Plant Genomics:

Summary of Scoping Meeting

ESRC Genomics Policy & Research Forum:

Problems and Prospects in Genomics Series

Edinburgh, April 6-7, 2005

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About the Genomics Forum

The Genomics Forum is a key component of a major investment by the Economic and Social Research Council (ESRC) in the area of genomics. It is part of the ESRC Genomics Network (EGN) which is examining different aspects of the relationship between genomics and society.

The Genomics Forum has been designed to ensure that research from the Genomics Network connects with public policy debates and brings outstanding social science into decision making. It does this through a programme of national and international activities created to draw natural and social scientists, policy makers and regulators, and civil society and business into an ongoing dialogue about the relationship between genomics and society.

The Genomics Forum is based at the University of Edinburgh. It is a university wide initiative that links the College of Humanities and Social Sciences, the College of Science and Engineering and the College of Medicine and Veterinary Medicine.

About the Scoping Meeting & Report

To help with the development of its Work Plan, the Genomics Forum held a series of scoping meetings and discussions on "Problems and Prospects in Genomics". These meetings brought together a diverse range of perspectives and groups, with representatives from business, government, civil society and academia. The third meeting focused on developments in the area of plant genomics, and was held in Edinburgh on April 6-7, 2005 (the agenda is at Appendix 2). The meeting combined informal discussion and debate with formal presentations on scientific and technical aspects of plant genomics, issues regarding the governance of these developments, and the role of social science.

This report summarises some of the critical discussions that occurred, identifying emergent themes and avenues for further consideration and action. Within the body of the report, individual speakers and contributors are not identified, but a list of those in attendance can be found in Appendix 1. *This report should not be referenced as an authoritative source or considered to represent the views of the Forum, those in attendance or they organisations they represent; please do not quote without permission.*

Summary of Scoping Meeting

This report first summarises some recurring themes discussed throughout the meeting, before identifying a series of threads for possible further consideration by the Forum.

1 The power and potential of plant genomic science – key discussion points

Genetically Modified Organisms (GMOs)

- The most recognised application of genetic science to plants is in the production of genetically modified organisms (GMOs) that, for example, have increased pest resistance or herbicide tolerance, act as 'biological factories' producing foods with enhanced mineral content or pharmaceuticals such as insulin and vaccines, or express human milk protein to add to infant milk formula.

- Despite a widespread perception, there is no obvious link between plant genomics and genetic modification. Although the two may be mutually informative, GM crops have been developed largely in the absence of genomic knowledge.

- By only discussing genetic modification, many of the most useful and innovative applications of genomic research may be overshadowed, or linked to the ongoing GM debate.

Non-GM applications for plant genomics

- Genomics offers a tool to facilitate an evolving approach to environmental protection. In Scotland, environmental regulation is shifting from substance control through licensing, monitoring and enforcement, to an approach based on achieving or maintaining desired environmental outcomes. Genomic research, it was argued, may facilitate a bridge between these two approaches, by increasing understanding of the relationship between controlled substances and specific outcomes.

- Genomics may facilitate an understanding of the mechanisms or pathways of harm enacted by particular substances, or identify which species are vulnerable to particular stressors. In turn, this may facilitate refined management techniques or closely targeted monitoring regimes.

- Genomics may also offer a more sophisticated definition of 'harm', and enable an early warning system based on biomarkers.

- Genomics facilitates new approaches to understanding and conserving biodiversity. For example, genomics can help in cataloguing biodiversity and facilitate taxonomic research. It was noted that one of the least understood aspects of our environment, yet one of the most important, is soil. We have very little knowledge of importance of the biodiversity it contains, and genomics may have a role in researching soil life.

- Genomics also enables the 'barcoding' of organisms. A technique still in development, barcoding would allow the identification of any plant by reading a short stretch of its genetic code. This would, for example, allow invasive foreign species to be identified, or monitor the spread of GMOs across intended boundaries. In this way, barcoding may have a role in regulation.

- However genomic research may have a negative impact on biodiversity. and may be developed most extensively by companies involved in the industrialisation and mechanisation of agriculture, which, it was argued, is based on monocultures.

