Zoonoses and Emerging Livestock Systems (ZELS)

Reducing the risk to livestock and people

Research Programme 2014

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Combating health risks linked to rapidly changing animal production in developing countries

The World Bank estimates that zoonotic diseases have cost global economies more than $20 billion in direct costs over the past decade, with a further $200 billion in indirect costs (World Bank, 2010).

Human population growth, rising demand for meat and dairy products and climate change are driving rapid transformation in the nature of livestock systems. This poses a potential threat to human and animal health as many diseases can be passed from wild or domesticated animals to humans. Such diseases are defined as zoonoses.

These zoonoses may affect livestock production and reduce market access. The economic cost of treating the diseases is heightened by the burden of reduced labour and income.

Interventions to control zoonoses therefore require concerted action between the veterinary and human health sectors, because they affect both people and animals.

The Biotechnology and Biological Sciences Research Council (BBSRC), the Defence Science and Technology Laboratory (Dstl), the Department for International Development (DFID), the Economic and Social Sciences Research Council (ESRC), the Medical Research Council (MRC) and the Natural Environment Research Council (NERC) have joined forces to announce £20.5M of new research and training to reduce the impact of zoonoses on poor people in developing countries and their livestock.

Dan Tucker

Eric Fevre

Cattle herd.

Zoonoses and Emerging Livestock Systems (ZELS): reducing the risk to livestock and people

The initiative is made up of 11 projects which will investigate emerging and endemic zoonotic diseases in developing countries.

Over the next five years, UK researchers will work in partnership with more than 30 overseas institutes and organisations to generate scientific evidence to inform the selection of risk-based and cost-effective prevention and control options which may contribute to decreasing the likelihood of occurrence, prevent the transmission, and reduce the impact of major zoonotic diseases.

The projects will also offer significant benefits to British farmers and consumers. Several of the zoonoses being tackled by the initiative have already had serious consequences in the UK. Global supply chain systems and climate change may result in more zoonoses crossing our borders.

A key outcome of these collaborations is to enhance the scientific capabilities of developing countries for the longer term. £1.5M of the funding has been set aside specifically to do this; 15 students from the UK and developing countries will receive doctoral training in ZELS related research.

By bringing together world-class scientists from various disciplines and from around the globe, the initiative aims to improve the health and well-being of animals, humans and the environment and, ultimately, enhance the lives of millions of people.

Facts

- £20.5M investment from the ZELS partners.
- 11 projects involving 19 UK institutions and over 30 overseas institutions
- Research in 10 countries in Africa, south Asia and south east Asia
- At least 61% of all human pathogens are zoonotic, and have represented 75% of all emerging pathogens during the past decade (World Health Organisation, 2007)

Looking at factors affecting transmission of zoonotic pathogens from livestock to people

Livestock systems in Africa are undergoing rapid transition. Changes in market dynamics, land-use and agricultural policy, environmental factors, cultural practices and technology are all changing the way people keep and manage livestock, both for food and as sources of income. However, the consequences of these changes on zoonotic disease risk are almost unknown.

This project is focusing on Brucellosis, Q-fever and Rift Valley Fever (RVF) which can all result in livestock production losses and cause severe illnesses in people, with the potential for chronic disability or death. Fever-causing zoonoses, such as these, are particularly problematic because they are difficult to diagnose on symptoms alone, and in sub-Saharan Africa are almost always misdiagnosed, with serious consequences for human health.

Tiziana Lembo

An interdisciplinary team of researchers from the UK, Tanzania, New Zealand and the USA will be examining how social, economic and environmental drivers of change affect zoonotic disease risks through changing patterns of livestock ownership, management and human behaviour.

The case of Tanzania will be used to explore the nature of livestock systems, focusing on two systems undergoing rapid transition: (1) the pastoral-wildlife sector affected particularly by expansion of crop-based agriculture and changes in land-use policy, and (2) the peri-urban livestock sector.

