property.

BSPB represents more than 50 members, comprising virtually 100% of public and private sector breeding activity in the UK. The Society promotes members' interests on technical, regulatory and intellectual property matters at a national and international level. A list of BSPB members is included as an appendix to this submission.

Overall, the Society aims to promote innovation in plant breeding by ensuring its members can operate in a proportionate, commercially relevant and cost-effective framework of regulation. BSPB organises a broad programme of statutory and commercial variety trials on behalf of its members.

Introduction

There is an acknowledged crisis in global food production. Demand is beginning to outstrip supply, and with limited land available to bring into agricultural production, the only realistic prospect of producing enough food for a rapidly increasing world population is through productivity growth – producing more crop per hectare.

It is increasingly evident that improvements in plant genetics – delivered through commercial plant breeding programmes such as those operated by BSPB members – will be the single most important factor in delivering the required gains in agricultural productivity.

Interim findings of a recent study by the National Institute for Agricultural Botany (NIAB) suggest that between 1947 and 1982, around half of the yield gain of major UK arable crops such as wheat and barley could be attributed to plant breeding, shared equally with the contribution of other factors such as improved agronomy, machinery or inputs. Since 1982, however, the contribution of plant breeding to yield gain has increased to more than 90%.

An expanding global population is not the only challenge. Climate experts predict that the effects of climate change – including extreme weather events and shortage of water – mean the world's agricultural productivity will rely increasingly on temperate regions such as Europe and North America.

Furthermore, the UK has a unique maritime climate and needs plant breeding to take place here in the UK. To illustrate this point, UK-bred varieties currently account for 95% of winter wheat, 89% of winter barley and 98% of spring barley grown in the UK.

The UK therefore needs strong, locally-based plant breeding to address the challenges of 21st century agriculture.

1. Is there a need to increase global food-crop production to support present and future populations and their consumption patterns?

There is an overriding imperative to increase global food production. With increasing population growth and no significant new land areas to exploit there is a real danger of civil unrest and political instability within the world when food supplies are either low or under threat. The UK has a role to play as part of an international approach to sustaining and improving food supplies.

2. What do you consider to be the major scientific and other challenges to increasing food-crop production in developed and developing countries over the next 30 years?

Overcoming political and public resistance to the application of new technologies, such as genetic modification, is essential if the full potential of advances in our genetic knowledge is to be realised and exploited. Within Europe, much mythology and public anxiety continues to surround a potentially valuable technology, already in widespread commercial use elsewhere in the world.

At a more general level, while the UK is blessed with academic excellence there is a divide between academia and the commercial parties responsible for delivering new technologies. Careers in plant science related research are often linked to academic excellence through peer reviewed publications rather than translation into products for commercial and public exploitation.

3. Can you identify recent or imminent scientific developments that will impact substantially on food-crop production over the next 30 years?

Developments in molecular genetics and multidisciplinary approaches to the identification and understanding of gene function could play a significant part, as could hybrid crops in current self-pollinating species such as wheat. The tracking of traits through breeding programmes using marker assisted selection and technologies such as double haploidy and other tissue culture techniques could lend themselves to faster integration of high value traits - but there is an urgent need to identify high value traits.

4. What biological approaches do you think have potential for food-crop improvement over the next 30 years and what benefits would they bring? These may include biotechnological, agroecological and other agronomic technologies. In your answer, please outline the current state of knowledge and the time you think it will take for the benefits from these approaches to be seen.

Much of the improvements in production have occurred through the integration of a wide range of technologies. There is still mileage in many of the technologies used previously. Biomass increase is a 'must have' in order that it can be portioned. Precision agronomy and the identification of micro and macro environments in which specific genotypes could prosper as well as better defined and targeted inputs would further enhance production.

The development of insect resistance (to a range of pests) through genetic means rather than the use of often unselective chemical insecticides is likely to lead to more stable yields as well as the maintenance of quality. The timescales for any benefits to reach the market place are long and thus there is a need to develop strategies sooner rather than later. The development of high throughput technologies such as double haploidy via microspore culture could have very significant benefits in shortening this time frame.

5. Which traits, across species or in specific food-crops, are appropriate targets for improvement? Comments could include information on why such traits are appropriate targets, the benefits they may bring, difficulties involved in targeting such traits and time required to see benefits from such improvement (for example, time needed to get improved varieties in farmers' fields).

