



BBSRC-RCUK Consultation Future Directions in research relating to food security

Background and coverage

This submission to the BBSRC consultation on *future directions in research relating to food security* comes from the ESRC Innogen Centre at the University of Edinburgh. Innogen is the ESRC Centre for Social and Economic Research on Innovation in Genomics.¹ Our focus is on the life sciences which have the potential to transform food production systems and healthcare in developed and developing countries and to provide one of the main platforms of economic growth and global competitiveness in the 21st century. Rapid developments in life sciences challenge our existing regulatory systems and raise new ethical and social issues and our research aims to provide a sound base for decision-making in science, industry, policy and public arenas and will improve our understanding of each of these groups and their interactions.

Staff at the Innogen Centre have experience since the 1980s in areas relevant to the role of biological and related sciences in enhancing global food crop production, including research projects funded from a range of sources, published reports and journal articles, and advice to government and other bodies nationally and internationally. Recent relevant grants and publications are listed in Annex 1.

In this submission we have focussed primarily on our area of expertise, **the relationship between agricultural science, innovation and development**, particularly in the international context of global food security.

Our research on these questions has covered the following:

- (i) knowledge generation in scientific and other communities and its translation to innovative products and processes;
- (ii) governance, policy development and risk regulation²; and
- (iii) public and stakeholder engagement and related values and perceptions.

We have therefore only answered questions that are pertinent to our area of expertise.

There are some key issues that we consider cut across almost all the issues and questions posed in the consultation. 1) We consider **interdisciplinarity** highly important given the increasingly complex nature of food issues and suggest training, appropriate institutional arrangements and carefully targeted research foci crucial. 2) We consider the issue of research **translation** and **innovation** crucial. We need to think very carefully about the ways in which science can make an impact in terms of food security, particularly in developing countries. 3) We consider **research** and other forms of **partnerships** crucial if research is to be appropriate, responsive and to have a real impact.

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² We use the term 'governance' to apply to the whole process of promoting basic science, setting the conditions for its development to useful products and processes, influencing market conditions for new technology and regulating the risks to people and the environment.

Q1 Most important drivers and wider considerations as the background to food security

We broadly agree that the most important drivers and wider considerations have been identified. However, we would wish to stress more strongly the complex nature of the issues at stake. Paragraph 11 makes reference to, and calls for another Green Revolution (tackling both food security and climate change). Whilst the Green Revolution made some inroads into increasing aggregate food supply, science has not had the hoped-for and predicted broad impact on the rural, or urban poor (Conway, 1987). The *International Assessment of Agricultural Knowledge, Science and Technology for Development* report (IAASTD, 2008) begins by highlighting the fact that whilst science and technology has been relatively successful in increasing agricultural productivity, it has been much less successful in dealing with the complex social and environmental problems, and sometimes consequences, that new technologies may raise. Indeed, the need to view issues of food security in a wider context is exemplified by the role that policies to promote the production of liquid biofuel production over the production of crop staples have had in exacerbating food shortages (World Bank, 2008).

We suggest that it is preferable to look at the suggested drivers and wider considerations in relation to each other. This obviously presents a challenge for the BBSRC and other Research Councils but if we are to gain maximum impact from research, the conceptualisation of research must be embedded in the appropriate contexts (no matter how complex), and the insights, outcomes and technologies that can be derived from research must also be contextualised if they are to impact upon the most vulnerable and food insecure groups. For example, para. 22 rightly identifies the UK's excellent research base in basic and strategic science and it would be useful to think carefully about how investments in these areas can build on existing investments to build inter-disciplinary research capacity to deal with complex problems such as global food insecurity.

Q2 What, if any, additional overarching issues need to be taken into account when formulating priorities for research relating to food security?