Collaborators

- University of Glasgow, UK
- Institute of Development Studies, Sussex University, UK
- Nelson Mandela African Institution of Science and Technology, Tanzania
- Sokoine University of Agriculture, Tanzania
- Kilimanjaro Christian Medical College, Tanzania
- Kilimanjaro Clinical Research Institute, Tanzania
- Ministry of Livestock and Fisheries Development, Tanzania
- National Institute for Medical Research, Tanzania
- Tanzania Wildlife Research Institute, Tanzania
- Food and Agriculture Organization of the United Nations
- University of Otago, NZ
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Zoonoses in Livestock in Kenya (ZooLINK)

Continuing changes to livestock production systems in Kenya and elsewhere to satisfy increased demand for livestock products affect the risk of zoonoses and other infectious diseases. The most important changes are the commercialisation and intensification of what was previously subsistence farming, changes in trading patterns (e.g. the distances that livestock and their products are transported), and changes in favoured breeds.

There is therefore a pressing need for good surveillance of zoonoses in order to establish their true burden, how that is changing and to support control measures.

Researchers from the UK and Kenya are joining forces with Kenyan government departments to provide evidence that an enhanced surveillance system can contribute to improving public health in a cost-effective manner. They will achieve this by increasing awareness of zoonoses, improving diagnostic support (including developing new diagnostic assays), enhancing the recording, storage, analysis, interpretation and sharing of data, and by bringing about closer integration between the human and animal health sectors.

During the five year project researchers working in western Kenya will closely monitor, model and optimise the enhanced surveillance system's performance, and undertake a comprehensive economic analysis of the activities. The evidence will contribute to a better understanding and anticipation of changes in zoonotic disease burdens, and to recommendations for effective interventions.

The research will also provide a platform for Kenyan public and animal health workers to get hands-on training and to become familiar with a 'One Health' approach to surveillance, creating a cadre of individuals with first-hand experience of this way of working - leaving a strong legacy in its own right.

Eric Fevre

Collaborators

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- University of Edinburgh, UK
- Royal Veterinary College, UK
- University of Nottingham, UK
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Javier Guitian

Establishing a strategy to control brucellosis in dairy herds of West and Central Africa

As one of the most prevalent zoonotic diseases, brucellosis is an important constraint on the livelihoods of poor people, directly by causing chronic disability and indirectly via decreased livestock productivity. The heaviest burden is on vulnerable populations in Sub-Saharan Africa, in particular West and Central Africa, where emergent livestock systems are rapidly expanding to meet demand for milk from burgeoning urban populations.

The main routes by which people can be infected by brucellosis are consumption of contaminated dairy products and direct contact with infected animals. Therefore, the control of human brucellosis depends on its control in animals, mainly ruminants.

Researchers from the UK and Senegal are taking an interdisciplinary approach to consider the different biological, social and institutional dimensions of the disease relevant for its control. The main focus is on the first phase of control of the disease: the reduction of prevalence by vaccination.

Field studies in a number of countries in West and Central Africa will measure the burden of brucellosis in livestock, identify routes by which people become infected, assess farmers' perceptions and attitudes toward the disease, assess vaccines for effectiveness in livestock, and explore key stakeholder and institutional relationships to identify how to effectively deliver control measures for brucellosis.

Collaborators

- Royal Veterinary College, UK
- London School of Hygiene and Tropical Medicine, UK
- Animal and Plant Health Agency, UK
- Global Alliance for Livestock Veterinary Medicines (GALVmed), UK
- Interstate School of Veterinary Science and Medicine – Dakar, Senegal

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Developing the evidence base to control brucellosis in sub-Saharan Africa

Brucellosis is one of most widespread human diseases acquired from animals, and is one of the highest priority animal diseases in Africa.

Brucellosis infects many animal species, including key livestock species - cattle, sheep, and goats - and most human infections are acquired through direct contact with livestock or transmission through untreated milk products. Brucellosis has wide-ranging impacts that include animal losses due to abortion, lost milk production, slaughter of infected animals, and human illness reducing work capacity.