Insect resistance is important as outlined in (4). The characterization of what determines reduced yields in continuous cropping of cereals as well as improved levels of disease resistance to current threats as well as intransigent targets such as take all could enhance wheat yields in the UK significantly. A longer term objective could be the possibility of improving photosynthetic efficiency, for example by modifying the Rubisco complex. As noted at (4) the time from research to market through a new variety is 10-15 years as a minimum; the research cost is too great and the risk too high for a commercial plant breeder to invest in these targets within the current limits of royalty income.

There does appear to be an element of 'intellectual snobbery' prevalent within certain strands of the academic community – preferring (or encouraged through Government funding) to work within areas of perceived high 'quality' science. There are major gaps in technology transfer from the academic community to the deliverers of key traits – plant breeders.

8. What might be the possible consequences and impacts of biological approaches to enhance food-crop production on:

a) crop yields and quality;
b) world food prices;
c) the environment;
d) the livelihoods of farmers; and
e) any other areas you think relevant.

Biological approaches to enhance food production must be a key part of any strategy to delivering sustainable output of high quality food. However the demands placed upon those 'burdened' with this target are vastly more difficult than those experienced with the development of the first 'Green Revolution'. The 'ideal' is to sustain (and preferably increase) food production with reduced inputs. Targets such as nitrogen and water use efficiency, biomass production (perhaps through the manipulation of the photosynthetic pathways), insect and disease resistance and introgression of traits through related or non-related species need to be addressed.

At present, strategies to confront these targets are sporadic and lack effective coordination. Whilst these may be pertinent to UK plc they do not seem to figure within Government strategies. The benefits of achieving just some of these targets would be beneficial to farmers and consumers, both in prices achieved and stability of supplies. If growers are adequately rewarded the environmental benefits will flow (at least for the majority of farmers) from the custody of the environments in which the crops are grown.

9. What are the potential barriers to the application of biological approaches to enhance food-crop production? These barriers might include matters relating to regulation, national and international policies, adequacy of the skills base, research infrastructure and resource availability including germplasm conservation, and knowledge transfer and intellectual property issues. Please also comment on the appropriate relative contribution of private and public sectors, and on whether there is sufficient public sector breeding and training in plant breeding.

Barriers exist at all levels because there is no agreed common strategy to boost food production and the targets involved are not (yet) perceived to be of high value.

Near term threats include the impact of unscientific or politically motivated regulation, particularly at EU level, ostensibly to protect or benefit consumers. Some of the strategies imposed may well be at variance with an objective of raising food crop output - for instance proposals to remove many known and safe agrochemicals, imposed reductions in the use of nitrogen fertilisers (a major driver for grain output) and over regulation with regard to water quality directives.

Recruitment of young plant breeders to the industry is difficult. In the plant breeding sector the low esteem given to workers within the agricultural community may discourage scientific high flyers from taking this route. In addition, agriculture has traditionally been a poorly paid sector, relying more on individuals' vocational aspirations than on financial remuneration. The industry has a high proportion of individuals who will retire in the next ten years and this will leave a knowledge gap.

Specifically in relation to UK plant breeding, there is a major gap between a rapidly advancing knowledge base in basic plant science and the delivery of new technologies to the market place. A major review of UK crop science in 2004, led by Professor Chris Gilligan, identified a serious imbalance between funding of basic plant science, in which the UK remains a world leader, and support for translating the outputs of that research into relevant crop species and varieties of practical benefit to UK agriculture. Although some crop-specific initiatives have subsequently been established to address the concerns expressed by Professor Gilligan, these have paid lip service to the crop science label and have failed to address the targets important for commercial plant breeders in our major crops, wheat, barley and oilseed rape. These initiatives have not resulted in a flow of material or knowledge suitable for use in commercial breeding programmes, and a fundamental imbalance persists today.

LINK has been a valuable mechanism for funding translational research and the plant breeding industry has used it successfully. But there is now a question mark over the future of LINK and a concern that the sole source of funding for truly relevant projects may cease to exist. The Technology Strategy Board within BERR has failed to bring forward funding calls to which breeding companies can apply, despite having many discussions with industry on the subject. Plant breeders are also frustrated at the Government's failure to engage with the breeding sector. For example a recent high level meeting to discuss Government R & D strategy involved public scientists and the agricultural sector but completely ignored the commercial plant breeders, the only route to exploiting plant genetics to improve productivity and, as the NIAB study referred to earlier shows, the only part of the innovation chain that has produced significant improvements in recent years.

