ADVISORY COMMITTEE ON ANIMAL FEEDINGSTUFFS

53rd Meeting of ACAF on 2 March 2011

Scoping Paper

SUSTAINABILITY: ASPECTS OF FEED PRODUCTION AND USE

Action required

The Committee is asked to:

- **consider if it wishes to consider this area of work, and if so;**
- **agree to take forward the points for further consideration in paragraph 109; and**
- **agree the desired outcomes in this area of work in paragraph 110.**

Secretariat
February 2011

SUSTAINABILITY:
ASPECTS OF FEED PRODUCTION AND USE

Purpose

1. To provide the Committee with relevant information on sustainability and its impact on animal feed and to seek its views this area of work.

2. Sustainability is becoming an important area of consideration in Government and the animal feed sector. Agriculture has a significant impact on the environment through affects on air, soil and water quality, biodiversity and climate change and through exploitation of resources. There are various methods of improving sustainability through manipulation of feed, novel processes or management of feed production; these may have an impact on feed safety. Additionally changes in demand and centres of distribution may affect feed safety. There appears to have been no UK guidance on this issue. Therefore, it is proposed ACAF consider this subject and provide advice to the Government and industry on how feed safety may be affected and how we can manage any risks.

Detail

3. At its 22 September 2010 meeting, the Committee agreed that a scoping paper on sustainability and its impact on animal feed should be prepared. As sustainability is a fast evolving topic, information provided in this paper covers information published up to the end of December 2010. The Secretariat felt that a cut off date was required as new studies, information and guidance on the area of sustainability was being published on a regular basis. However, where deemed necessary, salient papers are included after the cut off date. The information provided is a broad snapshot of issues surrounding animal feed sustainability giving examples where possible.

4. The paper has been split into three parts: part one concerns the background to sustainability and covers the definition of sustainability, Government policy, legislation, the future, targets and the economic impacts of sustainability. Part two concerns specific issues relating to animal feed sustainability, including feed safety areas, sustainability concerns relating to feed and livestock production and options for sustainable livestock and feed management. Part three gives conclusions on the scoping paper and actions for the Committee, including suggestions for how it can pursue this issue.

PART I - BACKGROUND

What is sustainability?

5. The goal of sustainable development is to enable all people throughout the world to meet their basic needs and enjoy a better quality of life, without compromising the quality of life of future generations. Sustainable development considers the links between society, the environment, and economy (known as 'the pillars' of sustainable development) and aims to deliver benefits for these areas trying where possible to minimise the negative impacts.

6. The Government is committed to sustainable development (SD), to making the necessary decisions now to realise our vision of tackling the deficit, maximising wellbeing and to protecting our environment without negatively impacting on the ability of future generations to do the same.

7. The Food Standards Agency's remit is to protect the interests of the consumer as regards food, for now and in the future. In achieving this objective, the Agency has made a commitment to take sustainable development into account in all of its activities and policy decisions.

Government policy leads

Defra

8. Defra leads on SD across government, with the aim of enabling Government to make more sustainable policy and to reduce the impact of Government's operations and procurement. An announcement is expected shortly from Defra on the strategy going forward for achieving these aims.

9. As a first step on the operations side, in November 2010, Defra published an Action Plan for driving sustainable operations and procurement across Government, which details the Government's approach to reforming its operations and procurement. The three main objectives of the action plan are:
    - to drive the agenda on transparency in the environmental performance of government by facilitating the release of departmental and supplier data;
    - to improve the sustainability of the supply base so that government builds stronger relationships with its suppliers and manages risk cost effectively; and
    - to reform government sustainable delivery by developing new tools and solutions which deliver greater efficiency and provide a lead across government and other sectors.

10. Defra is working in partnership with the Department of Energy and Climate Change (DECC), the Department for Transport (DfT) and the Cabinet Office to take these objectives forward.