Researchers in the UK, Tanzania and New Zealand will collaborate to develop the evidence-base to inform the use of *Brucella* vaccines in sub-Saharan Africa, and build capacity in Tanzanian laboratories to identify the disease. The project aims to identify the ruminant species that act as sources of human infection and the *Brucella* species most responsible for human disease in rural and urban environments in northern Tanzania. This project will provide the first large systematic evidence base to guide which vaccine should be used in which animal population.

The research will be conducted hand-in-hand with Tanzanian government scientists charged with formulating national policies for the control of brucellosis.

Collaborators

- University of Glasgow, UK
- Animal and Plant Health Agency, UK
- Sokoine University of Agriculture, Tanzania
- Kilimanjaro Christian Medical College, Tanzania
- Ministry of Livestock Development, Tanzania
- Central Veterinary Laboratory, Tanzania
- University of Otago, New Zealand

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Focus group discussion with livestock keepers Monduli, Tanzania.

Dan Haydon

Juliet Bryant

Ducks which have been vaccinated are dyed pink.

Combating bird flu by developing new diagnostic tools and vaccines

Dramatic progress has been made in providing animal protein at affordable prices to rapidly expanding populations. Poultry production in developing countries has helped meet goals in poverty alleviation and reduction in rural unemployment, particularly amongst women.

However, the emergence and spread of avian influenza viruses in many countries has threatened the sustainability of the poultry sector by incurring heavy losses in poultry production.

Avian influenza virus (AIV) is classified into highly pathogenic (HPAI), e.g. H5N1, and low pathogenic (LPAI) forms based on the severity of the illness they cause in poultry. The rapid genetic evolution of these viruses in birds remains a credible threat for pandemic emergence.

Large scale culling in response to outbreaks of disease in poor countries has become impractical for economic, ecological and ethical reasons.

A multidisciplinary research team from the UK, Vietnam and Pakistan will exploit next generation biotechnological approaches to advance our understanding of how genetic and antigenic diversity influence the protective power of poultry AIV vaccines and the sensitivity of diagnostic tests to differentiate AIV subtypes.

The research aims to develop more effective intervention strategies to minimise economic losses due to influenza within the poultry sector, and to mitigate the risk of pandemic emergence. Better control measures may offer substantial benefits to wider communities on both the national and global scale.

Collaborators

- The Pirbright Institute, UK
- National Institute for Medical Research, UK
- Imperial College London, UK
- University of Oxford, Tropical Medicine, Vietnam
- National Center for Veterinary Diagnostics, Vietnam
- University of Veterinary & Animal Science, Pakistan
- National Agricultural Research Centre, Pakistan Agricultural Research Council Pakistan

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An integrated approach for surveillance and control of zoonoses in emerging livestock systems

Endemic zoonotic diseases, primarily gastrointestinal infections, put the heaviest global burden on the health of poor people, and on productivity and profitability of their livestock. It is estimated that zoonotic gastrointestinal disease, caused by bacteria such as *Salmonella* and *Campylobacter* and related antibiotic resistance, accounts for around 1M human deaths per year globally with around 800M people being affected, most of them children under five-years-old.

Diverse emerging livestock systems, specifically pig and poultry production, are thought to be major sources of these infections.

The project will focus on the pig production sector in Myanmar which, of all the countries in the world, is expected to show the most rapid growth in pig production by 2030.

The project will exploit interdisciplinary expertise that includes social science, biological science, and governmental players from Myanmar, Vietnam and the UK. It will bring about step changes in control measures using knowledge-driven and culturally relevant strategies that improve both animal health and productivity and thus improve and protect human health.

Collaborators

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- Institute of Development Studies, Sussex University, UK
- Myanmar Department for Medical Research, Myanmar
- Myanmar Livestock Breeding and Veterinary Institute, Myanmar
- University of Oxford Clinical Research Unit, Vietnam

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Dan Tucker

Controlling and monitoring emerging zoonoses in the poultry farming and trading system in Bangladesh

Dirk Pfeiffer

Poultry at a market in Bangladesh.

Improvements in living standards and in global trade mean that there is a rapidly rising demand for and supply of animal protein. Poultry and specifically chickens are the major source of all protein consumed in the world and poultry production, adapting better than any other livestock sector to increased demand, will further expand in the near future. Intensification of poultry production sectors will increase the risk of future disease emergence including highly pathogenic avian influenza.

