

## **Workshop Summary**

### **1. Introduction**

#### **1.1 Workshop purpose**

The purpose of this workshop was to bring together UK and Chinese researchers from across a range of disciplines, to focus on the relationship between the growth in livestock production and consumption and a range of key issues. These include:

- Livestock-related greenhouse gas (GHG ) emissions;
- Human nutrition (over- and undernutrition);
- Animal welfare; and
- Livelihoods and employment.

For a summary of the research evidence on these issues, see Appendix One.

UK and Chinese perspectives on these issues were explored with a view to developing a future programme of collaborative research.

#### **1.2. Rationale for a *China-UK* workshop**

There are sound reasons for choosing to hold a workshop that explicitly sought to bring together the British and Chinese research communities, drawing upon the expertise of the Food Climate Research Network and the SAIN initiative.

The China-UK SAIN initiative has already made important progress in developing cooperative approaches to good farm management, in particular on nitrogen fertiliser use. Hence the aim was to complement recognition of the need for *production-side* improvements by focusing on the challenges, and necessity of achieving *consumption-side* changes – a shift towards GHG-efficient diets. This is an area where the Food Climate Research Network has been focusing on for some time.

*China* is a country which is now undergoing the ‘nutrition transition,’ whereby consumption of meat and dairy products is rising rapidly. Per capita intakes of these foods are still far lower than UK levels but, despite their nutritional benefits, they are playing a contributory part in

the growth in dietary related diseases.<sup>1 2</sup> As a positive environmental development, the Government is committed to 'circular agriculture' - a concept that embraces sustainability. China's first animal welfare law is moreover currently in the process of being drafted, although public awareness of welfare issues is still low.

*The UK* is an example of a country where meat and dairy consumption is no longer rising but meat and dairy consumption is high and embedded in dietary patterns (although a significant minority of people are vegetarians or 'meat-reducers'). Obesity and associated lifestyles illnesses are prevalent. It is in this context that a reduction in meat and dairy products has been highlighted as a possible route to improving health.<sup>3</sup> As possible developments to build upon, there is a strong current of concern for animal welfare issues; a legal requirement to reduce greenhouse gas emissions and a growing focus (even at the governmental level) on consumption related issues - the relationship between diet, nutrition and greenhouse gas emissions.

Hence China and the UK share some problems in common, while on other issues they have different perspectives that need to be raised and explored if progress on both sides is to be made.

### **1.3. Workshop background, form and structure**

The workshop concept was initiated by the Food Climate Research Network (FCRN), who organised it in collaboration with the UK-China Sustainable Agriculture Innovation Network (SAIN). It was funded by the World Society for the Protection of Animals and hosted by the Agro-Environment Protection Institute at the Chinese Academy of Agricultural Sciences. For more information about these organisations, see Appendix One.

Following the welcome and introduction by the co-organisers, the workshop began with an overview by Tara Garnett, FCRN, in which she introduced the themes of the workshop and highlighted the interconnected challenges that converge upon livestock production and consumption.

She emphasised that the main purpose of the workshop was to explore the links between different issues, discuss similarities and differences in the UK and Chinese contexts and identify the main uncertainties & research needs - to stimulate discussion, disagreement, and new ideas rather than to achieve consensus. One key objective was for participants to consider whether these themes further collaborative work between the UK and Chinese research communities – and our collective conclusions are discussed at the end of this paper.

Dr. Yuelai Lu, the co-organiser, then welcomed everyone and highlighted the work of SAIN so far in China (see xx below). Presentations by the key speakers were followed by extensive discussion among the participants, facilitated over the course of the two days by Tara Garnett, FCRN.

This summary attempts to capture the points made both in the presentations and in the discussions that followed, supplemented by further communications with speakers and

---

<sup>1</sup> Dearth-Wesley T, Wang H and Popkin B M (2008). Under- and overnutrition dynamics in Chinese children and adults (1991–2004) *European Journal of Clinical Nutrition* 62, 1302–1307

<sup>2</sup> Du S, Mroz T, Zhai F, Popkin B. Rapid income growth adversely affects diet quality in China – particularly for the poor! *Soc Sci Med* 2004;59:1505–15

<sup>3</sup> Friel S, Dangour A, Garnett T, Lock K, Butler A, Butler CD, Chalabi Z, Roberts I, Waage J, McMichael A J, Haines A. (2009), *The Lancet*, 374: 2016–25

participants where clarification on certain points was needed. The intention here is to capture the spirit of the discussions and draw out the major themes explored rather than to enumerate in detail all the points that were made.

## 2. Workshop presentations and discussions

### 2.1. Session one: Livestock and GHG emissions

#### **Professor Gao Shangbin, Agro-Environmental Protection Institute, Ministry of Agriculture**

Since there has been no quantitative analysis in China, to date, on mitigation potential arising from consumption-side changes, Gao's presentation focused on the mitigation potential achievable through changes in livestock rearing and farm management. He began by highlighting the significant contribution that livestock make to China's GHG emissions, accounting (in 2004) for about 0.49 billion tonnes CO<sub>2</sub> eq, or 8% of China's 6.1 billion tonnes of CO<sub>2</sub> eq. Agriculture as a whole contributes 17% of the national total. He also noted that climate change will negatively impact upon China's agriculture, and could damage both livestock productivity and the quality of output. However, it is important to note that while China's overall GHG emissions are very substantial, measured on a per capita basis, they amount to only 12% of that of the US.

The focus in China to date has been on examining production-side options for mitigating emissions, and in particular there is interest in applying the principles of 'circular agriculture,' the emphasis being on resource efficiency and the recycling of outputs as inputs. Examples of such systems include:

- Biogas linked systems: where animal waste is anaerobically digested to produce biogas (for fuel) while the digestate remaining could be used for various agricultural purposes, including fruit production and arable crops. Biogas systems can be applied both at the household level and at a larger, industrial scale.
- Integrated crop-livestock systems
- Increasing the proportion of concentrates in the diet to reduce methane emissions and increase livestock productivity (this approach was challenged in context of animal welfare, discussed below)
- Improvements in grazing land management to promote soil carbon sequestration
- Traditional rice-fish-duck cultivation systems, tree-poultry production
- Fermentation bed breeding: using microbes to treat waste water and faeces as an alternative to more water and energy intensive techniques
- More general measures not specific to livestock production include water saving irrigation, Integrated Pest Management, minimum tillage, more accurate testing of soils and diagnosis of fertiliser requirements

China is focusing quite substantially on biogas as a mitigation measure and is implementing a number of Clean Development Mechanism (CDM)-funded projects. It has been estimated that the implementation of rural household biogas facilities could reduce China's emissions by 1.43-2.02 tonnes CO<sub>2</sub> eq per household annually.<sup>4</sup> Other important approaches to incentivising mitigation include eco-compensation (Payments for Ecosystem Services).

---

<sup>4</sup> Dong Hongmin, Li Yu'e, Zhu Zhiping, et al. Greenhouse gas emission reduction potential of rural household biogas CDMproject[J]. *Transactions of the CSAE*, 2009,25(11): 293—296.

Gao Shangbin concluded by highlighting the key challenges for Chinese agriculture as follows:

- The need for better techniques for calculating and monitoring GHG emissions from agriculture.
- More case study-based research into the role of feeding and breeding techniques for improving livestock GHG efficiencies
- More collaboration between China and other countries, both into research and policy, and in particular greater opportunities for young researchers.

**Dr. Donal Murphy-Bokern (Murphy-Bokern Konzepte), Dr. Adrian Williams (Cranfield University) and Dr. Henk Westhoek (PBL Netherlands Environmental Assessment Agency).**

Having acknowledged his co-authors, Donal Murphy-Bokern began by arguing that the debate about the link between food consumption and greenhouse gas emissions and other global environmental problems is now mainstream in the policy community in Europe. He proceeded to give an overview of how this debate has developed, highlighting its basis in the agricultural and environmental science underpinning it. In particular he identified that four key studies / sets of studies have contributed to the development of the consumption debate:

- Life-cycle assessments of agricultural commodities,
- Estimates of emissions from the UK food system (including land-use change),
- A study on the effects of change on land needs,
- A study setting out a wider European perspective.

Emissions arising directly from the food system (i.e. excluding land-use change-related emissions) account for about 20% of consumption-orientated emissions. The latter represents emissions from the full range of foods consumed, including those that are imported, and including the emissions embedded in imported animal feed. More than half of these emissions arise from farming. Within farming, the delivery of livestock commodities provide one third of the food energy but account for nearly two thirds of the production emissions. So on a dietary energy basis, the livestock based component of our food system has double the emissions of the plant based component. Research shows that improving the efficiency of agricultural production has a relatively small effect on these emissions. Hence, Donal argued, the need to change consumption is founded on the need to effectively mitigate GHG emissions.

70% of the UK's agricultural area is grassland, ranging from intensive grassland for dairy production to very extensive semi-natural grazing land for sheep. In such a country with a high proportion of grassland, the idea of replacing livestock products with plant-based foods raises the question of the overall effect on land needs. Would such a switch increase the area of arable land needed? What would be the overall effect on emissions? Donal's presentation highlighted research showing that dietary change is likely to reduce the need for all types of land – grassland and arable in the UK and overseas. The net risk of unintended consequences such as increased demand for land to supply plant-based foods is low, but commodity production may shift between countries.

Donal also emphasised that the UK food system is embedded in the wider European food system. In particular, the pig and poultry sectors of the UK, Netherlands, Belgium and Denmark are closely related in resource use terms and use similar production practices. The presentation provided some related European perspectives drawing on the recent work on protein provision in Europe led by the Dutch Environment Assessment Agency. That

---

research brings together life-cycle, economic and land resource models to assess the overall and wider effects of changes in consumption.