- Plant genomic research has tended so far to focus on a limited number of species, particularly those that have industrial (including pharmacological) or agricultural utility. Some participants felt that this is an example of how the science of plant genomics may miss 'the bigger picture' within which it operates.

Summary

Overall, most participants were impressed by the range of potential applications for plant genomics. Genetic modification has dominated public debate and it is clear that social scientists need to engage with this broader range of possibilities. For example, social scientists have closely studied the regulation of GMOs, but less so the positive and active role that genomics might have

in more efficient regulatory regimes. It is also clear that boundaries between genomic and transgenic research, and the dominance of GM in the public consciousness, require clarification.

2 Plant genomics in the bigger picture: genomic vision – key discussion points

Genomic research

- Can have a useful function within biodiversity and taxonomy research, and in developing sophisticated regulatory regimes for environmental protection,
- Focusing on technical fixes for perceived technical problems, tends toward narrow vision.
- All the nutritional 'fixes' being developed within plants through genomic research (e.g. increased vitamin A and iron profiles) can already be found within edible plant species around the world. Indigenous knowledge is required to identify these species, but the move toward agricultural industrialisation based on a limited number of plant species is threatening the continued life of this knowledge and the plants themselves.
- Genomic research can facilitate the identification and understanding of these useful 'natural' plants at the genetic level.
- Genetic modification offers a more rapid method of increasing the levels of nutrients in food stuffs .

Agricultural Sustainability

- Need to understand crop plants as part of an 'agroecological' system. Genomics is facilitating conventional farming by building 'symptom suppressants' into crops rather than focusing on whole-farm health. For example, the Farm Scale Evaluations compared the environmental impacts of crop management regimes associated with GM and non-GM crops, but this did not include an analysis of soil, a key component in organic farming systems.
- Reductionism, fostered by genomic research, is a counterpoint to the more holistic or systems based approach required for sustainable agriculture. However, genomic research that leads to plant products that, for example, produce more refined biofuels may facilitate moves toward sustainable energy.

Summary

The discussion suggested that genomic research needs to be understood within the broader environmental and socio-political landscape within which it operates.

3 Innovation, patents and public utility – key discussion points

Intellectual Property Rights and Patenting Laws

- Intellectual property rights and patenting laws can limit innovation and public ownership of developments in plant genomics.

- The acquisition of patents, it was argued, is an important goal in industry, part of its internal reward and promotion scheme and can form the basis for new commercial ventures and the attainment of investment.

- Patents derived from genomic research, including sequencing results and functional tools, are in the control of a limited number of companies (probably less than five, and mostly US based). Although these companies have the capability for large R&D investments, this narrow ownership forms a barrier or counterforce to innovation; these companies have the right to prevent others working with either patented techniques or the knowledge derived from the application of these techniques.

- Research tends to focus on mainstream crops with the greatest potential for profit, rather than those that might be required by specific communities or civil society more generally.

Proposed Solutions

- Increased public investment in genomic research - if private companies are unwilling, or unable, to address issues with limited profit margins, then public institutions should pick up the responsibility. This could begin with a bottom-up approach to research, centred on societal needs.

- Involve universities and other publicly funded research institutions. It was proposed for example that industry involvement should be removed from university research, but that industry should be able to access knowledge produced for free and without restriction.

- As universities are publicly funded, any research carried out should have societal need in mind. This is unlikely be the case for applications developed by industry on the basis of this university research. One proposed resolution of this problem cast universities in the role of 'consultants', working with industry and government.

- The UK has a large number of universities, many of whom depend on industry finance to remain viable, with only a small number of these universities receiving the majority of public money. Any change in industry-university partnerships may threaten these universities. An additional barrier might be that university research was also caught up in the general rising scepticism and lowering trust of scientific institutions.

- All research institutions, whether publicly or privately funded, should, through legislation or voluntary agreement, share their intellectual property with anyone who wishes to work with it. However, some participants suggested that these information-sharing models, whether within or without the current system, share an assumption that 'technology' is in itself neutral, and therefore that control of technology (within plant genomics) only applies at the product-release stage of development. This is the case for GM crops, which are regulated only at the point at which they are intended for release onto the market, or in open-field trials (this is uncontained use; there are separate regulations covering contained use).