Outbreaks of new strains of influenza, such as H5N1, can have up to 100% mortality in chickens and other domestic poultry and very high mortality rates in human beings when the influenza "jumps" species from the animal/bird reservoir to humans.

When a new outbreak occurs, farmers and traders may change their behaviour to avoid economic losses. Such behavioural changes can modify the way disease spreads, and even prolong and strengthen the epidemic so that it becomes a widespread pandemic moving beyond a local area to the whole world.

Researchers from the UK, Bangladesh and Australia are joining forces to study the behaviour of people working in the Bangladeshi poultry farming and trading system. By combining sophisticated mathematical modelling of how poultry production and marketing works with detailed analysis of the social, cultural and economic factors which may promote disease maintenance and dissemination in Bangladesh, the collaboration aims to develop effective policies to reduce the risk of people's behaviour causing widespread disease dissemination.

Collaborators

- Royal Veterinary College, UK
- London School of Hygiene and Tropical Medicine, UK
- Chatham House, UK
- Chittagong Vet and Animal Sciences University, Bangladesh
- Institute of Epidemiology, Disease Control and Research, Bangladesh
- Bangladesh Livestock Research Institute, Bangladesh
- Bangladesh Department of Livestock Services, Bangladesh
- Food and Agriculture Organization of the United Nations in Bangladesh
- University of Queensland, Australia

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Researchers survey for Tsetse flies in Tanzania.

Steve Torr

Tackling Human African Trypanosomiasis on the edge of wilderness areas

Tsetse flies transmit trypanosomes, microscopic parasites which cause sleeping sickness (Human African Trypanosomiasis or HAT). There is no vaccine or drug for the disease and it is ultimately fatal if left untreated. In eastern and southern Africa, about 12M people are at risk of Rhodesian HAT, an acute form of the disease.

Rhodesian HAT is especially difficult to control because the trypanosome which causes it is present in a range of wild mammals and livestock. In wilderness areas, tsetse flies infected after feeding on wildlife can spread the disease to people and livestock in surrounding areas and livestock can consequently become a source of further infection to people.

Researchers from the UK, Tanzania and South Africa will spend the next three years identifying cost effective and "ecologically smart" strategies to control HAT to protect local people living around the Serengeti, focusing on disease hotspots at the boundary between wilderness and settled areas. Tsetse flies also carry other trypanosomes that cause serious disease in livestock, so control of HAT will also bring added benefits in reducing livestock disease and boosting the productivity of small-holder farmers.

The researchers will develop recommendations for farmers, doctors, veterinarians and managers of wildlife areas for control of the disease in humans and animals in the Serengeti area, and generate guidance on monitoring and managing HAT in wilderness areas.

Collaborators

- Liverpool School of Tropical Medicine, UK
- The Roslin Institute, University of Edinburgh, UK
- Scotland's Rural College, UK
- University of Glasgow, UK
- Tsetse and Trypanosomiasis Research Institute, Tanzania
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David Rollinson

Epidemiology and evolution of zoonotic schistosomiasis in a changing world

Schistosomiasis affects more than 240M people worldwide, and over 700M people live in endemic areas (WHO, 2014). Caused by schistosome parasitic worms, schistosomiasis is a disease that causes chronic and debilitating illness in people (typically the poor) who come into contact with fresh water where there are snails infected with the larval stages of the parasite. Species of schistosomes are also common in cattle, sheep and goats.

Environmental change and changes in agricultural practices may increase the potential for disease transmission and increase the opportunities for mixing of different species of human and animal schistosomes. This mixing within the human or animal hosts can result in novel hybrids which may influence their potential for disease transmission and morbidity.

A multidisciplinary team of researchers from the UK, Niger and Senegal, will spend the next three years in an effort to understand the populations at risk of infection and disease with hybrid schistosomes, with a view to informing control programmes, including schistosomiasis elimination.

The researchers also aim to produce new diagnostic tests and surveillance methods for use in the field.