## Discussion

The discussion broadly explored the following topics:

**Substitution effects:** The question was raised: “what will people eat if they don’t eat meat and dairy and what are the environmental impacts?” This is an important point – the studies highlighted in Donal’s presentation took into account the GHG embedded in greater consumption of grains, fruits and vegetables to meet current energy intakes, although protein levels fall with this consumption pattern slightly (still well within safe levels). However, it is certainly possible to consume animal product-free diets that are still very high in GHG emissions and so further exploration here may be useful.

**Different production systems and different qualities of land:** Many participants emphasised that not all land is ‘equal’ and that different land types are suited to different agricultural and environmental functions. For example, in Mongolia, grassland is the natural ecosystem state and it is not possible or environmentally desirable to do different things with that land. Hence livestock farming represents an efficient use of land. Understanding the different environmental qualities and potentials of land is therefore key to sustainable food production.

It was noted that grasslands are both a source of and sink for CO<sub>2</sub> emissions. CO<sub>2</sub> is released through the process of overgrazing, but if this is reversed, then grasslands can become a very important sink and have a significant role to play in GHG mitigation. One participant highlighted research (forthcoming) estimating that soil carbon sequestration has the potential to mitigate China’s fossil-fuel related CO<sub>2</sub> emissions by 16% if China’s National Grasslands Conservation Plan were fully implemented. It is not known how feasible this might be.

While rangelands represent substantial mitigation potential in China, they contribute very little to overall meat supply – grazing animals on rangelands account for about 25% of the mutton and beef consumed in China, but intakes of these meats is very low compared with pork and poultry. For example production of cattle and sheep/goat meat in the main grassland provinces in China (Inner Mongolia, Xinjiang, Qinghai, Gansu, Ningxia, Tibet and Sichuan) account for only about 4.5% of the volume of national meat production, or a slightly higher 7.5% measured by economic value.<sup>5</sup>

In general, it was agreed that grazing livestock in China account for very little of the ‘problem’ of livestock production, and not only have an important livelihoods role to play but, through their role in soil carbon sequestration, can be an major part of the mitigation solution. The important point was made that a focus only on carbon ignored the other vital ecosystem functions that grasslands provide. Equally significantly, for environmental measures in grasslands to succeed, economic development must form part of the policy package.

As regards the UK and Europe, while there are natural and semi-natural grasslands with high conservation value, much grazing land is ‘managed’ or ‘improved’ and does not necessarily perform valuable ecosystem functions. Hence a reduction in livestock numbers need not affect high-conservation value grazing lands, where grazing can continue.

---

<sup>5</sup> Andreas Wilkes, ICRISAT, pers.comm

It was commented that two systems seem to be emerging; on the one hand we are seeing growth in large scale intensive system, supplying food for the masses (ie. 2 million pigs in multistorey sheds). On the other hand, China is also experimenting with 'circular agriculture' oriented systems of the type highlighted in Gao Shangbin's presentation.

Finally, with regard to systems, it was noted that highly intensive facilities are based on oil based inputs, such as fertilisers, and pesticides. In coming years it will be imperative that farming systems move away from dependence on oil.

**Changes in production systems:** There are 500 million small farmers in China. Compared with Europe farm sizes are tiny – they can be much less than a hectare with householders owing 1-3 cattle and a few sheep, or a pig and a few chickens.

Many participants emphasised that smallholders are essential to food security. However, they are often seen as ineffective and their practices unsustainable. As such they are actively discouraged - small farms receive fewer subsidies than larger enterprises and indeed Government policy is to encourage farmers to leave aside smallholder farming and move to urban areas. Their role in Chinese food production is dwindling. 10-15 yrs ago, 80% of pig and poultry output was produced by small farmers, but this figure has fallen now to roughly 60% of pig and an even lower 30% of poultry production.<sup>6</sup> This said, the ruminant sector is still largely dominated by smallholders who own relatively few livestock – it was noted that the multinational company Nestle is supplied in China by small farmers who may own only 2-3 dairy cows).

Hence the huge increase in livestock production in China has been driven by investment in and Government support for the large scale intensive sector, driven by private interests.

The situation in the UK is different. Average farm sizes are much larger because the population is already highly urbanised. Following reforms in the Common Agricultural Policy, farmers of all sizes no longer receive subsidies for production, although they still receive payments for land management (whether or not they choose to produce food from it). This said, many dairy farmers in particular in the UK are struggling, and the UK is seeing many farmers leave the sector, and average farm sizes continuing to increase.

**Climate vulnerability and resilience:** The point was also made that it is necessary not only to consider the impact of agriculture on climate, but also the effects of climate change on agriculture. China is one of the countries most affected by environmental disasters. The risk of flooding is increasing in China – and an increasing population will increase pressures to farm on flood prone areas. This can have devastating livelihoods impacts. It was noted that the cyclone of 2008 that affected Myanmar, 130,000 draught cattle were killed, and to date only 10% of them have been replaced, with huge and negative impacts on the livelihoods of poor people.

**Production and consumption trends:** There was general agreement that continued growth in livestock production and consumption in China is inevitable and indeed it is a specific policy of the Chinese government to increase meat and dairy consumption. The real question that is open to discussion is, by how much? It was felt that while growth will happen, it may be possible to modify the rate of increase.

---

<sup>6</sup> Based on pers comm

***Agricultural policy drivers:*** While sustainability is a strong focus of the Chinese Government's latest (Twelfth) Five Year Plan, the focus in terms of GHG emissions is still on the energy and mining sectors. There is little detail on agriculture. This said, there is strong interest among researchers and policy makers and the policy infrastructure is there to take things forward. It was noted that once an idea gains credence among policy makers, it can rapidly be taken up and implemented. For example, local government support for carbon payments in one part of China has led to the schemes adoption by local businesses.

***Existing research focus:*** Areas identified where research is underway include: biogas production linked to nutrient management (a strong area of interest); nitrogen fertiliser management, water pollution and the role of carbon sequestration in mitigating GHG emissions. China will be publishing its latest livestock GHG inventory later in the year.

Life cycle analysis is still an underdeveloped research area in China, but interest is growing.

Discussions about consumption, in relation to environmental GHG mitigation, are still not common within the research community in China. This is in contrast to the situation in the UK, although it should be noted that while dietary shift is an area which may be a prominent topic for debate, there are as yet no government policies aimed at modifying meat and dairy consumption. The UK's food industry is familiar with the issues but mainstream retailers have as yet taken no action in this area.

#### ***Environment-related research questions:***

The discussion threw up a number of areas where further research is needed. These include:

- More understanding of the Chinese food supply chain as a whole– a focus that encompasses not just agriculture and/or livestock, but also manufacturing, retailing, transport and the catering sector.
- More LCA analyses. A word of caution was sounded on LCA – that it does not necessarily capture the different and interacting functions of different land types.
- Research to identify the key environmental impact areas in the food supply chain and how to reduce GHG emissions throughout the chain
- Further work is needed in China (as is already emerging in Europe) on the relationship between nitrogen excess in agriculture and nitrogen / protein excess in food intakes.
- More understanding of the differences between livestock production systems, and their strengths and weaknesses with respect to sustainability.

## **2.2. Session two: Nutrition and health**

### **Professor Fenying Zhai, Chinese Centre for Disease Control and Prevention**

Fenying Zhai gave an overview of trends in meat and dairy consumption and levels of overnutrition and malnutrition in China. She identified the key and linked drivers for changes in diet as: economic development, urbanisation, increased food supply, changes in lifestyle and levels of physical activity; and she noted the dual challenges both of over- and under-nutrition in China.

Two data sets formed the basis of the analysis in her presentation: the China Health and Nutrition Survey (CHNS), and the National Nutrition and Health Surveys in China.

The CHNS is a survey of 15,000 people (4280 households) in 9 Chinese provinces (from North to South in the Eastern part of China), undertaken between 1989-2009. The sample sites were clustered in the East of China. The National Nutrition survey was carried out in 1982, 1992, and 2002. This was a much larger survey than the CHNS, covering 28,000 households in 1992 and a smaller but still substantial 23,463 households in 2002.

Both survey data reveal an overall decline in cereal and tuber consumption, modified by a slight increase in rice intakes. While intakes of processed legumes (mainly tofu) have increased, consumption of dry legumes has declined. People are also consuming fewer vegetables although there appears to have been a fluctuating increase in fruit and nut consumption.

These overall declines stand in contrast to a very substantial increase in animal product intakes of all kinds - meat, eggs and milk. While both urban and rural consumers have substantially increased their consumption of meat products, the rise in milk is much higher for rural populations. Unsurprisingly, for all animal source foods, urban intakes are much higher than rural intakes, and much higher among high income than low income groups. Pork is by far the most popular meat, followed by poultry. Fish consumption is also increasing. Mutton and beef intakes are low. Egg consumption shows the least difference between income groups and between rural and urban populations.

The amount of food energy people consume appears to be declining and is lower in urban than in rural populations, reflecting more sedentary lifestyles. However, the proportion of energy derived from animal products and from 'empty calories' is higher in urban than in rural populations. Notably, 62% of the urban Chinese population derive more than 30% of their energy from fat and the figure is high in rural areas too, at 45%.

Following the differences in meat consumption, protein intakes are higher in urban than in rural populations, and of this protein, a higher proportion derives from animal source foods. In urban populations, vitamin A, calcium, phosphorous, zinc and copper intakes are higher than in rural populations, although for B vitamins the difference is more slight.