We strongly support the call for integrated and systems-based approaches (para 26). There is no unitary global food system, there are multitudes of fluid, diverse, sensitive and ephemeral systems that serve different markets, are based on different agro-ecological conditions and are beholden on complex sets of policies, markets and other external stimuli. We need more research to understand the relationships between these factors, the most fundamental and compelling challenges lie in the relationship between factors such as energy security and climate change not within one or the other alone. We need to understand these relationships in order to understand how influencing one factor shapes and influences others. Only in understanding multiple food systems as systems will we be able to influence change in a positive, planned and foreseen manner. It is likely that science and technology will increasingly be called upon to offer 'quick fixes' to complex structural problems and this will place greater emphasis and importance on understanding the process of generating new technologies through science, and developing the sort of stimuli that create an approximate mix of new technologies, political will and lifestyle changes that will be necessary if we are to address these problems in a meaningful, sustainable way.

Likewise, we would like to emphasise the importance of recognising and analysing both synergies and conflicts (para 27). The recent biofuel/bioenergy debate underlines the potential conflicts that may occur regarding food production and as in the case of biofuels many conflicts may be unforeseen. Balancing likely conflicts is likely to require more than simply inputs from BBSRC investments. Policy and science must be effectively coupled if we are to deal with the sort of complex trade-offs and tensions that biofuel production, for example, can throw up.

The UK (para 28) has shown global leadership in international development and must continue to play a central role in driving a global 'agricultural research for development' agenda. The UK could play a pivotal role in affecting change, particularly in the EU in terms of the complexities of investment in not only agricultural research and new technologies but also in understanding the impact of potential changes in trade rules, production subsidies, multi-level governance and local capabilities.

Effective research coordination is important (para 29), and translation of research into practical applications (para 30) is also critical, and we would identify these as particularly important overarching issues that will shape the impact of BBSRC research investments. Again, we would like to emphasise the importance of systems thinking and interdisciplinarity in and between all overarching priorities.

Q5 Research targets for agricultural practice – which are the most important/urgent priorities (indicating timescales, if possible)

As well as research into improving farming practices in developing countries to reduce damage to the ecosystem (para 37e), consideration should also be given to the social aspects of farming practices. Innovation systems approaches for developing country agriculture also allow farmers to articulate their technological needs in ways that may not have been possible in the past. For example, the private sector often cannot or will not respond to farmers' demands for new technologies as farmers cannot articulate their need through markets or there is simply no likely profit to stimulate their engagement. We can think through ways to bridge these knowledge gaps in the system, perhaps via new forms of organisation or partnership. For example a public-private partnership might bridge such a gap in the system, the public sector partner may better understand what farmers want and provide some sort of financial stimulus to encourage the private sector to become involved.

In the context of developing countries in particular para 38. (sustaining facilities and infrastructure for research) and issue c. (making more efficient use of water, energy and chemical inputs) should be priorities that need to be dealt with if the other research targets are going to be effectively met.

Q8

c) Does the UK have sufficient facilities/infrastructure to deliver the research?

The UK has significant research capacity but in order to seriously make the greatest impact in improving developing country food insecurity careful thought needs to be given to appropriate research partnerships and networks (with southern research councils and international agricultural research centres for examples), possible capital investment in developing countries, possible joint research investments, and possible joint public-private research investments and activities. The 'periphery' of the UK's research capacity needs to be analysed and possibly supplemented and widened through these mechanisms if food insecurity is going to be dealt with at a global level.

d) In which topics could UK research make the greatest impact in improving food security for developing countries?

In order to focus agricultural research for development we must recognise multiple knowledge bases, the complex contexts and practices of agriculture and the multiple needs of the farmer, and in doing so foreground the role of collaboration and communication within research. This will involve marrying the best BBSRC-funded research with the work of other Research Councils and local, southern partners in order to achieve maximum impact. Besides the quality of UK science, the UK is well-versed in promoting and supporting interdisciplinary research (far more so than most developing countries) and there are important additional lessons here for developing country focused research.

Q9a) How should the translation of research into policy and practical application for food security be best supported?

In the developing country context, we would encourage the UK to reflect on 'best practice' case studies from a range of levels, of scale, scope, technological complexity, nature of actor, and nature of partnership in order to promote effective, locally-nuanced, low-impact and sustainable approaches to dealing with food insecurity from household to nation state. These case studies provide the appropriate context in which BBSRC research investments can be prioritised, developed and translated into local benefits.