The project will help scientists document the evolution of a zoonotic infection.

Collaborators

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- The Natural History Museum, UK
- RISEAL Niger
- University Gaston Berger - Saint-Louis, Senegal

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Controlling Bovine Tuberculosis in Ethiopia

Ethiopia has the largest livestock population in Africa including 53M cattle. A rapidly growing human population (85M people) and high rate of urbanisation puts more pressure on farmers to meet the demand for food.

In Ethiopia livestock contributes to a high proportion of national income and is key to economic development. Traditional, extensive farming systems with the less productive local Zebu cattle are being supplemented and replaced with intensive farming of imported breeds such as Holstein-Friesian at a rapid rate.

Although bovine tuberculosis (bTB) is endemic in Ethiopia the prevalence is low among the local Zebu cattle, potentially because they are extensively reared and seemingly relatively resistant to the disease. Expansion of dairy farms around major urban centres has however created hotspots of TB infected cattle. With no legal requirement to test and cull infected cattle in Ethiopia, unlike in developed countries, the potential for rapid spread of bTB across the cattle trade routes through amplification by the dairy farms in these areas is a real emerging danger.

Working closely with government and local communities, researchers from the UK, Ethiopia and Switzerland will determine disease prevalence among dairy cattle in different areas, study risk management and mitigation practices for households and document how prevailing social, cultural and economic factors impact them. The researchers will compare disease susceptibility among the local and Holstein cattle and evaluate the degree of protection given by vaccination to cross-breed cattle.

The results will provide practical and effective bTB control strategies, which when applied, will significantly reduce the high rate of bTB and its zoonotic transfer in the expanding dairy sector; minimize trading of bTB infected dairy cattle to protect the national Zebu herd and the livelihood of poor farmers; and reduce the risk of zoonosis in high risk populations.

Collaborators

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- Animal and Plant Health Agency, UK
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- Addis Ababa University, Ethiopia
- Ethiopian Institute of Agricultural Research, Ethiopia
- National Animal Health Diagnostic and Investigation Center, Ethiopia
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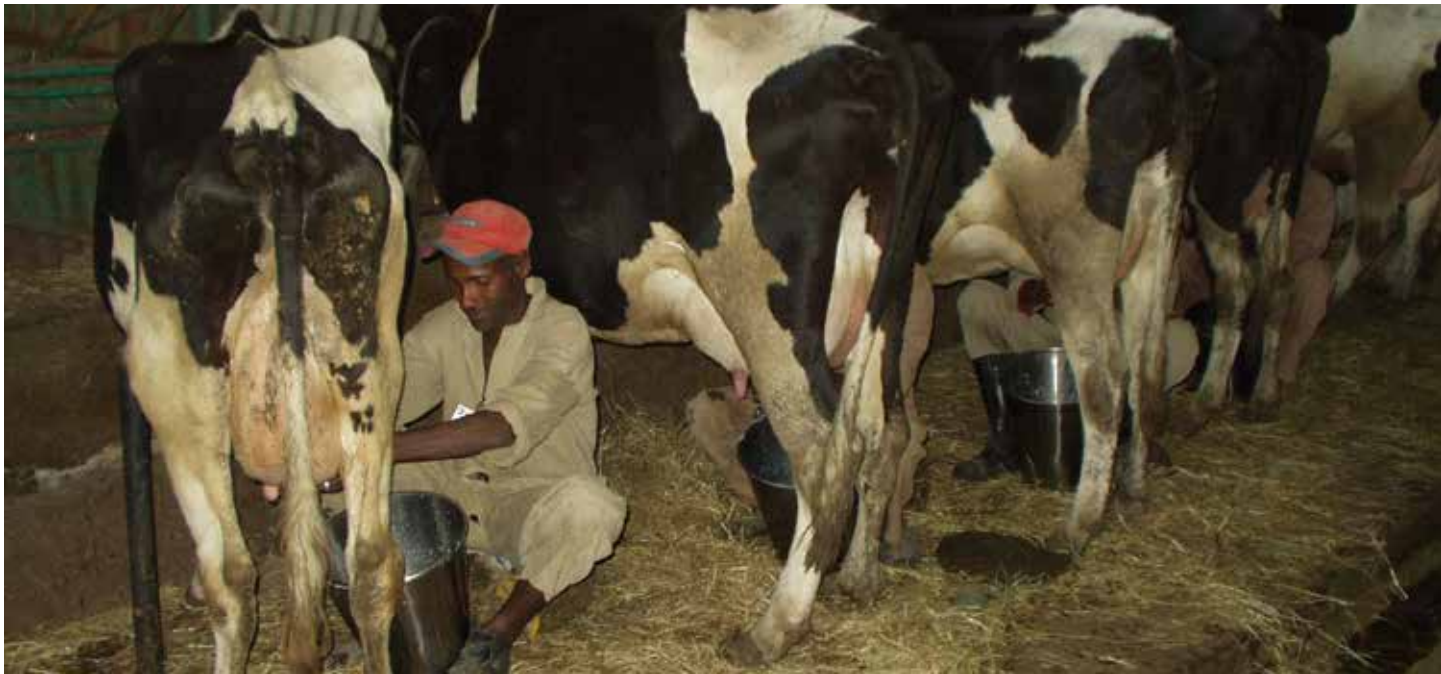