The average weight of the Chinese population as measured by BMI has increased over time, as have hypertension levels. Diabetes rates are higher in urban than in rural populations. The incidence of overweight and obesity is higher among urban populations.

As regards conclusions, Professor Zhai was, on balance, of the view that the diets of the Chinese population has improved since levels of malnutrition have declined. However, a proportion of the population consumes a high energy density diet and as a result the growing prevalence of hypertension, diabetes mellitus, overweight, obesity and abnormal blood lipid require close attention. At the same time, the long standing malnutrition-related dietary problems continue to persist, including intake deficiencies of calcium, retinal and ascorbic acid and low consumption of dairy and legume products are problematic. Hence China today suffers the burdens both of over nutrition and of undernutrition.

### **Professor Joe Millward, University of Surrey**

Joe Millward's presentation focused on examining the evidence regarding the relationship between meat and dairy products and health outcomes.

He began by outlining the role of meat and dairy foods in the UK diet, and highlighting key health statistics for the UK. In the current British diet, meat and dairy protein provides at least 50% of all protein, with meat consumed by 95% and dairy by 99%. Overall meat intakes having increased over the last 10 years. Overall, the lifespan of the UK population is increasing, although healthy life expectancy has been static for 20 years. Cardiovascular disease (mainly CHD and stroke) remains a major cause of premature death (<75y) with mortality rates higher in the UK than in much of Western Europe. However rates have been falling steadily at one of the fastest rates in Europe, with a 44% fall in premature death in the last 10 years. Most of the fall is through decreases in risk factors, mainly smoking. Inequalities of CVD mortality have also decreased in terms of the large North-South divide (with northern populations more at risk) and the urban-rural divide. However, improvements in CVD mortality for the better off has not been observed for the poorer population groups, which means that the health-inequality gap has worsened.

Up to two thirds of all CVD risk factors may be related to poor diet and physical inactivity, acting mainly through central obesity, which explains the gender difference (men are more at risk). The main established dietary risk factors are saturated fat, salt and sugar/high glycaemic index carbohydrates, while fruit and vegetables, high fibre foods and possibly oily fish are protective. The reductions in saturated fat, salt and sugar intakes and the increases in fibre and fruit and vegetable since the 1970s may account for some of the reductions in mortality but increasing obesity, continuing excessive intakes of saturated fat and salt, and inadequate intakes of fibre and fruit and vegetables compared with dietary targets may explain the higher CVD mortality in the UK compared with other countries and the regional and socioeconomic differences within the UK.

Consumption of meat and dairy products can increase CVD mortality risk, because of their saturated fat content (a complex relationship acting through several mechanisms), through salt in processed meats (acting through hypertension) and by displacing high fibre foods and fruit and vegetables (high meat and dairy consumption is inversely related to these foods). This said, the availability of low fat dairy foods, especially low fat milk at little extra cost mean that dairy foods in the diet need not supply high levels of fat. For meat there is a large price gradient for fat content and quality such that cheap processed meat products contain much more saturated fat (and salt) than more expensive lean meat. Most case control studies of mortality between meat eaters and vegetarians within generally healthy and populations with similar lifestyles and socio-economic status (often affluent) show little difference in mortality. While some studies report that both red meat (and dairy foods) do increase CHD mortality, several (but not all) studies separating red from processed meat show that risk is only associated with processed meat.

Cancer mortality in the UK is decreasing overall and currently accounts for 35 % of premature deaths in men and 45% in women. The incidence is highest for breast, prostate, lung and colorectal cancer, more in men than women for those cancers occurring in both sexes and generally more overall in white than in Asian, Chinese and mixed ethnic groups. The relationship between deprivation and cancer is complex and multifaceted, with smoking a major cause of inequalities in cancer incidence, mortality and life expectancy. Around a third of all cancer deaths have some link to diet (especially cancers of the gastrointestinal tract (mouth, larynx and oesophagus, stomach, bowel) and breast and prostate cancer. Obesity is probably the major causal pathway with mortality from most, although not all, cancers increasing with BMI. However the BMI-cancer link is less marked compared with BMI-CVD. Low intakes of fruits and vegetables, wholegrains, pulses and fish and high intakes of red and processed meat are commonly said to increase risk of cancer, but it has proved very difficult to quantify or in many cases even to confirm these relationships. Plausible mechanisms exist linking high intakes of red and processed meat with bowel cancer, and observational evidence supports such a link in large US and EU studies. However in the latter case only processed meat is associated with significant increased risk

and case control studies of UK meat eaters compared with non meat eaters do not find excess bowel cancer mortality. Milk and dairy foods have no overall relationship with cancer mortality, because the possible benefits (e.g. of milk for colo-rectal cancer) balance out possible risk (eg. for prostate cancer). Fish appears to be protective.

In terms of nutrient supply, moderate intakes of lean carcass (unprocessed) meat and low fat dairy products can have a role in a healthy diet, with B12, zinc, iodine, calcium and riboflavin supply particularly important. Current views of iron nutrition suggests that the importance of red meat compared with plant iron sources has probably been overestimated in the past so that on this basis, dairy foods are probably more important nutritionally than meat in the diet. This means that low meat or even meat free lacto ovo fish-based vegetarian diets can probably meet nutritional requirements for all population groups. Only vegan diets pose a serious nutritional challenge requiring supplements to ensure adequacy.

## Discussion

The participants' discussions clustered around the following themes:

**Data quality:** There was considerable discussion about the quality of nutritional survey data in China. It was commented that rural areas chosen for survey data gathering were not representative for the whole of China. They nutrition survey areas tended to be in the East of China – and it was noted that differences between diets when comparing the East and West of China may be bigger than the difference between urban and rural populations in the same area.

Questions were also raised about underreporting in the Chinese context – an issue in UK food survey data gathering, where survey respondents tend to underreport the amount of foods they consume, particularly those high in sugar and fat. This may be an area meriting further research.

**Consumption trends:** As in the session on GHG emissions, the feeling was that meat and dairy consumption will inevitably rise. The market encourages people to eat more meat and government encourages farmers to produce more. China provides subsidies for Muslims to buy beef. However it was also observed that some of the survey data in the China Nutrition and Health Survey seem to suggest a flattening out of some forms of meat consumption in urban areas. Fenyng Zhai pointed out that the survey exercise was accompanied by health advice and the slowing of the meat consumption increase may represent responsiveness to health messages to reduce saturated fat intakes.

**Over and undernutrition:** Everyone agreed that concerns around overconsumption should not be at the expense of considering the needs of many people in rural areas. It was argued that for them, meat and dairy consumption needs to increase to improve their health. Talk about 'average' meat consumption in China is misleading given the size of the population and the geographical and social spread of the country. Poor people consume little while rich people's intakes are going off the scale. This said even in rural areas, as Prof Zhai's presentation showed, consumption is rising.

It was also noted that the Chinese government has been funding 'bottom-up' work to improve diets in rural areas, with activities including: nutrition education, home gardening for fruit and vegetable production, and household level livestock rearing. In southern China these programmes have been very successful and reduced child malnutrition by 25%, as well as a 39% reduction in anaemia. 80,000 children have benefitted.

***The wider food supply system:*** As observed in the discussion session on environmental impacts, it is necessary to look at the total diet including fruit, vegetables, oils, processed foods, fish and so forth, and not just meat and dairy products, to get an understanding of dietary trends and health impacts.

In addition the context within which food is consumed needs to be considered. China is currently following a western development pathway and if trends continue consumption patterns may reach western levels. China's social and logistical structures – its use of public space, logistics networks and so forth, are creating an obesogenic environment. As in the UK, the policy focus in China has been on educational and awareness raising campaigns, rather than on economic structures, and to date policies to promote fruit and vegetables have not been successful. It is essential to focus not just on demand side issues but on what kinds of food are supplied (how much meat and dairy), and how it is supplied (price, delivery mechanisms, retailing structure, spatial context and so forth).

Strategic government interventions on diet can make a difference and benefit public health, as the UK's experience with rationing in World War Two showed – rationing improved the quality of people's diets and led to higher birthweights in babies born in that era. Since then, it was noted, the UK government has failed to maintain a strategic role in influencing diets, with negative health consequences.

The role of big companies, such as Macdonalds was seen as double-edged. On the one hand their vast advertising budgets can overwhelm policy signals encouraging people to adopt healthier diets. On the other hand, engaging with big companies can be very constructive – when they decide to make a positive change, there can be huge market effects.

***Calcium, dairy and bone health:*** Several people raised the question of the relationship between calcium, dairy products and bone health in China since traditionally Chinese people consume very little dairy produce.

A comment was made that bone health has started to emerge as a concern among older people. It is unclear whether the emergence of this issue reflects life style changes (more indoor, sedentary lifestyles reducing exposure to Vitamin D from sunlight and lower levels of physical activity) or whether the problem was there too in the past, but simply under reported in the past. For example there has been a high prevalence of vitamin-D deficiency-related rickets, and low average adult heights in Mongolia for some time.

The relationship between calcium and bone health is highly complex, as Joe Millward's presentation noted. Different countries make different recommendations on calcium intakes – the UK 700 mg/day, the US 1000mg/day and China 800 mg/day. A major Chinese project on calcium requirements is currently underway in China, and the results should be published in 2012. The findings of this study may or may not lead to a review of current calcium requirements.

