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Genomics and Crop Plant Science in Europe

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Abstract

Recent reports reviews and funding initiatives in the field of plant genomic research are considered in the context of their translation into practical and economic value via plant breeding. It is concluded that there is a deficit in investment and that a change in working styles towards knowledge sharing and connectivity is required.

The review of genomics and crop plant science in Europe published in late May by EASAC[1] and authored by a collection of top flight plant scientists and institutional sages highlights the contribution of genomics research to plant breeding but paints a disturbing picture of resource deficit and neglected opportunity by both national and community[2] (European Union) research initiatives. Its announcement follows sequentially an in-depth review of UK research relevant to crop science prepared for the Biotechnology and Biological Sciences Research Council (BBSRC) posted in April 2004[3] which also points to a shortfall in coordination and investment and takes a strong position on the perceived failure of plant science research to reach through to crop improvement. Certainly both reports represent special pleading, but to criticise them for this would perhaps be a little harsh given their conviction and authoritatively argued case that genomics coupled to plant breeding has much to contribute to the UK and the community beyond the call of increased food crop productivity. This is especially the case in the areas of environmental conservation and renewable sources of feed-stocks, pharmaceuticals and energy. They both, correctly in my view, identify genomics-informed molecular marker assisted breeding and selection as the key pressure point and call for concerted action on this technical front. A well-argued rationale for this position has been articulated by Snape (2001)[4]. The third and more recent report submitted by the European Plant Science Organisation (EPSO) to the Commission of the EU takes a very similar stance.

[1] European Academies Science Advisory Council : Genomics and Crop plant science published 24th May 2004 at http://www.easac.org/CPG%20report_fin5.pdf

[2] I use the old fashioned term community to represent the member states of the European Union since "Union" could potentially be ambiguous.

[3] **http://www.bbsrc.ac.uk/news/reports/Welcome.html**.

[4] ,The influence of Genetics on Future Crop Production Strategies, J.Snape, Annals of Applied Biology 138, 203-206 (2001)

Their report [5] released on 24th June and entitled "Plants for the Future" presents a compatible strategic vision of sustainable and healthy food production, energy and feedstock production, and environmental conservation driven from a platform of plant genomic knowledge[6], whilst bemoaning past piecemeal attitudes and the inadequacy of current investment.

The former high profile EASAC report was heralded in the media, at least by the breakfast broadcast media[7] which I engage, as an expression of concern that reaction within the community against GM crops had been a cause of a waning enthusiasm for plant genomics and plant science in general. In short, those two letters "GM", signifiers of a category of plant varieties subject to discrete regulatory oversight, in their transition to signifiers of a category of plants subject to public disquiet and stigma, had spread their influence across the "G" in genomics. As a critic of the commonplace conflation of genetic modification and genomics[8] I could associate with that sort of collateral setback, the misfortune of being tarred with the same brush, and looked forward to viewing the evidence for it in the report. Sadly there is rather little discussion of the suggested GM stigma in the report itself and still less evidence for it beyond a reference to a shared perception by scientists, industry and policy makers that GM has turned the world against them. This vague notion is linked to a call for the reestablishment of public trust based on a distancing of plant genomic research and crop science from GM and the building of an appreciation for the potency of genomics-informed tools of plant breeding such as marker-assisted selection.

So, is there any hard evidence that the spectre of GM has driven investment in plant genomics away? For sure, crop science and genomics have not been awarded priority in the community FrameworkVI Programme research calls as they had in various guises in the previous framework programmes. For sure Monsanto, a major proponent of GM crop technology, has sold up and withdrawn from its European Cereal Stronghold based at PBI-Cambridge. For sure other companies have consolidated and withdrawn their genomics investment to the USA. To link all this to a GM reactionary environment is compelling but is it right?

Perhaps we should remember that the process of consolidation in the plant biotech sector began before the GM backlash took hold, likely as a reflection of the resources needed at that time for effective

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[5] http://www.epsoweb.org

[6] http://www.epsoweb.org/Catalog/TP/EPSO%20pressrelease%20web_22Jun04.htm

[7] BBC Radio Channel 4: Farming Today, and Today Programme 24th may

[8] I argue that thus far there has been relatively little cross-information between the practices of genetic modification and plant genomics , in fact the current generation of GM field crops have been scarcely informed by plant genomics at all.

deployment of genomics-informed breeding technologies. Perhaps we should not assume that statements of support for marker assisted breeding from such contra-GM activists as Greenpeace and Mr Michael Meacher (ex UK minister for the Environment) are entirely disingenuous postures (intended to counter the claim that they are constitutively anti-technology). Perhaps we should on this occasion even take at face value Monsanto's admission of a miscalculation of the economic potential of even dominant position in cereal seed breeding in the community as the reason for its withdrawal. Perhaps we might even imagine that the bean counters of Brussels have similarly made an economic assessment of the potential impact of crop genomic research and compared it with the overall value added to the community by arable agriculture[9]. They may even have examined the 80mecu[10] or so spent on genomics research across the community states and consider it to be not an inappropriate risk especially when seen against the highly variable impact of technology change on agricultural productivity among members of the Community[11].