Q9b) What new funding mechanisms for knowledge transfer and translational research would be beneficial?

In the context of developing countries this can be quite difficult as poorly-defined markets and weak research-society interactions often mean science does not easily translate into developmental impacts. It might be useful to explore the health innovation sector in and for developing countries as interesting ways to stimulate demand for technologies, fund research and create functioning research partnerships have arisen in the past 15-20 years. For example public-private partnerships such as the International Aids Vaccine Initiative or Global Fund, or mobilisation around advance purchase agreements. It is likely that the private sector (both North and South) needs to be engaged with (and stimulated) if knowledge transfer and translational research is to be effective in the global south.

Q10b) Training. What areas are most urgent to address, and on what basis should investment in training and skills be prioritised

The increasing complex of global food systems, the risks of climate and environmental change, the evolution of new forms of value chains, the threats of new trade offs and disputes over productive resources and the increasing numbers of people who are classified as food insecure means that we need the ability to understand the interactions between complex systems that shape food production, prices, shortages and access. This requires investment in skills and training that will equip people with the analytical tools to identify problems, bottle necks, priorities and strategic points within food systems where the greatest advantage can be leveraged. Additionally, if we are to respond adequately to new forms of trade offs and threats we need people and intuitions who are equipped to analyse complexity if research is to be properly prioritised, its impacts modelled and effect policy implemented. It is not clear at the moment that enough of this sort of expertise exists but it is crucial if BBSRC and other Research Council investments are to make the most positive impact.

Q11a) How should coordination of research related to food security be improved (in the UK and internationally)?

Stronger inter-departmental thinking between international development, trade and environmental issues could be key to improving coherence, strategy and impact.

Cross-government strategy coherence within the UK aimed at global food insecurity could be improved. This is to be expected given the complex set of drivers and interrelationships that shape global food insecurity. In particular, stronger inter-departmental thinking between international development, trade and environmental issues could be key to improving coherence, strategy and impact.

Q11

a) How should coordination of research related to food security be improved (in the UK and internationally)

In the UK RCUK coordination would be a good start and appropriately targeted cross-Research Council research priorities and calls would be a useful mechanism. Internationally, coordination with DFID, in particular, and DFID partners and investments in the UN System (FAO) and elsewhere would greatly facilitate the global impact of research.

b) What overseas models for funding and co-ordination should the UK consider adopting?

Again, there may be interesting lessons to be learnt from health innovation and the BBSRC and other Research Councils might consider interacting with the UK Department for International Development, which has played an important role in many of these endeavours.

Q11c) What will be the most important opportunities to maximise the effectiveness of UK research spending through coordination with activities overseas?

Again, the UK's Department for International Development is well-placed to play a key role here, in partnership with UK research councils. DFID is increasingly making strategic investments in broad science and technology initiatives and by linking Research Councils into the work of organisations like FAO and the Consultative Group on International Agricultural Research the effectiveness of UK research spending can be greatly enhanced.

Q12 In what ways does the regulatory framework in relation to food production and supply present barriers to improving food security, and how best might any such barriers be overcome?

A costly set of regulatory requirements for GM crops has resulted in the dominance of large multinational companies in setting the innovation strategies for the sector as a whole. Small companies that want to develop novel biological approaches to enhance food crop production are unable to raise the necessary funding on a long enough time frame, from commercial or public sources, and must work with and through multinational companies. Any novel approach that may challenge or compete with multinational company strategies is thus unlikely to be developed in the current regulatory climate.

As very many people have remarked, we need to learn the lessons from the GM crops experience. However, the lessons quoted are invariably too simplistic, focusing on failure to engage with the public at an early enough stage, untrammelled pursuit of profits by multinational companies and failure of regulators to exercise sufficient control over the technology. Our research has shown a much more complex picture resulting from the interaction of a number of different factors including company strategies, the regulatory regimes adopted and the nature of advocacy for GM crops.