***Is there an optimal diet?*** Joe Millward and others pointed out that there are a number of ways in which people can satisfy nutritional needs - there is no 'set' optimal diet to which people should adhere – particularly in the context of China, which is home to 56 ethnic groups with very diverse traditional dietary habits. Human beings are highly adaptable.

One sensible approach might be to take a society, look at its traditional consumption patterns, attitudes and cultures around food and try to generate diets that are based, but improve on, those. It was noted that China traditionally has very high levels of vegetable consumption (less so for fruit) – this is something to build upon.

Finally, the point was made that in natural ecosystems there is a relationship between ecosystem diversity and function, and this is also the case for human nutrition. It may be important to look at the overall diversity of the diet rather than focus just on individual nutrient requirements.

### ***Health-related research questions***

The following potential research ideas were identified in the discussion:

- What are the constraints and opportunities within which household farmers operate? For example, how do small households, producing very little surplus, cope with risks such as drought and flooding, human and animal health risks, SARS, H1N1 (swine flu), H5N1 (bird flu)?
- There is a need for greater understanding of the different nutritional needs for populations in rural and in urban areas, in different parts of China, and of different ethnic groups.
- Complementing this, there is a need for more research into the consumption habits and nutritional needs of communities in transition - those who have recently moved from rural to urban areas - to explore how and why diets change during this time
- There is a need to look at policies in non-food related sectors, such as transport and urban planning) and see how these affect the environment within which food is delivered to the public, and consumed.
- There is a need for greater clarity on calcium and bone health in China, where dairy intakes are traditionally very low.
- What are the similarities and differences between UK and China in the development and emergence of diet related diseases.
- Data quality was highlighted as an issue: more work is needed to improve the quality of the survey data.
- What policy changes may be needed to alter consumption patterns? To what extent can any changes in consumption arise without fiscal measures to drive it? A set of likely policy interventions can be modelled, drawing interdisciplinary research including economics, psychology and nutrition.

## **2. 3. Session Three: Animal welfare**

### **Xianhong Gu and Yue Hao, Chinese Academy of Agricultural Sciences**

Yue Hao began by highlighting China's global importance as a producer of livestock products – it produces 46% of pork produced globally and 41% of eggs. Livestock production accounts for 34% of the value of China's agricultural output and is an important contributor to farmers' incomes. However, its livestock sector is experiencing major challenges – zoonotic disease outbreaks (swine fever, foot and mouth disease, avian flu), rising feed prices and production costs, and increased consumer concerns about the quality and safety of animal products.

It is within this context that concerns around animal welfare need to be addressed. Yue Hao defined animal welfare as a situation which animals experience little stress, are raised in an environment to which they can readily adapt, and in conditions that enable them to meet their physical, psychological and behavioural needs. Humane treatment and management to reduce disease risks are also essential. While it is necessary to strike a balance between human and animal needs, improvements in animal welfare can also benefit humans. She outlined the concept of "health feeding" whereby livestock are provided with a good ecological environment and adequate nutrition to ensure rapid growth, to minimise disease,

and to produce safe food for the public. She emphasised that there is a link between good animal health, good animal welfare, a reduction in disease risks, and food safety.

As regards trends in production, China has seen a rapid transition in how animals are fed – it is moving away from systems based on the feeding of household waste, scraps and byproducts to those in which animals are fed on dedicated feedcrops, driven by efforts to increase productivity. Between 1990 and 2009 the use of dedicated feed production has grown six-fold, from 25.6 million tonnes to 115 million tonnes per annum.

Her presentation highlighted the advantages and disadvantages of different systems of livestock production, that currently coexist in China, as follows:

*Traditional household production* is characterised by the feeding of leftovers, and the close proximity of livestock to the household. This is a resource efficient form of production, and livestock have more space to roam around, but it also has its disadvantages in so far as productivity is low and livestock may often not be vaccinated (posing zoonotic disease concerns).

*Small and medium scale farms* where animals are reared in barns or other structures have the advantages of relatively low construction costs. Animals are kept at relatively low stocking levels, have access to natural light and ventilation and are better able to express natural behaviour. They are also more likely to meet consumer expectations of what constitutes good welfare. On the other hand, productivity is lower than in large-scale farming and effective manure management is harder to achieve.

As regards *intensive large scale systems*, they have their advantages too. Productivity is considerably higher and veterinary care can be logistically easier to provide. However, building and energy costs are high, animals are not able to express natural behaviours and the risk of disease spread is increased. Nutrient surpluses can cause major problems and very rigorous health and hygiene standards are needed to manage environmental pollution.

In the case of *outdoor free range systems*, animals are better able to express natural behaviour. However on the downside land requirements are higher, vegetation can be destroyed and the risk of disease infection through contact with wildlife is increased. Unstable groups can increase aggression, and these systems are not suitable for high yielding varieties. They are more vulnerable to fluctuations in weather.

Yue Hao argued that in the case of trade and the role of welfare in determining trade, the economic context of different countries needs to be taken into account. She noted and endorsed the views of the OIE which is that “Animal welfare is prone to differences and conflicts. ... Animal welfare should not become the means of trade protectionism, and should not be a tool to maintain special interests. When formulating the international animal welfare standard, the international community should consider the economic development level and other restrictions of developing countries.”

Interestingly, Yue Hao’s presentation highlighted considerable, and rising interest in animal welfare. Survey data suggests that there is strong public support for improved animal welfare even if this translates into a rise in prices. Within the academic domain, she highlighted a growing number of research projects that incorporate animal welfare, as well as an increase in the number of university courses that offer animal health and/or welfare modules. At the Government level, the concept of ‘health feeding’ was outlined in the Twelfth Five Year Plan. Finally a China Farm Animal Welfare website<sup>7</sup> has been set up.

---

<sup>7</sup> <http://www.cfaw.net.cn/>

## **Basia Romanowicz, World Society for the Protection of Animals**

Basia began by pointing out the importance of livestock to many of the world's population – 1 billion people, most of them in developing countries depend on animals for food, income, transport and social status. Currently, 60 billion animals are produced for food each year and it is predicted that this number may double by 2050 to meet the growing demand for meat and dairy products. The majority of this growth will come from intensive systems, with significant impacts on the environment, biodiversity, human health and animal welfare. The welfare costs of such systems are extremely high for billions of animals: scientific research shows high levels of ill health (such as lameness and respiratory disorders) and the prevention of basic animal behaviours such as exercise, the ability to forage for food or even to stretch their wings (in the case of battery caged hens), or turn around (in the case of breeding pigs).

Basia's presentation made the case that high welfare animal production systems are central to achieving environmental, social and economic sustainability. Fortunately, humane systems can also offer profitability and low environmental impact.

Integrating livestock and crops in mixed farming systems provides a solution to some of the environmental problems otherwise associated to livestock farming, through better recycling of nutrients and lower reliance on imported feeds. Farms that integrate crop and livestock are also shown to be more resilient against climate change. Marketing chains that create and retain value along the chain are another key element to sustainable food supply. Examples of dairy cooperatives in India, China and the U.S. demonstrate that it is possible to maintain a structure of medium scale producers reliant on grazing systems that are competitive in the national and global markets. In addition, good animal health and welfare can reduce costs and raise profits for producers. For example, in dairy production, investing in increased cow longevity and fertility will help to achieve better returns in the form of milk and calves during the animal's lifetime.

There is high demand for higher welfare products in Europe, demonstrated by the recent growth in sales of cage-free eggs and higher welfare meat. She noted that people choose these products not just for ethical reasons, but also for perceived higher nutritional quality and greater food safety. Although the availability and demand for higher welfare food in China appears lower, there is interest in animal welfare, with the majority of citizens in a recent survey stating that animal welfare matters to them personally.

She concluded that, for livestock production to be sustainable, it must be biologically based, economically viable and ethical. To achieve this, animal welfare needs to be included in all future discussions on agriculture, land use and climate change. There is a need for more research on farming systems which meet all of these needs. Animal welfare is also integral to protecting livelihoods and food security from disasters. Animal protection should be implemented into national plans and policies at the government level, along with the integration of animals into the processes, assessments and projects of humanitarian and development agencies.

## **Discussion**

Discussion centred on the following topics:

**Food safety and zoonotic diseases:** Although the focus of this workshop was not specifically on issues relating to zoonotic diseases and food safety, these are clearly major concerns with links to welfare and inevitably they came up in the discussion.

As regards zoonotic diseases, the comment was made that pandemics are more likely to come from intensive systems – in other words, precisely those systems that are seeing rapid growth in China. There is also a whole raft of issues to do with routine use of antibiotics in intensive systems. One participant argued that in more extensive systems, animals may be more genetically robust and be better able to withstand disease challenges. However, another participant pointed out that mass vaccinations are easier undertake when livestock are concentrated together in large numbers, rather than dispersed among many small-scale farmers.

Food safety and trust is a major and growing concern in China. Demand for organic and other 'green' products is rising among urban populations, driven partly by concerns about food safety, but there is a lack of certification and verification – and a huge number of fake labels. At present there is no statutory definition of 'organic' or 'higher welfare' practices and processes.

Traceability is a linked issue. Government is starting to develop legislation in this area but it is still early days. China's retail structure is characterised by a large number of small producers supplying a large number of small retailers; even larger retailers are still supplied by many smaller players. This makes the task of improving traceability very difficult (although there can be economic benefits as regards access to markets by smaller players). One key priority is to develop ideas for improving traceability in this difficult context.

For comparison, it was argued that in the UK, standards have been developed not by statutory agencies, but by the private sector. The UK food system is dominated by a very small number of large retailers, and a slightly larger number of large manufacturers. Traceability requirements are mainly driven by retailers as an approach to managing risk; it was argued that, where a food safety outbreak occurs, the source of the outbreak can be identified and hence blame can be passed from the retailer to the supplier.