There has been an explosion of new knowledge about the genes controlling many aspects of plant growth, development, metabolism and responses to biotic and abiotic stresses. In addition, progress in molecular techniques and laboratory automation, as well as the development of computing power and revolutionary mathematics open up significant opportunities for the genetic improvement of crop plants.

However, as new understanding of plant biology has progressed, the knowledge-transfer chain has become less functional because the required level of investment for translational activities has not been available.

Plant breeding is a private sector activity. Plant breeders derive their income from royalties, provided for by Plant Breeders' Rights (PBR) legislation. Royalties are paid for the use of seed: on certified seed supplied by seed multipliers (agricultural merchants) and at a substantially lower rate on farm-saved seed (around 50% of the royalty paid for the use of certified seed, with farm saved seed accounting for nearly 50% of all seed use in the major crops). The dynamics of the industry are such that the total income to breeders is relatively inelastic and equates to around £30 million per year.

An inevitable consequence of linking royalty income to the volume of seed sown has been to restrict the total amount of money available at the point of collection, a situation compounded by a trend towards reduced seeding rates and increased use of farm-saved seed. In IP terms, this situation has detached plant breeders from the rest of the value chain, and limited the sector's ability to derive a more realistic share of the genetic value added beyond the farm-gate.

A consequence of the limited revenue streams available from plant breeding is that breeders simply cannot invest in more speculative or long-term targets. Around one third of breeders' income is devoted to research activities, the vast majority of which is required to maintain existing breeding programmes. For some crops, further growth in the proportion of farm saved seed to certified seed use may result in the closure of the few remaining breeding programmes as income will be insufficient to sustain them.

Because of this, the market-based approach to financing near-market and applied R&D is not working, and opportunities to exploit the UK's world-leading, publicly funded research base in plant science are being lost.

There is an urgent need to bridge this hiatus in research activity. Significant investment in publicly-funded translational crop science and pre-breeding programmes is required to ensure public benefit – in the form of enhanced food crop productivity – can be derived from current taxpayer investment in basic scientific research. The role of private sector plant breeders will be pivotal for further exploitation of material developed or characterised through such activities.

BSPB
promoting innovation

APPENDIX

BSPB membership

Full Members – Large

DLF Trifolium Ltd
Elsoms Seeds Ltd
Germinal Holdings Ltd (BSH)
KWS UK Ltd
LS Plant Breeding
Monsanto (UK) Ltd
Nickerson-Advanta UK Ltd
Syngenta Seeds UK Ltd
Saaten Union UK Ltd
RAGT

Full Members - Small

Cygnet Potato Breeders Ltd
Senova Ltd

Associate Members – Large

Agrico UK Ltd
Barenbrug (UK) Ltd
Caussade Semences
Danisco Seed
Deutsche Saatveredelung AG (DSV)
Grainseed Ltd
Masstock Arable Ltd
Pioneer Hi-Bred (NE) Ltd
Rijk Zwaan UK Ltd

Associate Members - Small

AFBI
Advanced Technologies (Cambs) Ltd
Caithness Potato Breeders Ltd
David Trethewey Seeds
Enza Zaden
Euro Grass Breeding GmbH & Co KG
Frontier Agriculture Ltd
Harlow Agricultural Merchants Ltd
Harper Adams
Huntseeds Ltd
HZPC Holland B.V.
IBERS
I G Pflanzenzucht GmbH
Irish Potato Marketing Ltd
JE & VM Dalton Ltd
John Ebbage Seeds Ltd
John Innes Centre
John Turner Seed Developments
Lion Seeds
Maïsadour Semences
MBM Produce Ltd
Mike Pickford
Nunhems Seeds
Potato Innovations Ltd
PWB (Seeds) Ltd
Sakata UK Ltd
SCRI (Mylnefield Research Services)
Seminis Vegetable Seeds UK Ltd
Top Green SAS
Tozer Seeds Ltd
TV Seeds
United Oilseeds
Wherry & Sons Ltd