In developing countries, the legacy of simplistic interpretations of benefits and risks of GM crops has developed into ideological debates through which little real engagement can take place. Debates hinge around the ways in which developing countries and their citizens are unable to make their own decisions about GM technologies, so that decision-making happens for or on behalf of them. In this policy vacuum meaningful, contextualised debates do not develop and support here is crucial. Issues such as the risks of alienating European export markets, the different R&D capacities of different developing countries, the appropriateness of different crops or even agricultural systems, and the maturity and strength of different countries' regulatory systems are often by-passed in favour of disconnected, macro-debates about whether GM is 'right' or not. This inability to contextualise decision-making and policy has not helped to alleviate uncertainty, or to build knowledge bases or develop the capacity for more nuanced, appropriate decision-making regarding GMOs.

If biological science is to contribute fully to future European farming systems, if it is to attract the necessary commercial, as well as public, investment and if European agriculture is to remain globally competitive, there is an urgent need to begin to reform the overall governance of biological science and crop production.

Attempts to ignore this past experience, to side-step the shadow of GM and to progress unhindered to new generations of biological innovation are unlikely to be successful. New biological approaches would benefit from a move to governance systems (including regulatory approaches) that are better attuned to the opportunities presented by 21st Century science, and that are robust and flexible and democratic in the face of current societal pressures while continuing to ensure safety for people and the environment.

Regulation should take account of the following important aspects of biological technologies:

- i. Where there is a very long lead time, first in the conduct of scientific research and then in its development as a safe and effective new approach, it is impossible to know in advance the outcome of the research or its costs, risks and benefits. Any attempt to apply a precautionary approach will therefore be very speculative indeed.
- ii. Public attitudes are labile and can change rapidly in response to new political, environmental or financial circumstances. It is therefore unwise to make judgements today about future responses to a biological approach which may not be put into practice for 10-15 years.

- iii. Future engagement on biological approaches should take equitable account of the views of all stakeholders including (although this is difficult) those who currently do not know or do not care about these approaches.
- iv. Good standards of scientific validity should be applied to evidence quoted in support of discussion points. Failing this, equitable scepticism should be applied to evidence brought forward by, for example, industry and environmental groups.
- v. Good standards of engagement practice should be agreed to by all taking part in an engagement exercise, e.g. willingness to listen to, and be influenced by, the views of others.

A joint strategic approach could usefully be developed to modifying the current European governance system to make it more flexible and robust in the face of global climate change and a changing financial environment, and at the same time to deliver products that are in tune with the needs and values of the European public (but as noted above, without allowing the values of one factional interest to dominate decision making). This would then facilitate the governance of future biological approaches.

Components of such a strategy that could effect rapid and far-reaching change could include developing regulatory 'fast tracks' for biological approaches that could provide public benefits compared to existing crop production methods.

REFERENCES

Conway, G. (1987) *The Doubly Green Revolution*, Penguin, London.

IAASTD (2008) *The Report of the International Assessment of Agricultural Knowledge, Science, Technology and Development*, World Bank, Washington, D.C.

ANNEX 1 RELEVANT GRANTS & PUBLICATIONS

DEVELOPMENT-RELATED

DFID PISCES – Policy Innovation Systems for Clean Energy Sustainability (2007-2012, £4.75mn) A research consortium that examines the trade offs between food security, climate change and bioenergy provision.
www.pisces.or.ke

Journal articles

Chataway, J., Tait, J. and Wield, D (2008) 'Off the rails or on the mark?' *Nature Biotechnology* (Correspondence), 26(5) 499-501

Smith, J. (2008) *Food security and development. We need dialogue, not rhetoric*, *Food Ethics*, September.

Ayele, S. (2008) Biotechnology and biodiversity debates and policies in Africa, *International Journal of Biotechnology*, 10(2/3) 207 - 223

Smith, J. (2007) Culturing development: bananas, petri dishes and 'mad science' in Kenya, *Journal of Eastern African Studies*, 1(2), 212-233.

Harsh, M. and Smith, J. (2007) Technology, governance and place: situating biotechnology in Kenya, *Science and Public Policy*, 34(6), 251-260.

Chataway, J. and Smith, J. (2007) CGIAR Centre-Civil Society Organisations: Report of Six Case Studies, Science Council of the CGIAR, Rome.