**Welfare in intensive versus extensive systems:** A key point that came up over and over again was good and bad welfare can occur in any system; good stockmanship is critical. Poor welfare can be found in extensive, small scale systems as well as in intensive large scale enterprises. For example in western China in spring when grass is scarce, extensively reared grazing animals can experience starvation - yaks can nearly halve their body weight. However, Basia from WSPA pointed out that some practices that are generally associated with with large scale systems are ethically unacceptable, such as the use farrowing crates for sows, and the rearing of livestock breeds that have very rapid growth rates, leading to physiological problems such as bone fractures. She argued that more extensive systems have their own problems but tend to have higher potential for achieving good welfare, even if this is not always realised.

As in the case of environmental GHG mitigation, there is no 'one size fits all' livestock system that is optimum for welfare. It was suggested too that breeding livestock (including through GM techniques) for greater leg strength or cardiovascular health can also be a useful approach to improving welfare.

## **2.4. Session four: Economic development**

**Jikun Huang and Jun Yang, Center for Chinese Agricultural Policy (CCAP), Chinese Academy of Sciences (CAS)**

The agricultural sector in China is expanding rapidly – the agricultural GDP growth rate is currently four times that of population growth. Within the sector, livestock production is taking an increasing share. Yang Jun's presentation outlined the main forces driving this growth in the livestock sector, addressing both demand and supply side influences, and examined the prospects for the future.

As regards the demand side, the key forces he identified are: population, urbanisation and economic development, although their relative importance is changing over time.

Population has until recently been an important force driving the growth in livestock. However, the rate of growth is now slowing and in coming years population growth per se will not be an important driver of further demand. The growth in the urban population (at the expense of the rural) will, by contrast, continue to be a major driver of livestock production. The urban population is increasing rapidly – currently nearly 50% of the Chinese population lives in urban areas and this is projected to reach nearly 65% by 2030. Urban populations tend to eat more meat than their rural counterparts, as Fenying Zhai's presentation also illustrated.

A third major driver of livestock production is economic growth. China's GDP in 2010 was nearly 20 times what it was in 1978. This dynamic growth is expected to continue and, combined with the process of urbanisation, these changes will have profound effects not just on China but (given its size) on the rest of the world.

Economic development has brought with it a rise in incomes, and this in turn has led to a strong growth in demand for meat and dairy products. The combined process of urbanisation and economic growth has led to changes in how and where people consume. Urban populations are increasingly eating out of the home and spending here has increased nearly five-fold between 1992 and 2009. Significantly, meat is more likely to be consumed in restaurants and other eateries than at home and the continued rise in out-of-home eating is therefore likely to favour the trend towards more meat consumption.

As regards the supply side, the key drivers here are: technological changes, the use of dedicated feed and market reform.

Agricultural productivity has grown massively – total factor productivity has grown at 3% per annum. As regards livestock, much of this growth is the result of increased use of dedicated feedstuffs, facilitated by the reduction in agricultural tariffs and the rise in feed imports. Until recently China was a net agricultural exporter but the situation has reversed in recent years in the case of animal feed commodities. In particular there has been strong growth in imports of soy, while the country has moved from being a net exporter to a net importer of maize.

In future years, economic forecasting models suggest that while China will continue to be self-sufficient in most products this will not be the case for sugar, milk and in particular for oilseeds. Exports of agricultural commodities across the board are predicted to decline, with the exception of processed foods, fruits and vegetables.

As regards the impacts on employment and livelihoods, wages have risen strongly since 2000 while at the same time the structure of the livestock industry has changed. Household 'backyard' production has declined steeply since 2001 while medium and large scale enterprises have grown.

To conclude, the livestock sector has been rapidly expanding and will continue to grow in the future. The major driving forces of demand are income growth and urbanization, which together have given rise to diets richer in meat and dairy products. The major supply side drivers include rising domestic demand, technological developments, market liberalization, and the growth in feed imports. As incomes and wages have risen, China has seen a shift from backyard livestock rearing to medium and large scale production systems.

### **Dr. Mike Gooding, Farm Animal Welfare Initiative**

Mike highlighted the global scale of the challenge in relation to population growth and food security. With global populations set to grow to 9.5 billion by 2050, demand for food and the resources needed to produce that food will place major pressures on the global community. Food price increases in this context are inevitable and the question then arising is 'can there be room for ethical animal production when people are hungry?'

Mike's presentation began with an overview of the agricultural economic situation in the UK. The total share of agriculture in the UK economy has continued to decrease in recent years, although variations have resulted in peaks and troughs. Of the total utilisable land available (9 million hectares) in the UK, 44% is cropped and 43% is permanent grass. Livestock numbers have decreased (with the exception of chicken which has grown by 8.5% to 125 million chickens) reflecting poor returns, market volatility and the move away from production based subsidy payments to rewards for more sustainable land management. Other challenges beyond farmers' direct control include fluctuations in exchange rates and supply and demand dynamics on the global market.

Hence the focus for the UK farmer must be on what he or she can control – the inputs to the system. Mike argued that what we conventionally define as 'inputs' is misleadingly narrow, and in the long term, in the context of higher oil prices, climate change and population growth, farmers need to start considering the true nature of what they put into, and what comes out of, the farm system. Inputs include not just feed and energy, labour costs, fertiliser and pesticide inputs, but also water, ecosystem services and 'social cohesion' – that is the 'input' of being able to farm in a relatively socially stable context (a benefit that may change in the context of food insecurity and climate change). The outputs include not just food but also waste, and effects on biodiversity and human and animal wellbeing.

Mike reiterated the point made by Basia in her presentation that farming for the future needs to consider all three elements of sustainability: economic, environmental and ethical. As such we need to challenge the perceived wisdom that systems which are based on oil and oil derivatives are highly efficient and productive, since they override other critical elements, including environmental resilience and ethical acceptability.

Mike concluded his presentation by highlighting the work of the Farm Animal Welfare Initiative which sets out to develop sustainable farming systems that meet the future challenges faced by the global community. In particular Mike illustrated FAI's approach by outlining its experiments with pig production systems based on a forage diet. The FAI has successfully trialled silage based diets with pigs, following the simple idea that producing pig meat on a diet of mainly forage rather than grain is more environmentally sound, is economically viable and better for the pig's welfare. It is also experimenting with woodland production with chickens (combining livestock production with carbon sequestration), and the integration of pig systems with aquaculture (carp).

## **Discussion**

The main areas of discussion were as follows:

***Soy dependence:*** The question was raised as to whether China's dependence on soy and other feed imports can be sustained in the long term. Brazil, one of the major producers may not be able to keep up with domestic demand. One participant commented that this is in fact a major global problem that affects industrial livestock systems in all countries.

***The role of small farmers:*** some participants pointed out that smallholders have generally been sidelined in discussions on delivering agricultural GHG mitigation in China, due to policy-bias. However, smallholder livestock farming is essential to the livelihoods of millions of Chinese people and if these farmers receive sufficient support in the form of capital, knowledge and enabling institutions, they can play their part in delivering agricultural mitigation. A key research question to consider is how to price environmental services in such a way that poor farmers can benefit from mitigation.

***The broader food system:*** The point was made that while this workshop's focus has been livestock production and on meat and dairy consumption, the vital intermediary link between primary production and consumption is missing – the role of the manufacturing and retailing sectors. Their influence both on the process of agricultural production and on patterns of meat and dairy consumption needs to be investigated, since they can have both negative and positive roles to play.

### ***Research questions***

The following were identified:

- How can poor livestock farmers benefit from knowledge on agricultural GHG mitigation and what supporting structures (capital, infrastructure, knowledge) and pricing incentives are needed to ensure this?
- More broadly, how can the real (including social, ethical and environmental) costs and benefits of agricultural production be factored into assessments of the productivity of farm systems?

## **3. Workshop conclusions**

The broad themes that emerged from the workshop were as follows:

There is an enormous amount that can be done in China to reduce agricultural (including livestock related) GHG emissions through improvements in farm practice. In the short term this may be the priority. However, the discussion on meat and dairy consumption will not go away, and will grow in importance in coming years. Hence it is necessary to examine the issue now in order to be able to address concerns as and when they become more prominent.

For the UK, most of the gains in GHG efficiency have now been achieved, and further improvements in this area will deliver relatively little by way of mitigation. The debate around the need to reduce meat and dairy consumption is well advanced in the UK, and in Europe in general, although so far this has not translated into policy action. Actually achieving behaviour change is a key priority for researchers and policy makers in these countries.

In China, meat and dairy consumption will inevitably rise in coming years, and for many people, this will yield nutritional benefits. There is opportunity here to align environmental and health goals and thereby influence and modify the rate of the increase in livestock production and consumption.

In the UK, where meat and dairy consumption levels are very high, a shift away from meat and dairy towards more plant based diets can be compatible with dietary requirements and is likely to benefit some at-risk groups.

As regards livestock systems, China is experiencing massive changes in the livestock sector – moving away from household-level subsistence level production towards a rapid growth in large and medium sized enterprises – although subsistence farming is still an essential livelihoods survival for millions of Chinese people. These agricultural changes are linked to massive demographic shifts towards urban living and urban lifestyles, and strong economic growth. Overall self sufficiency in China is undermined by increasing reliance on soy and maize imports, both key elements of industrialised livestock production. The UK, by contrast, is seeing a decline in the importance of its agricultural sector, and is already far more dependent on imports from abroad than is the case in China. This reflects, among other things, an already mainly urbanised population, larger-than-European-average farm sizes, and increasing exposure to global market influences.