Department of Energy and Climate Change (DECC)

11. The Department of Energy and Climate Change (DECC) is responsible for all aspects of UK energy policy, and for tackling global climate change on behalf of the UK. DECC key policy areas include global climate change and energy, and a low-carbon UK.

Sustainable Development Commission

12. The Sustainable Development Commission (SDC) is the Government's independent watchdog on SD until 31 March 2011. The SDC is currently being disbanded as all the UK Administrations have announced that they will stop funding the SDC at the end of the financial year. The Government is making arrangements to ensure that the legacy of the SDC is maintained, and that the government's work on SD is open to scrutiny by both the public and Parliament.

Policy

Common Agricultural Policy

13. The Common Agricultural Policy (CAP) has identified three priority areas (see below) for action to protect and enhance the EU's rural heritage:
    - biodiversity and the preservation and development of 'natural' farming and forestry systems, and traditional agricultural landscapes;
    - water management and use; and
    - dealing with climate change.

14. The CAP ensures that its rules are compatible with environmental requirements and that CAP measures promote the development of agricultural practices preserving the environment and safeguarding the countryside. Farmers are encouraged to continue playing a positive role in the maintenance of the countryside and the environment. This is achieved by:
    - targeting aid at rural development measures promoting environmentally sustainable farming practices, like agri-environment schemes; and
    - enhancing compliance with environmental laws by sanctioning the non-respect for these laws by farmers through a reduction in support payments from the CAP.

The FSA's Approach to Sustainable Development in Policy Making

15. The Agency has an approach to sustainable development in policy making that commits the Agency to sustainable policies. Key aspects of the approach are:
    - in deciding what risk management action or policy option to take, it is important to consider the full range of potential impacts – environmental, social and economic;
    - in deciding whether the benefits of a policy justify the costs we will give greater weight to protecting the consumer in relation to food safety (FSA Scotland and NI will also give priority to nutrition reflecting their remit);
    - the Agency will take greater responsibility for any remaining negative impacts of its policy – either directly or indirectly (through working with other Government Departments and organisations); and
    - recognition of the need for greater partnership working with Government departments and others.

16. In adopting the approach, the Agency will choose the most sustainable policy option consistent with its remit. Only in exceptional circumstances will the Agency not do so. In these cases the reasons will be clearly communicated and every effort made to minimise the resulting negative impacts.

Legislation

17. DECC works to ensure that the right legislative framework is in place to meet its policy objectives namely: reducing greenhouse gas (GHG) emissions in the UK,

confirming global commitments to tackle climate change, and ensuring secure, affordable energy supplies.

18. The following acts are the main legal drivers implemented by DECC.
    - Energy Act 2008: The Energy Act updates energy legislation to reflect the availability of new technologies (such as Carbon Capture & Storage (CCS) and emerging renewable technologies), correspond with the UK's changing requirements for secure energy supply (such as offshore gas storage) and protect our environment and the tax payer as our energy market changes.
    - Climate Change Act 2008: The Climate Change Act creates a new approach to managing and responding to climate change in the UK, by setting ambitious, legally binding targets, taking powers to help meet those targets, strengthening the institutional framework, enhancing the UK's ability to adapt to the impact of climate change and establishing clear and regular accountability to the UK Parliament and to the devolved legislatures.
    - Energy Act 2010: This Act implements some of the key measures required to deliver DECC's low carbon agenda. It includes provisions on delivering a new financial incentive for carbon capture and storage, implementing mandatory social price support, and introducing a package of measures aimed at ensuring that the energy markets are working fairly for consumers and delivering secure and sustainable energy supplies.