Chataway, J., Smith, J and Wield, D. (2007) Shaping Scientific Excellence in Agricultural Research, *Int. J. of Biotechnology*, 19(2), 172-187.

- Ayele, S., Chataway, J. and Wield, D (2006) Partnerships in African Crop Biotechnology and the Millenium Development Goals, *Nature Biotechnology*, 24, 619-621.
- Hall, A., Reddy, P. and Clark, N. (2006) Client-driven biotechnology research for poor farmers: a case study from India, *International Journal of Technology Management and Sustainable Development*, 5(2), pp.125-147
- Ayele, S. and Wield, D. (2005) Capacity building and Public-private Partnership in African Crop Biotechnology', *Journal of International Development*, 17(5), 631-646.
- Ayele, S. and Wield, D. (2005) Science and technology capacity building and partnership in African agriculture: perspectives on Mali and Egypt, *Journal of International Development*, 17(5) 631-646
- Vogel, C. and Smith, J. (2002) The politics of scarcity: conceptualising the current food security crisis in southern Africa, *The South African Journal of Science*, 98, 1-3.
- Clark, N. (2002) Innovation Systems, Institutional Change And The New Knowledge Market: Implications For Third World Agricultural Development , *Economics of Innovation and New Technology*, 11(4 & 5), 353 - 368

Books & book chapters

- Smith, J. (2009) *Technology and Development: Development Matters*, Zed Books, London.
- Lyall, C., Smith, J. and Pappaioannou, T. (2009) *Limits to Governance: The Challenge of Policymaking in the Life Sciences*, Ashgate, London.
- Smith, J. (2009) Biosciences, 'development' and the abstraction of governance, in C. Lyall, T. Papaioannou and J. Smith (eds), *The Limits of Governance: The Challenge of Policy-Making for the New Life Sciences*, Ashgate, London.
- Clark, N., Mugabe, J and Smith, J (2007) *Governing Biotechnology in Africa*, ACTS Press, Nairobi
- Smith, J. (2005) Globalising Vulnerability: The Impacts of Unfair Trade on Developing Country Agriculture, in Harrison R. & Hester R. (eds) *Sustainability in Agriculture*, pp 81-102: Royal Society of Chemistry

GM CROPS RELATED

Journal articles

- Tait, J. and Chataway, C. (2007) The Governance of Corporations, technological change and risk: Examining industrial perspectives on the development of genetically modified crops. *Environment and Planning – C: Government and Policy*, 25, 21-37.
- Tait, J. (2001) More Faust than Frankenstein: the European Debate about Risk Regulation for Genetically Modified Crops. *Journal of Risk Research*, 4(2), 175-189
- Arundel, A., Hocke, M. and Tait, J. (2000) How Important is Genetic Engineering to European Seed Firms? *Nature Biotechnology*, 18, 578.
- Tait, J. and Levidow, L. (1992) Proactive and Reactive Approaches to Risk Regulation: the Case of Biotechnology, *Futures*, April, 1992, pp 219-231

Innogen Policy Briefs

see <http://www.genomicsnetwork.ac.uk/innogen/publications/policypapers/>

- Tait, J., Bruce, A., Chataway, J. and Wield, D. *Appropriate Governance of the Life Sciences – 3: Regulating GM Crops: Lessons for the Next Generation*
- Lane, A., Oreszczyzn, S. and Carr, S. *Farmers' Understandings of Genetically Modified Crops within Local Communities*

Books & book chapters

- Tait, J. (2008). Risk Governance of Genetically Modified Crops: European and American Perspectives. In eds. O. Renn and K. Walker, *Global Risk Governance: Concept and Practice Using the IRGC Framework*. Dordrecht, NL: Springer Science and Business Media; pp 133-153.

Tait, J. and Bruce, A. (2004) 'Globalisation and Transboundary Risks' in McDaniels, T.L. and Small, M.J. (eds) *Risk Analysis and Society: Interdisciplinary Perspectives*, Cambridge University Press, Cambridge: 367-419

Tait, J. (2002) The US, Europe, Precaution and Risk Management: Foods Derived from Biotechnology. In eds. Koen Verlaeckt and Virginia Vitorino, *Unity and Diversity: the contribution of the social sciences and the humanities to the European Research Area*. Office for Official Publications of the European Communities, L-2985, Luxembourg, EUR 20484, pp 198-201.