Good and bad welfare are possible whatever the system, and good management is key. This said, intensive systems are generally less able to provide animals with the ability to express certain natural behaviours. Different systems pose different risks in terms of food safety and the spread of zoonotic diseases – and all are vulnerable in different ways. Public concern for animal welfare is high in the UK and is growing rapidly in urban China too, partly driven by food safety concerns.

As regards the inherent sustainability of one system over another, while industrial systems appear efficient, measured in terms of productivity, and GHG emissions, their reliance on fossil fuel inputs and feed inputs (particularly soy) renders them increasingly vulnerable in the face of future resource constraints. The question is not one of scale but of dependence on non renewable inputs.

This workshop has made a start in highlighting the links between the health, welfare, economic and environmental agendas, and in bringing together researchers and policy makers across disciplines. More work is needed in this area, to investigate synergies between social, ethical and environmental objectives and to consider viable policy options.

## **4. Next steps**

There was strong agreement among participants that further research in this area is needed and that collaboration between the UK and Chinese research communities would be constructive.

A great many research questions were identified by participants at this workshop, as highlighted above, and they all merit investigation. However, there was a general view that, before launching into focused research there was a real need for a short ‘state of play’ review – mapping or scoping study, to identify what is known, what is not known and to try and help identify research and policy priorities. Such an analysis can inform and help define subsequent more focused research studies.

Hence we agreed that it would be helpful to seek funding for a Chinese-researcher/analyst-led scoping study that sought to:

- Highlight the **main drivers** - economic, demographic, political, climatic, cultural - shaping current and future food production and consumption in China. The emphasis should be on the whole supply chain – encompassing not just agricultural production but also manufacturing, retailing, distribution and consumption – and should focus not just on livestock but on the full range of foods consumed.
- Identify the main **food related trends** that are emerging in terms of: agri-environmental impacts and concerns, nutrition/food security trends; other health concerns (eg. food safety, zoonoses); economic impacts; changes in agricultural systems (eg. concentration) and in retailing structures
- Explore how all this differs **by region, difference between urban and rural** etc
- Map out the **key policies** (national and international) that have potential to influence these trends
- Identify the main **research gaps**, and the main research priorities.
- Perhaps give a sense as to what the **main priorities in terms of research and policy focus** should be in the immediate future (1-5 years), in the mid term (5-15 years) and longer term (15 + years), for health, climate change, welfare and economic development.

There was a strong sense that **collaboration with a UK partner** would be helpful in so far as it could stimulate different ways of thinking and perspectives and foster a more interdisciplinary approach. Collaboration could also help situate the research in a more strategic policy context. However the work would essentially need to be **China led and China based**.

The next stage is to identify sources of funding and potential collaborators on taking his piece of work forward.

## Appendix One: Background to the issues

The latest report by the Intergovernmental Panel on Climate Change<sup>8</sup> states that we need to reduce global greenhouse gas emissions by 50% - 85% by 2050 in order to limit global warming to 2 to 2.4°C, although the majority of the world's governments now state a need to limit warming to below 1.5 °C. A very significant global greenhouse gas (GHG) emissions is attributable to the rearing of livestock.<sup>9 10</sup> It has been estimated that livestock account for around 12-18% of global GHG emissions<sup>11 12</sup> and for the majority of agricultural impacts.

A third of this impact is attributable to livestock induced land use change, including deforestation and land degradation. Livestock already cover 70% of agricultural land and hence expansions in the sector would put additional pressure on increasingly scarce land resources as well as increasing emissions. To date, 20% of pastures and rangelands globally have been degraded by overgrazing – 73% in dry areas.<sup>13</sup> Cattle ranching is currently the dominant cause of deforestation in the Amazon region,<sup>14</sup> with soy cultivation to feed livestock in industrial systems in Europe, in China and elsewhere (and for biofuels) an emerging driver of growing importance.<sup>15</sup> Soy production is a major driver for the conversion of the biodiversity-rich Brazilian Cerrado to cropping.<sup>16</sup>

With current growth trajectories indicating that global production and consumption of meat and dairy products could double by 2050, absolute emissions are set to increase. Much can be done to reduce emissions from livestock through good management and technological innovation, but a growing number of studies suggest that these measures alone will not be sufficient to achieve the cut in emissions that the global community as a whole needs to achieve, and that shifts in consumption patterns are essential.<sup>17, 18, 19, 20, 21, 22, 23, 24, 25</sup>

---

<sup>8</sup> IPCC(2007b): *Summary for Policymakers*. In: *Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer (eds)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

<sup>9</sup> *Environmental impact of products (EIPRO): Analysis of the life cycle environmental impacts related to the total final consumption of the EU25*, European Commission Technical Report EUR 22284 EN, May 2006.

<sup>10</sup> Williams, A.G., Audsley, E. and Sandars, D.L. (2006) *Determining the environmental burdens and resource use in the production of agricultural and horticultural commodities*. Main Report. Defra Research Project IS0205. Bedford: Cranfield University and Defra.

<sup>11</sup> *Livestock's Long Shadow*, FAO, Rome, 2006

<sup>12</sup> Netherlands Environmental Assessment Agency (PBL) (2009). *Environmental Balance: Summary*. Netherlands Environmental Assessment Agency (PBL), Bilthoven

<sup>13</sup> *Livestock's Long Shadow*, FAO, Rome, 2006

<sup>14</sup> McAlpine, C.A., Etter, A., Fearnside, P.M., Seabrook, L. and Laurance, W.F., (2009) 'Increasing world consumption of beef as a driver of regional and global change: A call for policy action based on evidence from Queensland (Australia), Colombia and Brazil', *Global Environmental Change*, vol. 19, pp21–33

<sup>15</sup> Nepstad D C, Stickler C M, Almeida O T. (2006). Globalization of the Amazon Soy and Beef Industries: Opportunities for Conservation, *Conservation Biology* Volume 20, No. 6, 1595–1603

<sup>16</sup> Dros J M (2004). *Managing the Soy Boom: Two scenarios of soy production expansion in South America*, report for WWF, AIDEnvironment, Amsterdam, The Netherlands

<sup>17</sup> Goodland, R. (1997). Environmental sustainability in agriculture: diet matters. *Ecological Economics* 23, 189–200.

<sup>18</sup> Weber, C., & Matthews, H. (2008). Food-Miles and the Relative Climate Impacts of Food Choices in the United States. *Environmental Science & Technology*, 42(10), 3508-3513.

<sup>19</sup> Stehfest E, Bouwman L, van Vuuren D P, den Elzen MGJ, Eickhout B, Kabat P. (2009). Climate benefits of changing diet, *Climatic Change*, Volume 95, Numbers 1-2.

<sup>20</sup> Garnett T. Livestock-related greenhouse gas emissions: impacts and options for policy makers. *Environmental Science & Policy* 2009;12(4):491-503.

Indeed the growth in livestock farming gives rise to concerns in a range of environmental and ethical areas. Livestock production is associated with unsustainable water extraction and use, the contamination of soil and waterways, ammonia emissions and biodiversity loss.<sup>26</sup> Certain systems may also have unacceptably high costs in terms of animal welfare.<sup>27</sup>

<sup>28</sup> On the other hand, millions of the world's poorest people depend upon livestock rearing for food, traction, leather, manure, and other services, and in an increasingly insecure world, they represent a vital survival strategy.

The health impacts of diets rich in meat and dairy foods have also been viewed with concern.<sup>29</sup> On the one hand, malnutrition is widespread in many parts of the developing world, and animal source foods are rich sources of protein and of micronutrients and minerals such as calcium, iron, zinc and vitamin B12. On the other hand, increasing consumption of meat and dairy products, a pattern in developed countries and now some developing countries, is often associated with the growth in obesity and with an associated range of chronic diseases, including cardiovascular disease, diabetes, strokes and some cancers.<sup>30</sup> In rapidly industrialising economies, such as China, these health problems are also growing in prevalence and combine with continuing malnutrition to create a new, 'double burden of disease' for the world's poor. Growing consumption of meat and milk is also associated with globalized trade in livestock and livestock products and the potential spread of infectious diseases, such as avian influenza, and toxicants, like melamine. Finally, as growing demand for feed grains diverts arable land to feed production, this may have implications for food price and food security, affecting malnutrition and health indirectly.

In short, livestock production has become the focus of a nexus of concerns that span the environmental, health, socio-economic and ethical arenas (Figure One).

### Figure one: Livestock – interconnected challenges

---

<sup>21</sup> Audsley, E., Brander, M., Chatterton, J., Murphy-Bokern, D., Webster, C., Williams, A. (2010) *How low can we go? An assessment of greenhouse gas emissions from the UK food system and the scope for reducing them by 2050*. FCRN and WWF-UK, Godalming, UK.

<sup>22</sup> Environmental impact of products (EIPRO): Analysis of the life cycle environmental impacts related to the total final consumption of the EU25, European Commission Technical Report EUR 22284 EN, May 2006.

<sup>23</sup> Williams, A.G., Audsley, E. and Sandars, D.L. (2006) Determining the environmental burdens and resource use in the production of agricultural and horticultural commodities. Main Report. Defra Research Project IS0205. Bedford: CranfieldUniversity and Defra.

<sup>24</sup> Popp A, Lotze-Campen H and Bodirsky B (2010). Food consumption, diet shifts and associated non-CO2 greenhouse gases from agricultural production, *Global Environmental Change* 20 451–462.