Future & targets

19. In June 2009, the US Census Bureau published data predicting population status from the five most populous countries for 2010, 2025 and 2050, shown in Table 1 (Annex II). As the world's population increases so will the demand for cereals, meat and dairy products. In 2010, the FAO published a report on 'Climate-Smart' Agriculture. This report notes the projections of population growth and food consumption patterns and the need for increase agricultural production to meet demands by 2050. It provides a range of practices, approaches and tools aimed at increasing the resilience and productivity of agricultural production systems whilst reducing emissions. The report notes that the livestock sector has expanded rapidly and will continue to do so as the demands for meat, eggs and dairy products continue to grow. To meet demand in terms of both food security and development requirements, but at the same time minimise resource use and GHG emissions from production, the report states that developing countries need to improve their practices for productivity.

20. Examples that focus directly on animal productivity, feed and management are suggested in addition to a range of grassland management practices that can address mitigation and improve resilience. The FAO noted that the production of cereals and meat will grow to over 3 billion tonnes and to over 470 million tonnes in 2050. The total percentage of these products being consumed in developing countries will rise from 58% to 72%. (FAO, 2009).

Food matters

21. In July 2008, the Cabinet Office published 'Food Matters', which set out what the objectives of a future food strategy should be and the measures needed to achieve them. It called for better integration of food policy across Government and highlighted the economic, equity, health, safety and environmental challenges. The Government's resultant food strategy "Food 2030" was published in January 2010.

The strategy aims to encourage and assist farmers, fishermen, food businesses, local and regional government, voluntary organisations, consumers and others in doing more to contribute to a sustainable, secure and healthy food system.

22. By 2030, the strategy aims include:
    - consumers are informed, can choose and afford healthy, sustainable food. This demand is met by profitable, competitive, highly skilled and resilient farming, fishing and food businesses, supported by first class research and development.
    - food is produced, processed, and distributed, to feed a growing global population in ways which:
        - use global natural resources sustainably,
        - enable the continuing provision of the benefits and services a healthy natural environment provides,
        - promote high standards of animal health and welfare,
        - protect food safety,
        - make a significant contribution to rural communities, and
        - allow us to show global leadership on food sustainability.
    - the UK has a low carbon food system which is efficient with resources – any waste is reused, recycled or used for energy generation.

23. The strategy focuses on six main themes:
    - encourage consumers to eat healthy sustainable diets;
    - ensuring a resilient, profitable and competitive food system;
    - increasing food production sustainably;
    - reducing the food systems GHG emissions;
    - reducing, reusing and reprocessing waste; and
    - increasing the impact of skills, knowledge, research and technology.

24. The strategy recognises that food has to be produced in a sustainable way. Global economic growth, climate change and an increasing population all contribute to the impact on natural environment and subsequently on food production and vice versa. Better management of food systems including reducing food waste across the piece will play a vital role in the future health of our natural resources and ecosystems enabling a more sustainable (economically, socially and environmentally) farming and food chain. Soil erosion, eutrophication and degradation, use of clean water for food production, greenhouse gas emissions and agricultural practices contribute to costs to the environment and society. There are links between the economy and the natural environment where each provides services for and impacting on the sustainability of the other. In addition the strategy suggests that by improving productivity and competiveness in food production, increases in sustainability can be achieved, thus conserving and enhancing the natural environment. Furthermore, placing a financial value on the natural resources the food system receives from the ecosystem could lead to better management and accountability. Therefore the strategy aims to encourage UK farming and fishing to produce more and impact less on the natural resources on which food production depend.

The Future of Food and Farming

25. In January 2011, the Government Office for Science launched the report 'Foresight. The Future of Food and Farming', also known as the Beddington report. The report considers the global food system to 2050 and identifies the future challenges in demand, production, supply and environmental issues for policy makers. The report does not focus on food safety, but highlights its importance. The report included a number of conclusions regarding food security, including:
    - the critical importance of interconnected policy making;
    - a need for substantial changes throughout different elements of the food system;
    - a need to address climate change and achieve sustainability in the global food system need to be recognised as dual imperatives;
    - a need to revitalise moves to end hunger and greater priority to rural development and agriculture and incentives to the agricultural sector;
    - that policy options should not be closed off (i.e. the option of using new technologies, such as GM); and
    - that self-sufficiency should not be an option for nations to contribute to food security.