- Some participants questioned this assumption of neutrality. It was suggested that this model treats technology as objects, whereas social scientists tend to view technology as an extended process combining knowledge, skills, practices and objects .Therefore,, social scientists argue that technologies are not politically or ethically neutral and plant genomics is no different in this respect.

- Technology may be designed and/or implemented in ways that are not democratically determined and intentionally serve the interests of powerful groups socially and politically.

Summary

The role of intellectual property rights in innovation is a site for further investigation, and it is clear that the potential for shared or even publicly owned genomic knowledge requires further thought and analysis. The role of social science in facilitating a bottom-up approach to utilising genomics might also be further considered.

4 The regulation and governance of plant genomics – key discussion points

Regulatory frameworks for plant genomics

- Regulatory costs are a barrier to innovation; there is a need for 'smart' streamlined and rational regulatory frameworks.

- There are several anomalies in current regulations. For example, it was noted that GMOs are regulated through specific EU directives, but transformations via cell fusion, or through breeding methods such as radiation induced mutation and marker assisted selection (which may be assisted through genomic research), are not regulated in the same way, even though they can induce similar traits.

- The definition of 'GMO' is problematic. For example, 'cisgenic' organisms, which contain no genetic material from foreign species because gene transfer has occurred within the same species, may not be considered 'transgenic' in the same way as organisms that do contain foreign material. Better definitions of 'GMO' and 'novel plant' are required.

- The safety testing of transgenic plants and food products from GMOs is inefficient. A rapid 'sift and learn' system would identify potentially hazardous plants whatever their origin, but would quickly discriminate those plants that pose no conceivable hazard from those that might. This might be followed by a two level assessment system that first subjects a novel plant to a strict biosafety assessment, and then a sustainability assessment of that organism within the broader environmental system..

- Questions remain over who should be involved in deciding how to overhaul the current system and determining the character of new regimes; in particular, who would we (meaning the public, policy-makers, industry etc.) trust to do this?

Governing plant genomics

- Innovation and R&D agendas are shaped by societal and political processes as well as patenting and regulatory regimes. For example, these processes have stimulated an increase in research into environmental risks, food and feed safety, and sustainability of GM crops.

- Research into the ethical, legal and social aspects of genomic science (ELSA) has increased through the 1990s to the present. The motivation behind ELSA research is a moot point – it may be part of a process to improve the democratic governance of genomics, or a tool in the social engineering of public opinion toward acceptance.

- The role of the public, and of NGOs, in the governance of plant genomics was widely debated. NGOs claim to represent the public, but they are not democratic institutions and the alliance of their position with that of the public should not be taken for granted; their interests, activities and policies should be analysed on the same terms as those of the organisations they claim to be against.

- NGOs ('active public') dominate the 'passive public' over a limited number of carefully chosen subjects (e.g. GM foods) in order to promote a particular economic and political system. This domination is achieved through theatrics, powerful and dictatorial central organisation, and sowing seeds of doubt.

- It was countered that this characterisation does not apply to all, or even the majority, of NGOs. Further, it was observed that in the past, NGOs, particularly environmental organisations, had a good relationship with science, the media, and public intellectuals. However, these parties have become sceptical of NGOs, and it would be useful to try and account for this movement.

- NGOs may not be up to date with latest scientific developments. Whilst this might limit their involvement in a technical debate, it should not exclude them from debate over the political and social implications of genomics, about which they may have valuable expertise. Additionally, NGOs such as the Soil Association (representing the organic sector) may have valuable technical knowledge.

- That activists dominate public and media discourse may be considered an argument for the identification of more sensitive approaches to including public and stakeholder interests in policy making.

- Genetic modification has dominated public debate since the late 1990s, and it was suggested that views over GM are well entrenched and unlikely to evolve, and so are therefore likely to remain in their current polarised state.