Stefan Berg

Food safety hazards in emerging livestock meat pathways (HAZEL)

Whilst meat production for the commercial market offers an economic opportunity to poor farmers in developing countries, changes to meat supply systems may have major implications for food-borne diseases because risks of infection and contamination are likely to increase with production intensification of production and advancing complexity in getting food from farm to fork.

Tanzania has been identified as a hotspot for bacterial foodborne disease, including disease caused by Salmonella and Campylobacter, bacteria that may be carried by ruminants and poultry. Most livestock meat supply chains in Tanzania are informal but commercial supply chains and markets are expanding rapidly to meet growing demand from consumers. Changes in the meat supply chain may contribute to the foodborne disease risk.

A multidisciplinary team of researchers from the UK, Tanzania, New Zealand and the USA will spend the next three years assessing the microbiological hazards for human health in emerging systems of livestock meat production, processing, distribution and consumption in Tanzania. Their approach will involve a mixture of social and biological science, including field and laboratory activities and a technique known as modular process risk modelling (MPRM).

The researchers will also conduct systematic reviews of national and international regulations and policy as well as key informant interviews to identify strengths, weaknesses, opportunities, and threats (SWOT) in current food safety policy. SWOT analysis will be informed by MPRM findings to identify gaps and suggest improvements to national, regional, and international food safety policies.

Collaborators

- University of Glasgow, UK
- Institute of Food Research, UK
- Kilimanjaro Christian Medical Centre, Tanzania
- Nelson Mandela African Institute of Science and Technology, Tanzania
- Sokoine University of Agriculture, Tanzania
- Ministry of Livestock and Fisheries Development, Tanzania
- University of Otago, New Zealand
- Massey University, New Zealand
- Washington State University, USA

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Stefan Berg

Eric Fevre

International training for the next generation of scientists

The ZELS projects have formed a consortium to provide a concentrated focus for doctoral training in ZELS-related research. Through the ZELS-Associated Studentships (ZELS-AS) a single intake of 15 UK and developing country students will commence training in October 2015.

Each student will spend half their time in the UK and the other half in a developing country, and will have two supervisors, one in the home country and one in the host country.

The training environment will provide students with excellent opportunities to gain transferrable skills and to conduct original and scientifically excellent research, building a strong and active cohort of students who are able, and encouraged, to work together.

ZELS-AS will build research capacity in the UK and developing countries, aligned with the aim of reducing the impact of zoonoses on poor people and their livestock.

Contact details

For more information about the initiative, please contact Amanda Read: amanda.read@bbsrc.ac.uk

Details of DFID supported research can be found at: www.research4development.info

Details of BBSRC funded research can be found at: www.bbsrc.ac.uk

Details of NERC funded research can be found at: www.nerc.ac.uk

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