<sup>25</sup> Pelletier N, Pirog R, Rasmussen R (2010). Comparative life cycle environmental impacts of three beef production strategies in the Upper Midwestern United States, *Agricultural Systems* 103 (2010) 380–389.

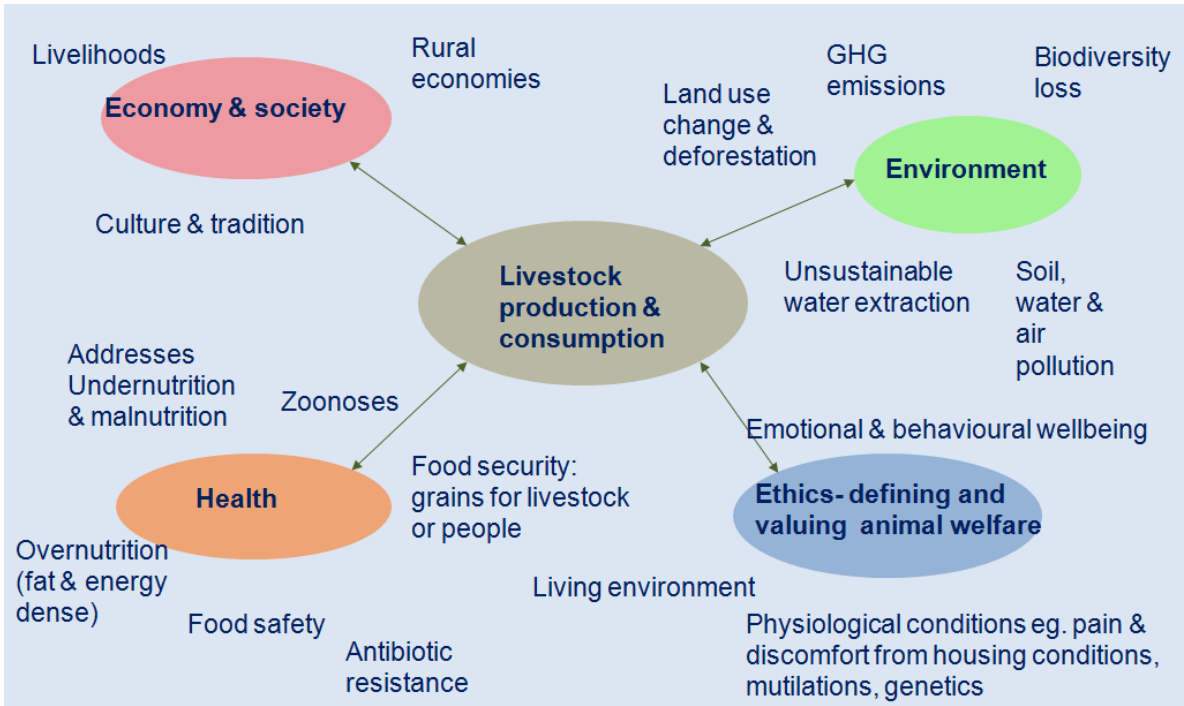
<sup>26</sup> *Livestock's Long Shadow*, FAO, Rome, 2006

<sup>27</sup> Pew Commission on Industrial Farm Animal Production (2009). *Putting Meat on the Table: Industrial Farm Animal Production in America*, A Project of The Pew Charitable Trusts and Johns Hopkins Bloomberg School of Public Health

<sup>28</sup> Webster J. (2005). *Limping towards Eden*. Wiley-Blackwell, UK.

<sup>29</sup> McMichael AJ, Powles JW, Butler CD, Uauy R. Food, livestock production, energy, climate change, and health. *Lancet* 2007; 370: 1253–63

<sup>30</sup> Popkin B M and Gordon-Larsen P (2004). The nutrition transition: worldwide obesity dynamics and their determinants *International Journal of Obesity* 28, S2–S9



## Appendix Two: About the conference organisers

**Food Climate Research Network (FCRN), organiser:** The aim of the Food Climate Research Network is to increase our understanding of how the food system contributes to greenhouse gas emissions and what we can do to reduce them. Its focus is broad, encompassing technological options, behaviour change and the policy dimension. Its focus is not only on the role of technology in reducing food-related emissions but also at what changes in behaviour (in what and how we eat) can achieve. The FCRN recognises that the climate challenge needs to be seen in a broader social, ethical and environmental context and seeks to understand how actions to reduce GHG emissions might affect other areas of concern such as human food security, animal welfare, and biological diversity. The FCRN is funded by the UK's Engineering and Physical Sciences Research Council and is based at the University of Surrey.

**Sustainable Agriculture Innovation Network (SAIN), co-organiser:** The China-UK Sustainable Agriculture Innovation Network (SAIN) was established to provide a coherent framework developing and implementing the China-UK collaboration on sustainable agriculture. It supports the aims of the existing China-UK Sustainable Development Dialogue (SDD) and provides a flexible and enduring platform for long-term China-UK collaboration in this area. SAIN is supported by the UK's Department for the Environment, Food and Rural Affairs, and the Chinese Ministry of Agriculture.

**World Society for the Protection of Animals (WSPA), sponsor:** The World Society for the Protection of Animals is an international organisation which has been working to promote animal welfare for more than 25 years. Our work is concentrated in regions of the world where few, if any, measures exist to protect animals. Our work is focused on four priority animal welfare areas: Humane and sustainable agriculture, exploitation of wild animals, companion animals and responding to animals affected by disasters. WSPA's vision of humane, sustainable agriculture is for animal production which is high welfare along with delivering food security and good diets for people, ensuring livelihoods and protecting the environment.

**Agro-Environmental Protection Institute (AEPI), host:** The main purpose of the Agro-Environmental Protection Institute is to undertake research, monitoring and inspection, and information exchange into agri-environmental issues, and to foster the sustainability of Chinese agriculture. Its research focuses in particular on the following areas: ecological toxicology and environment remediation; pollution prevention, resource recycling; environmental monitoring, ecological agriculture and environment assessment.

## Appendix Three: Participant List

姓名 Name	工作单位 Affiliation	联系方式 Contact Information
Tara Garnett	Food Climate Research Network, University of Surrey	<a href="mailto:taragarnett@fcrn.org.uk">taragarnett@fcrn.org.uk</a>
Joe Millward	University of Surrey	<a href="mailto:d.millward@surrey.ac.uk">d.millward@surrey.ac.uk</a>
Donal Murphy- Bokern	consultant	<a href="mailto:donal@murphy-bokern.com">donal@murphy-bokern.com</a>
Lu Yuelai	Sustainable Agriculture Innovation Network	<a href="mailto:y.lu@uea.ac.uk">y.lu@uea.ac.uk</a>
Lisa Zhao	Suerte Int	<a href="mailto:lisazhao1122@gmail.com">lisazhao1122@gmail.com</a>
Eve Feng	Suerte Int	<a href="mailto:evefengx@gmail.com">evefengx@gmail.com</a>
Basia Romanowicz	World Society for the Protection of Animals	<a href="mailto:BasiaRomanowicz@wspa-international.org">BasiaRomanowicz@wspa-international.org</a>
Long Ruijin	Lanzhou University	<a href="mailto:longrij@lzu.edu.cn">longrij@lzu.edu.cn</a>
Ding Shijun	Zhongnan University of Economics and Laws	<a href="mailto:Dingshijun2006@yahoo.com.cn">Dingshijun2006@yahoo.com.cn</a>
Tong Yanan	Northwest Agriculture and Forest University	
Zhai Fengying	Chinese Nutrition Society	<a href="mailto:zhai@infh.ac.cn">zhai@infh.ac.cn</a>
Bo Zhaohai	China Agricultural University	<a href="mailto:Baizh1986@126.com">Baizh1986@126.com</a>
Xianhong Gu	CAAS	<a href="mailto:guxianhong@vip.sina.com">guxianhong@vip.sina.com</a>
Hao Yue	CAAS	<a href="mailto:haoyueemail@163.com">haoyueemail@163.com</a>
Peter Ben Embarek	WHO	<a href="mailto:benembarekp@wpro.who.int">benembarekp@wpro.who.int</a>
Liang Long	China Agricultural University	
Andreas Wilkes	ICRAF	<a href="mailto:a.wilkes@cgiar.org">a.wilkes@cgiar.org</a>
Li Guohua	China Agricultural University	
Mike Gooding	FAI	<a href="mailto:Mike.gooding@faifarms.co.uk">Mike.gooding@faifarms.co.uk</a>
Mel Brown	World Society for the Protection of Animals	<a href="mailto:MelissaBrown@wspa-asia.org">MelissaBrown@wspa-asia.org</a>
Ian Dacre	World Society for the Protection of Animals	
Zhang Su	Department for International Development	<a href="mailto:s-zhang@dfid.gov.uk">s-zhang@dfid.gov.uk</a>
Jennifer Holdaway	Social Sciences Research Council	<a href="mailto:holdaway@ssrc.org">holdaway@ssrc.org</a>
Derk Byvanck	Oxfam Hong Kong	<a href="mailto:derk@oxfam.org.hk">derk@oxfam.org.hk</a>
Wang Huijun	Centre for Disease Control	<a href="mailto:whj@infh.ac.cn">whj@infh.ac.cn</a>
Wang Shiping	Institute of Tibetan Plateau Research, CAS	<a href="mailto:Wangship2008@yahoo.cn">Wangship2008@yahoo.cn</a>
Jia Xiangping	CAS	<a href="mailto:jiexp.ccap@iqsnrr.ac.cn">jiexp.ccap@iqsnrr.ac.cn</a>
Yang Jun	Institute of Geographic Science	<a href="mailto:yjydy.ccap@iqsnrr.ac.cn">yjydy.ccap@iqsnrr.ac.cn</a>