- Polarisation is fostered by the media and key actors 'egging up' their case, but also by interpretations of what it means to 'debate'. It was suggested, for example, that the GM Nation debate held in the UK in 2003 became a series of adversarial occasions where supporters and opponents of GM were pitched against one another. This limited the effectiveness of the method for deliberative public participation.

- Although debate over 'old' GM technologies may be immutable, the proper terms of public deliberation should move on with the development of new techniques and products enabled by plant genomics.

- It is important that information on the latest developments in plant genomics be made publicly available, and for scientists to develop good and productive relations with the media, the main information sources in the public sphere. This relationship needs to be carefully managed so that the media do not alter or distort the facts, the goal being informed debate and governance based on common understanding.

- However, the public is now increasingly aware of inherent uncertainties in scientific and technological developments, and that this model assumes a rational decision-making process which is difficult to achieve in the current social and political climate.

- Foregrounding scientific information may limit the terms and discourses of debate. There needs to be a place for other values such as spirituality and understandings of nature within the governance of plant genomics, and that the focus of scientific rationality on the *products* of plant genomics may delegitimise citizens' moral or political concerns over the *process*.

Summary

The debate shows something of the complexity of governing plant genomics. Information sources, including the media, NGOs, and scientists are not necessarily complementary and may therefore need to be 'managed'. However, who should be responsible for this management is part of the governance question. The interests of a wide range of actors need to be balanced and compared 'symmetrically' so that no one group is seen to be privileged or beyond scrutiny. Further, research is required into the discursive or political dominance of certain groups.

5 Plant genomics and the social sciences – key discussion points

- Plant genomics fits into a number of current research threads within the social sciences. For example, survey work has long been a feature of social science, and continues with public attitudes to genomics.[1]

- However, it was contended that a fully realised social science of genomics should move beyond established research threads. Genomics challenges us to rethink and redefine the social sciences because genomics challenges us to rethink everyday life, notions of identity, and established institutions and institutional frameworks.

- The challenge for society, and therefore social science, is to find a way to combine plant genomics and economic liberalism (an ideology not readily acknowledged by social science), in order to achieve sustainable agriculture, food security and safety, and political legitimacy and support.

- Specific research agendas might include: the effects of different and competing representations of citizens, and the institutions that generate these representations; the representation of public concern, and the political legitimacy of participation; the identification of social and biological sustainability criteria; transnational accountability; connections between technology and inequality; and market/state boundary work and market regulation.

- Some of the 'old' work might also continue. For example, there might still be useful work to be done on the observed 'deficit of trust': people do not distrust experts, science, and political institutions even most of the time, and therefore it is still necessary to explain why the public do not trust the institutions that control and regulate GM but do trust other technologies (e.g. mobile phones).

[1] See http://www.surrey.ac.uk/SHS/genomics/ for information on the ESRC attitudes to genomics project, hosted by the School of Human Sciences at the University of Surrey.

Summary

Genomics – including plant genomics – offers the opportunity to re-think social science's approach to science and technology. A new critical agenda might emerge which moves beyond survey work and the public understanding of science and technology. Some aspects of this possible new agenda are outlined below.

6 Possible threads for further exploration

The power and potential of genomic science:

- boundaries between genomic and transgenic research
- the dominance of GM in the public sphere
- the potential role of plant genomics in efficient regulatory regimes
- genomics as 'sophisticated' understanding

Genomic vision:

- genomics, the industrialisation of agriculture, and technical 'fixes'
- genomics and codifying indigenous knowledge
- genomics and sustainability

Innovation, patents and public utility:

- the role of intellectual property rights and patenting in innovation
- social science as an agent in 'bottom-up' research
- the role of publicly funded institutions and orphan research agendas
- public-private partnerships and knowledge sharing
- genomics as a site for the study of the 'politics' of technology

Regulation and governance:

- the effect and 'rationalisation' of regulatory regimes
- the development and significance of ELSA research
- 'joined up' public participation and sensitive participation methodologies
- the role of NGOs in shaping public discourse and in governing genomics
- information channels and the role of the media
- debate and the role of scientific/non-scientific framings
- competing actors and organisations in the public sphere