Tait, J. (2000) Risk assessment, perception and communication for GMOs. In eds. N. Atreya and R. Billington, *Human Exposure to Pesticide Residues, Natural Toxins and GMOs: Real and Perceived Risks*. Proceedings of an international symposium, Brighton, UK, 13 Nov., 2000. British Crop Protection Council, Symposium Proceedings No 75., pp 69-76.

Tait, J. and Chataway, J. (2000) Technological Foresight and Environmental Precaution: Genetically Modified Crops. In eds. M.P. Cottam, D.W. Harvey, R.P. Pape and J. Tait *Foresight and Precaution*, Proceedings of ESREL 2000, SARS and SRA-Europe Annual Conference, Edinburgh, Scotland, 15-17 May, 2000, Vol 2. Rotterdam: Balkema, pp 829-838.

Selected project reports

Lane, A. Oreszczyn, S., Carr, S. (2007) Farmers' understandings of genetically modified crops within local communities: Full Research Report. ESRC End of Award Report, RES-151-25-0046. Swindon: ESRC.

INNOVATION

Journal articles

Tait, J. (2007) Systemic Interactions in Life Science Innovation. *Technology Analysis and Strategic Management*, 19(3), 257-277, May 2007.

Chataway, J., Tait, J. and Wield, D. (2006) The governance of agro- and pharmaceutical biotechnology innovation: public policy and industrial strategy. *Technology Analysis and Strategic Management*, 18(2), 1-17.

Chataway, J., Tait, J. and Wield, D. (2004) Understanding company R&D strategies in agro-biotechnology: Trajectories and Blindspots. *Research Policy*, 33/6-7, 1041-1057.

Tait, J., Chataway, J. and Wield, D. (2002) The Life Science Industry Sector: Evolution of Agro-Biotechnology in Europe. *Science and Public Policy*, 29(4), 253-258.

Bijman, J. and Tait, J. (2002) Public Policies Influencing Innovation in the Agrochemical, Biotechnology and Seed Industries. *Science and Public Policy*, 29(4), 245-251

Tait, J. (2001) Science, Governance and Multifunctionality of European Agriculture. *Outlook on Agriculture*, 30(2), pp 91-95

Tait, J. and Bruce, A (2001) Globalisation and Transboundary Risk Regulation: Pesticides and Genetically Modified Crops. *Health, Risk and Society*. 3(1), 99-112.

Tait, J., Chataway, J. and Wield, D. (2000) The Life Science Industry Sector: Evolution of Agro-biotechnology in Europe. *Science and Public Policy*, 29(4), 253-258

Chataway, J. and Tait, J. (1993) Management of Agriculture-Related Biotechnology: Constraints on Innovation. *Technology Analysis and Strategic Management*, 5(4), 345-367

Innogen Policy Briefs

see <http://www.genomicsnetwork.ac.uk/innogen/publications/policypapers/>

Tait, J. *Appropriate Governance of the Life Sciences -1: Multinational Company Innovation Strategies*

Tait, J., Chataway, C. and Wield, D. *Appropriate Governance of the Life Sciences – 2: The Case for Smart Regulation*.

Books & book chapters

Lyall, C., Papaioannou, T. & Smith, J. Eds (2009) *The Limits to Governance: The Challenge of Policy-making for the New Life Sciences*, Aldershot, Hampshire: Ashgate Publishing Ltd.

Lyall, C. and Tait, J. (2005) *New Modes of Governance: Developing an Integrated Policy Approach to Science, Technology, Risk and the Environment*. Aldershot, Hampshire: Ashgate Publishing Ltd.

Tait, J., Chataway, J. and Wiold, D. (2006) Governance, Policy and Industry Strategies: Agro-biotechnology and Pharmaceuticals. In eds. M.Mazzucato and G. Dosi, *Knowledge Accumulation and Industry Evolution*. Cambridge University Press, pp 378-401.