Global Food Security Programme - Research Strategy

26. The Global Food Security Programme (see www.foodsecurity.ac.uk) will coordinate research supported by the programme partners across Government departments, the Devolved Administrations, Research Councils and the Technology Strategy Board. The programme, which is about to publish a strategic plan, aims to provide evidence to enable food producers and processors, retailers, consumers and government to respond to and manage the challenges facing the UK food system and related global issues, including the many challenges confronting the developing world. It will build on the activities of the partners, aiming to add value to their investments, and complement rather than replace individual strategies. It will bring additional coherence by acting as a focus for joint activities and helping to ensure alignment of individual activities with shared goals.

27. The programme will take interdisciplinary and whole systems approaches to research on UK and global food supply systems, from both a consumer and producer perspective. The scope of the programme includes: food production and resource management; food economics, markets and trade; food processing, manufacture and distribution systems; food safety and nutrition; consumption habits and practices; and waste in the food system.

28. The programme comprises four cross-disciplinary themes based on those set out in the *UK Cross-Government Food Research and Innovation Strategy*. All themes (but especially Themes 2 and 3) will take into account the sustainability of ecosystems related to food production (including land use, biodiversity and other ecosystem services) and the overarching challenges of reducing greenhouse gas emissions and reducing losses and waste throughout the food system.

29. The research themes for the programme are:

1. *Economic resilience* – securing a better understanding of how poor economic resilience leads to hunger, poverty and environmental degradation across the globe and how this might be addressed
2. *Resource efficiency* – including water, energy, nutrients and other inputs; land use and soils with particular focus on the sustainable use of resources; improving efficiency and reducing waste
3. *Sustainable food production and supply* – including farming systems, food production from crops and animals (including fish), food processing, manufacture and transport
4. *Sustainable, healthy, safe diets* – including food safety throughout the supply chain, nutrition, consumer behaviour, food choice and accessibility.

30. Each research theme will be co-ordinated jointly by a Research Council and a government department, but will involve all relevant funders and main stakeholders, and will be coordinated with the other themes. The Food Standards Agency is jointly coordinating theme 4 with the Medical Research Council.

31. The Strategic Plan summarises the background and context for the programme, outlines how the programme is organised and managed, and describes its scope and some main objectives for the initial five-year period, 2011 – 2016. The plan will be refreshed as the programme develops over that period and beyond.

United Nations Climate Change Conference

32. Between 29 November to 10 December 2010, the United Nations hosted an international conference on Climate Change in Cancún under the United Nations Framework on Climate Change (UNFCCC) in order to consider what can be done to reduce global warming. Elements of the Cancún Agreements include:
    - industrialised country targets are officially recognised under the multilateral process and these countries are to develop low-carbon development plans and strategies and assess how best to meet them, including through market mechanisms, and to report their inventories annually.
    - developing country action plans to reduce emissions are officially recognised under the multilateral process. A registry is to be set up to record and match developing country mitigation actions to finance and technology support from by industrialised countries. Developing countries are to publish progress reports every two years.
    - parties meeting under the Kyoto Protocol agree to continue negotiations with the aim of completing their work and ensuring there is no gap between the first and second commitment periods of the treaty.
    - the Kyoto Protocols Clean Development Mechanisms has been strengthened to drive more major investments and technology into environmentally sound and sustainable emission reduction projects in the developing world.
    - parties launched a set of initiatives and institutions to protect the vulnerable from climate change and to deploy the money and technology that developing countries need to plan and build their own sustainable futures.
    - a total of $30 billion in fast start finance from industrialised countries to support climate action in the developing world up to 2012 and the intention to raise $100 billion in long-term funds by 2020 is included in the decisions.
    - in the field of climate finance, a process to design a Green Climate Fund under the Conference of the Parties, with a board with equal representation from developed and developing countries, is established.