Let us glance at what they might have seen if of this mind-set. The gross community product (gcp) from arable agriculture is of the order of 160 bn ecu pa to which can be added a further 200 bn ecu if forestry is included. This can be directly compared with the 80 million ecu pa to be spent on crop genomic research, making the research investment at 0.025% gcp seem rather modest. It looks modest also in the context of the expected Framework VI funding for genomics and human health of 2.3bn ecu or more[12] or the expected investment in plant genomics of about 220 $US in the United States. Looked at in terms of the value generally added to arable productivity by seed breeding, which amounts to 1-2% pa , dependent on crop, then the 80mecu investment seems at 2.5% to be more reasonable, but still rather short of *strategic* in relation to the requirement of AESA that Europe defend its options or its position of pre-eminence in the field. In this light and my earlier conjecture that sceptical bean counters rather than GM-aversion are the reason for the under-investment then they have got it wrong. More investment is justified and desirable and if necessary the world will have to learn to live with the difference between genomics-derived technologies and GM. One thing is clear, however, the fraction of that 1- 2% value added to arable productivity by the commercial breeding concerns which can be recovered as operating

[9] http://statistics.defra.gov.uk/esg/publications/auk/2003/excel.asp table 2.6
[10] the estimate of 80m ecu articulated in the AESA report is almost certainly an underestimate given the figures it quotes for the UK relative to the BBSRC review, the gap here being about 10m ecu
[11] http://www.ers.usda.gov/publications/WRS0404/WRS0404fm.pdf pp33-49
[12] http://education.guardian.co.uk/egweekly/story/0,5500,12228473,00.html

margin on royalties, will not support a commercial contribution capable of making a significant difference to the projected 80mecu (British Society of Plant Breeders – personal communication).

The solution, as recognised by the EASAC report lies in strategic EU support, international collaboration, public-private partnership, information-sharing and a measure of joined up thinking bout the integration of genomic knowledge into plant breeding. In this light it is worth noting that the Generation Challenge Programme "Genetic Diversity for the Resource-Poor" floated by the Coordinating Group for International Agricultural Research (CGIAR) similarly aims at the support of genomics and molecular marker assisted breeding . It is being launched with an initial annual budget of a mere $8m some 5m of which is contributed by the EU. True, this programme contains no costly total DNA-genome sequencing commitments , but its focus on mandated poor people's crops, international dissemination and capacity building for the developing world deserves more support. Sadly this initiative which might form the core of international collaboration receives scant attention from the EASAC. Well represented and welcomed in the report, however, is a community-wide coordinating activity under the ERA-net scheme[13]. for European plant genomics called ERA-PG, based in the Netherlands. Perhaps this coordinating function could, in the future, take on a broader global scope and link up to the Generation Challenge Programme. Knowledge sharing is a particularly important aspect of such an ambition but remains problematic in the context of public-private partnership. At the same time, one might expect by this time to see the plant genomics fraternity starting to take a leaf from the book of the software development and informatics sector and adopt the bottom-up, self organising, peer-production systems which have emerged from the "open source" initiative[14]. Funding agencies might be persuaded to support this trend by requiring that submissions contain details of how information sharing and tool sharing will be promoted and the arrangements for sharing and deployment of the projected genomic knowledge into networked breeding practice. In this regard it is interesting that the BBSRC review makes a plea for the reassertion of public sector breeding activities especially for those crops for which there is not a strong commercial breeding imperative (orphan crops). Their recommendation takes its lead from the observations of Knight(2001) of a major contemporary decline in decentralised breeding activity.[15]

[13] http://europa.eu.int/comm/research/press/2004/pr3001-2en.html
[14] http://www.benkler.org/CoasesPenguin.html
[15] Knight,J., 2001 "A dying breed" Nature 421, 568-570

I welcome the high level interventions from EASAC and EPSO and the BBSRC review group and am impressed that the grandees have identified cooperation as a major necessity. May they have success in enhancing the resources for plant genomic research! But, as I reflect above I can't deny the suspicion that the delivery and dissemination of accessible plant genomics knowledge is becoming too important to be left to the generals or markets or conventional chains of command alone. It is time for the foot soldiers to self-organise and take a hand in setting the terms of engagement and hopefully the conventions of public-private partnership will not exclude commercial breeding concerns from this activity.

Steve Hughes is co-director of the Economic and Social Research Council Centre for Genomics in Society at Exeter University UK. He has a background in genetics, and plant science and has worked in commercial plant breeding (PBI Cambridge) as well as in academia. His current research interests include the interaction of technical and cultural factors in the translation of genomic knowledge into agricultural development.