Tait, J. (2000) Technology transfer in crop protection: the policy context. *BCPC Conference, Pests and Diseases 2000*; 13th November 2000, Brighton. Farnham, Surrey: British Crop Protection Council, pp1177-1184.

Selected project reports

J. Tait (with D. Wiold, J. Chataway and A. Bruce) (2008) *Health Biotechnology to 2030*. Report to OECD International Futures Project, "The Bio-Economy to 2030: Designing a Policy Agenda", OECD, Paris, pp 51; <http://www.oecd.org/dataoecd/12/10/40922867.pdf>.

Oreszczyn, S. Lane, A.B. and Carr, S. (2007) New technologies and scientific developments: Exploring better ways to support farmers' decisions. The Open University Milton Keynes.

J. Tait, A. Bruce, C. Shelly-Egan, A. Rosiello, N. Nicholls, G. Butterfield, S. Yogendra, C. Lyall, J. Suk, G. Plastow, F. Huzair (2007) Contribution on 'Modern Biotechnology in Primary Production and Agro-food'. In E. Zike, I. Papartyfon, O. Wolf, M. Gomez-Barbero, A.J. Stein and A-K. Bock, *Consequences, Opportunities and Challenges of Modern Biotechnology for Europe (Bio4EU)*, Seville, Spain: Institute for Prospective Technology Studies (IPTS), Report EU 22728 EN, pp49-80. <http://bio4eu.jrc.ec.europa.eu/documents/eur22728en.pdf>

Tait, J. (2001) How are governments influencing innovation and uptake of technologies for sustainable farming systems: pesticides and biotechnology. *Adoption of Technologies for Sustainable Farming Systems*, The Wageningen Workshop, OECD, Paris.

Tait, J., Chataway, J. and Wiold, D. (2001) *Policy Influences on Technology for Agriculture: Chemicals, Biotechnology and Seeds - Final Report*. Policy Influences on Technology for Agriculture (PITA): Report to the European Commission Targeted Socio-Economic Research Programme (TSER), Project no. SOE1/CT97/1068. Available at: <http://www.technology.open.ac.uk/cts/pita/> and <http://www.supra.ed.ac.uk/NewWeb/Reports.htm>

ANIMAL-RELATED RESEARCH

Selected research projects

Mitigating the environmental impact of cattle and sheep: animal genetics and farmers' readiness for uptake, ESRC Grant RES-000-22-3737, Jan 2010-Dec 2011 (A. Bruce)

A science and technology study on newly emerging diagnostic technologies in agriculture, ESRC Defra Placement Fellowship, Sept 2009-Dec 2009 (A. Bruce)

Journal articles

Suk, J., Bruce, A., Gertz, R., Warkup, C., Whitelaw, C.B.A., Braun, A., Oram, C., Rodríguez-Cerezo, E., Papartyfon, I. (2007) 'Dolly for dinner? Assessing commercial and regulatory trends in cloned livestock'. *Nature Biotechnology* **25**(1): 47-53

Bruce, A. (2007) [GM animals – another GM crops?](#), *Genomics, Society and Policy*, Vol.3, No.3, pp.1-14

Clark, N., Smith, J. and Hirvonen, M. (2007) Livestock R&D in east and southern Africa: an innovation systems perspective with special reference to the International Livestock Research Institute, *International Journal of Technology Management and Sustainable Development*, 6(1), 9-24.

Smith, J. (2005) Context-bound knowledge production, capacity building and new product networks, *Journal of International Development*, 17(5), 647-659. □

Innogen Policy Briefs

see <http://www.genomicsnetwork.ac.uk/innogen/publications/policypapers/>

Bruce, A. *Regulation of cloned farm livestock*

Selected project reports

Braun, A., Bruce, A., Gertz, R., Oram, C., Suk, J., Tait, J., Warkup, C. and Whitelaw, B. (2005) Series of reports to the Institute for Prospective Technology Studies (European Commission Joint Research Centre) on *Animal Cloning and genetic modification: a prospective study*