- A new Cancún Adaptation Framework is established to allow better planning and implementation of adaptation projects in developing countries through increased financial and technical support, including a clear process for continuing work on loss and damage.
- Governments agree to boost action to curb emissions from deforestation and forest degradation in developing countries with technological and financial support.

Economics

33. Economic growth has seen disposable incomes increase for a significant share of households. As incomes increase households tend to spend more of their disposable income on food. Evidence shows that in emerging economies increasing incomes has a significant effect on meat consumption where for every additional 1% increase in disposable income, households tend to spend 2% more on animal protein (IFIF, 2008). Continued growth in emerging economies coupled with rapid population growth rates is expected to significantly increase global demand for animal products, which in turn increases derived demand for livestock inputs such as animal feed.

34. Responding to the demands of an expanding global economy and rapid population growth will put pressure on conventional livestock and food production systems. As supply is increased through more intensive methods of production to meet growing demand, managing animal feed resources and food production on a sustainable basis would become more of a challenge when balancing the trade-off between economic growth and its ecological impact.

35. Commodities markets experience high levels of volatility as a result of uncertainty of future levels of supply meeting demand. Due to demand and supply being at similar levels in the cereal market, a disruption in the level of stocks will have a significant effect on the price. In a fully functioning competitive market, higher prices should act as an effective signal for farmers to increase production of a commodity to take advantage of a higher price. This in turn would increase supply along with the derived demand for inputs such as land, water, energy and fertilizer putting pressure on the ability to manage natural resources and the environment on a sustainable basis.

36. Agricultural commodity prices are highly sensitive to severe weather and the price of oil, as it influences energy, transport, fertiliser and other input costs. The outlook for the real price of oil is that it will rise to US$75 a barrel in 2019. However, this projection could be conservative as the price of a barrel of oil, exceeded $90 by the end of 2010 (*Financial Times*, 2010). Also, wheat prices experienced significant volatility and price increases in 2010 due to an anticipated lower harvest following Russia's decision to place an embargo on wheat exports.

PART II – SUSTAINABILITY ISSUES RELATING TO ANIMAL FEED

Feed safety

37. There is some concern that, in the quest for more sustainable animal feed or where resources become limited, safety standards may be lowered or new feed safety risks may arise. For example, the Committee has noted problems regarding the presence of packaging from processing surplus human food to feed. There have also been safety issues highlighted with the use of biofuel co-products in animal feed. Below we consider various sustainability issues that are affected by animal feed production.

Sustainability concerns relating to feed and livestock production

38. Livestock production has many impacts on the environment. This section focuses on general causes of concern in livestock production that are specifically related to animal feed. Examples are provided where possible.

Air pollution

39. Greenhouse gases (GHGs) are atmospheric gases that absorb and emit heat or infrared radiation and trap heat to cause a warming effect on the atmosphere. This greenhouse effect is key to regulating earth's surface temperature. Increases in levels of these gases cause global warming; the average temperature of the earth's surface has risen by 0.6°C since the late 1800s (FAO, 2006). Each GHG has a global warming potential (GWP) which allows the calculation of carbon dioxide equivalents (CO_2e); this allows comparisons of the warming potential of each gas over a set time period relative to that of CO_2. Table 2 (Annex II) lists the main GHGs and their GWPs over 100 years. For example, one tonne of the methane (CH_4) in the atmosphere has 21 times the warming potential of one tonne of CO_2.

40. The Food and Agriculture Organisation of the United Nations (FAO) published 'Livestock's Long Shadow – environmental issues and options' in 2006. This report considered the impact of the livestock sector on various environmental issues. The report claimed that livestock production contributed an estimated 18% to total anthropogenic GHG emissions; a higher share than from transport. However, others suggest that this figure may be closer to 51% (Goodland and Anhang, 2009). Table 3 (Annex II) gives a brief outline of the report's estimates. Although not a GHG, the report also estimated that livestock also account for 64% of global emissions of ammonia (NH_3); this has implications for air and environmental pollution.