	and Natural Resource Research, CAS	
Gao Shangbin	Agro-Environmental Protection Institution, MOA	<a href="mailto:gaoshb@agri.gov.cn">gaoshb@agri.gov.cn</a>
Yang Dianlin	Agro-Environmental Protection Institution, MOA	<a href="mailto:dlyang@caas.net.cn">dlyang@caas.net.cn</a>
Zhang Guilong	Agro-Environmental Protection Institution, MOA	
Liu Hongmei	Agro-Environmental Protection Institution, MOA	<a href="mailto:hmliu@caas.net.cn">hmliu@caas.net.cn</a>
Song Xiaolong	Agro-Environmental Protection Institution, MOA	<a href="mailto:xlsong@caas.net.cn">xlsong@caas.net.cn</a>
Wang Hui	Agro-Environmental Protection Institution, MOA	
Zhao Yunjie	Agro-Environmental Protection Institution, MOA	
Cai Yanming	Agro-Environmental Protection Institution, MOA	<a href="mailto:hbskyc@caas.net.cn">hbskyc@caas.net.cn</a>
Zhao Run	Agro-Environmental Protection Institution, MOA	
Shen Fengju	Agro-Environmental Protection Institution, MOA	

## Appendix Four: Agenda

<b>Monday 6th June 2011 (Reception Centre of the Chinese Academy of Agricultural Sciences)</b>		
<b>08:00-18:00</b>	<b>Registration</b>	
<b>18:00-20:00</b>	<b>Dinner (Reception Centre of the Chinese Academy of Agricultural Sciences)</b>	
<b>Tuesday 7th June 2011 (Reception Centre of the Chinese Academy of Agricultural Sciences)</b>		
<b>07:00-08:00</b>	<b>Breakfast</b>	
<b>08:00-08:30</b>	<b>Sign up</b>	
<b>08:30-08:45</b>	<b>Opening welcome</b>	Prof. Gao Shangbin
<b>08:45-09:00</b>	<b>Welcome from UK organisers</b> <ul style="list-style-type: none"> <li>Welcome</li> <li>Background to workshop</li> <li>Workshop format and structure</li> </ul>	Dr. Lu Yuelai, Tara Garnett and Basia Romanowicz
<b>09:00-09:50</b>	<b>Livestock – an overview of the issues</b> <ul style="list-style-type: none"> <li>Introduction to the Food Climate Research Network</li> <li>Why this workshop?</li> <li>Setting the scene: key issues to explore</li> <li>Workshop goals</li> </ul>	UK: Tara Garnett
<b>Morning (9:55-12:00)</b>		
<b>09:50-10:50</b>	<b>Overview of food system's contribution to greenhouse gas (GHG) emissions in the UK and China and the specific role of livestock</b> <ul style="list-style-type: none"> <li>Overview of studies estimating impacts of reducing emissions through various means</li> <li>How effective are technological approaches in achieving reductions?</li> <li>What are the trade offs between GHG mitigation and other environmental concerns</li> <li>What shifts in consumption might also be needed?</li> </ul>	<b>Speakers</b> China: Prof. Gao Shangbin  UK: Dr. Donal Murphy-Bokern
<b>10:50-11:10</b>	<b>Tea</b>	
<b>11:10-12:45</b>	<b>Discussion</b> <ul style="list-style-type: none"> <li>What are the commonalities and differences between the UK and China as regards livestock emissions, trends and systems?</li> <li>Can we agree that livestock represent a concern for the UK and China in terms of their contribution to GHG emissions and that measures need to be taken to reduce emissions associated with livestock production?</li> <li>Do we have an idea of the emissions reductions achievable through improved farm management, and an understanding of the environmental and ethical trade offs that mitigation measures might create?</li> <li>Is there an "emissions gap?" That is, in order to achieve long term and sufficient reductions in emissions, that measures to reduce the GHG intensity of meat and dairy production will need to be complemented by reductions in meat and dairy consumption among some high consuming population groups?</li> </ul>	
<b>12:45</b>	<b>Lunch</b>	

<b>Afternoon (14:00-17:00)</b>		
<b>14:00-15:00</b>	<ul style="list-style-type: none"> <li>• Overview of health, food security and the role of meat and dairy products</li> <li>• Overview of health impacts of current diets and role of meat and dairy, both positive and negative</li> <li>• Nutrition and consumption imbalances between poor and rich, rural and urban, and between regions</li> <li>• What is UK / China official advice / policy on diets?</li> <li>• Health impacts of diets low in meat and dairy: is it possible to have nutritionally balanced diets low in meat and dairy products?</li> </ul>	<b>Speakers</b> China: Prof. Zhai Fenyong, Ministry of Health and CDC UK: Prof. Joe Millward, University of Surrey
<b>15:00-15:20</b>	<b>Coffee</b>	
<b>15:20-17:00</b>	<b>Discussion</b> <ul style="list-style-type: none"> <li>• Can we agree on where the challenges lie in the food chain in the UK and China?</li> <li>• Can we identify a potential synergy between health and environmental goals both in the UK and China?</li> <li>• Can we identify different nutritional needs/issues for different population groups within China and the UK?</li> <li>• What direction do we need to go in to achieve a healthier, low GHG impact diet? What foods are important to consume?</li> <li>• What are the habits and barriers to consumption change? What are the opportunities and within which socio-economic / demographic groups? What is the role of culture in shaping diets?</li> </ul>	
<b>18:00-20:00</b>	<b>Dinner</b>	
<b>Wednesday 8th June 2011</b>		
<b>07:00-08:00</b>	<b>Breakfast</b>	
<b>08:30-09:30</b>	<b>Overview of animal welfare issues</b> <ul style="list-style-type: none"> <li>• Overview of trends in farming systems and implications for animal welfare (UK and China)</li> <li>• Are some systems better for animal welfare than others?</li> <li>• Assessment of trends in consumer attitudes to welfare</li> <li>• What is the relationship between animal welfare and environmental impacts in different farming systems?</li> </ul>	<b>Speakers</b> UK: Basia Romanowicz, World Society for the Protection of Animals China: Yue Hao Chinese Academy of Agricultural Sciences
<b>9:30-10:20</b>	<b>Discussion</b> <ul style="list-style-type: none"> <li>• What are the particular animal welfare concerns in UK and China livestock production systems</li> <li>• What have been the most effective drivers to improve animal welfare in the UK, and would they work in the Chinese context?</li> <li>• Where there are trade offs between animal welfare and GHG production efficiency what approaches can we adopt to manage them?</li> <li>• What are the characteristics of livestock farming systems that optimise animal welfare and where there could also be advantages to the environment, rural economies and animal health?</li> </ul>	
<b>10:20-10:40</b>	<b>Coffee Break</b>	

10:40-11:40	<p><b>Overview of livestock and economic development</b></p> <ul style="list-style-type: none"> <li>• What is the contribution of livestock production to the economies of the UK and China?</li> <li>• Which systems/scale are a. most dominant and b. most profitable?</li> <li>• What is the role of imports and exports?</li> <li>• Are there examples of economically viable livestock models that deliver high welfare, high standards of humane food safety and environmental efficiency?</li> <li>• What are the economic drivers influencing the growth in livestock production, and the development of particular systems of livestock production?</li> </ul>	<p><b>Speakers</b>  UK: Dr. Mike Gooding, FAI Farms Ltd  China: Dr. Jun Yang, Chinese Academy of Sciences</p>
11:40-12:40	<p><b>Discussion</b></p> <ul style="list-style-type: none"> <li>• Under a situation where the growth in livestock consumption needs to be constrained / reduced, what would the economic / livelihood impacts be and what policies would need to be put in place to manage the negative impacts?</li> </ul>	
12:40-13:30	Lunch	
<b>Afternoon (14:00-17:00) Discussion</b>		
13:30-15:00	<ul style="list-style-type: none"> <li>• Can we identify dietary patterns that can foster health, environmental, economic and welfare co-benefits? Can we define levels of meat and dairy consumption for the UK and China that are healthful and sustainable bearing in mind urban-rural and socio economic inequities and other differences?</li> <li>• Are there societal trends that are moving consumers in the UK and in China in directions that are more mindful of: <ul style="list-style-type: none"> <li>○ Health,</li> <li>○ Animal welfare and</li> <li>○ Environmental issues?</li> </ul> </li> <li>• Can we envisage alternative, more sustainable future scenarios for consumption and production?</li> <li>• What about the policy dimensions in both countries? Can we identify existing policy 'space' or opportunity for taking change forward (vis a vis consumption and production)?</li> <li>• Where are the gaps in our knowledge about: <ul style="list-style-type: none"> <li>○ The physical science (environmental and health issues)</li> <li>○ Behaviour and behaviour change</li> </ul> </li> </ul>	
15:00-15:20	Coffee	
15:20-17:00	<p><b>Next steps</b></p> <ul style="list-style-type: none"> <li>• Is there scope for developing further work in this area?</li> <li>• What are the key potential areas?</li> <li>• Who would like to collaborate in developing a proposal further work?</li> <li>• Discussion of future actions</li> </ul>	
18:00-20:00	Dinner	
<b>Thursday 9th June 2011</b>		
07:00-8:00	Breakfast	
08:30-17:00	Farm visit	
18:00-20:00	Dinner	