Plant genomics and the social sciences:

- reacting to developments in plant genomics and rethinking social science
- social science as operating amongst, but also studying, governments, markets, publics
- representations of public and citizens and the political legitimacy of participation
- comparative study of genomic and other technologies or political issues

Appendix 1

Scoping Meeting on Plant Genomics

6-7 April 2005, Edinburgh

LIST OF PARTICIPANTS

Name	Designation	Organisation
Prof. Michael Banner	Director	ESRC Genomics Forum
Prof. Barry Barnes	Co-director	Egenis, Exeter University
Dr Richard Buckland		MRC Genetics Unit
Carey Coombs	Policy Manager	Soil Association Scotland
Almut Caspary	Research Fellow	ESRC Genomics Forum
Prof. Rob Hagendijk		University of Amsterdam
Matthew Harvey	Research Fellow	ESRC Genomics Forum
Dr Catherine Heeney	Research Fellow	ESRC Genomics Forum
Prof. Steve Hughes	Co-director	Egenis, Exeter University
Prof. David Ingram (Chair)	Master, St Catherine's College	University of Cambridge
Dr Brian Johnson	Biotechnology Advisor	English Nature
Nadja Kanellopoulou	Research Fellow	ESRC Genomics Forum
Prof. Nigel Poole		Sekona Partnerships
Dr Caspian Richards	Senior Policy Officer	SEPA
Mr P Schenkelaars		Schenkelaars Biotechnology Consultancy
Jonathan Suk	Research Fellow	ESRC Genomics Forum
Prof. Anthony Trewavas		University of Edinburgh
Dr Johannes Vogel	Programme Leader	Natural History Museum

Appendix 2

ESRC GENOMICS RESEARCH AND POLICY FORUM

Scoping Meeting on Plant Genomics

6-7 April, Edinburgh

AGENDA

DAY 1 – WEDNESDAY 6 APRIL

1 - 2pm Arrival and Lunch

2 - 3:30pm Session 1: Reflections on the Past: Prospects for the Future

Chair: Professor David Ingram, St Catherine's College, University of Cambridge

- Prof. Michael Banner - Welcome to the Forum (10 mins)
- Prof. Steve Hughes, EGENIS, Exeter University (20 mins) – "From patents to Nuffield and back: reflections on a career in agri-food biotechnology."
- Prof. Anthony Trewavas, Institute of Molecular Plant Sciences, University of Edinburgh (20 mins) – "Recent developments in plant genomics."
- Discussion

3:30 - 4pm Break

4 - 5:30pm Session 2: Governing Plant Genomics

Chair: Professor David Ingram, St Catherine's College, University of Cambridge

- Piet Schenkelaars, Schenkelaars Biotechnology Consultancy, (20 mins) – "The governance of plant genomics: issues for the future"
- Dr Brian Johnson, Head of Biotechnology Advisory Unit, English Nature (20 mins) – "Advances in plant genomics from the policy and regulatory viewpoint"
- Discussion

7:30pm Dinner: Holyrood Hotel, Flints Restaurant

DAY 2 – THURSDAY 7 APRIL

9:30 - 11am Session 3: Environmental Challenges Ahead

Chair: Professor David Ingram, St Catherine's College, University of Cambridge

- Carey Coombs, Soil Association (20mins) – "Problems and prospects in plant genomics: the view from the Soil Association".
- Dr Caspian Richards, Policy Development Officer (Socio-Economics), Scottish Environmental Protection Agency (20 mins) – "SEPA's interests and concerns in the area of (plant) genomics".
- Discussion

11 - 11:30am Break

11:30 - 1pm Session 4: Understanding Developments: A Role for Social Science?

Chair: Professor David Ingram, St Catherine's College, University of Cambridge

- Prof. Rob Hagendijk, International School of Humanities and Social Science, University of Amsterdam (20 mins) – "Plant genomics: markets, publics, and governance."
- Prof. Barry Barnes, EGENIS, Exeter University – Observations on the meeting.
- Discussion
- Where Next?

1 - 2:00pm Lunch and Departure

END