41. Comparing this to other parts of the production chain, in 2006 the FAO estimated that 56% of agricultural emissions came from crop cultivation, 42% from animal production, with transport and industrial processing of feed having a low impact. The main sources of GHG emissions from livestock production include (in no particular order):
    - CH_4 produced during enteric fermentation (the microbiological breakdown of carbohydrates in ruminants, producing CH_4);
    - CH_4 and nitrogen dioxide (NO_2) produced during the decomposition of manure;
    - CO_2 emissions from land use changes (e.g. deforestation or pasture degradation);
    - CO_2 produced from processing and refrigeration of animal products;
    - CO_2 emissions from production of crops used in livestock feed;

- CO_2 produced during transportation of animal feed and animal products; and
- CO_2 produced from feed production.

42. Defra's Food 2030 strategy considers the food system's GHG emissions. It stated that the UK food chain emitted 160 mt CO_2e in 2006, an estimated 22% of emissions associated with all UK economic activity. It also stated that primary production accounts for one third of the UK's food chain's GHG footprint; this is predominantly from CH_4 and N_2O emissions from agriculture, with a small amount associated with the fuel used by the UK's fishing fleet.

43. In 2009, WWF and the Food Climate Research Network produced the report 'How low can we go?' that considered how GHG emissions could be reduced by 70% in UK food systems by 2050 (Audsley *et al.*, 2009). The report estimated that food chain emissions (excluding land use change), contributing 20% of overall UK consumption related emissions. However, including CO_2 emissions from land use change increases the food's carbon footprint by 50% and increases the contribution of the food system to 30% of overall UK consumption related emissions. It states that meat and dairy products make an important contribution to this figure; emissions from livestock accounting for over 57% of agricultural emissions. The report states that no one measure will lead to the reductions required, but policy makers will need to put in place a combination of measures to change the way we produce and consume food.

44. Professor Chris Reynolds (University of Reading) gave a presentation on the environmental consequences of food production at ACAF's March 2010 meeting. He stated that 'depending on diet composition, 3 to 12% of the dietary energy consumed by ruminants is lost as CH_4, which can represent up to 30 MJ/d in lactating dairy cattle.' He stated that high fibre diets tended to result in higher methane emissions/kg feed consumed, and that N_2O from manure now accounts for two thirds of estimated N_2O emissions.

45. On the 21 October 2010, the FSA published a report that considered the impact of climate change on food policy in the UK. The review was carried out by the University of East Anglia on behalf of the Agency. It looked at the impact of climate change on nutrition, food safety, food & food waste and how responses to climate change may influence nutrition and food safety. One of the policy implications is that GHG emissions for different foods and processes (such as production, transport etc.) need to be monitored so that information is known on where GHG emissions arise and how these can be managed. The report also refers to reducing intakes of meats and dairy foods, replaced with products with lower GHG emissions. The findings in the report are currently being considered by the Agency.

46. In 2009 FEFAC produced an environmental report, which described Lantmännen's system for calculating GHG emissions linked to compound feed production. It calculated the average GHG value for compound feed to be between 450 – 520 g CO_2e per kg of compound feed; the highest input was from cultivation and processing, whereas transport and feed manufacturing had inputs of 9% and 7% respectively.

47. There are many sources of research on the carbon footprints of animal products. For example, Defra funded Cranfield University to evaluate the environmental burdens of

agricultural and horticultural commodity production from 2003-2005 in England and Wales (Williams *et al.*, 2006). Table 4 (Annex II) shows average emissions for various field and livestock products produced in England and Wales. The data show that meat products from ruminants have a considerably higher GWP due to CH_4 and N_2O emissions. In monogastric production, the emissions mostly arise from feed production.

Land and water pollution

48. Livestock play a significant role in land and water pollution as a result of excretion of nutrients (phosphorus or potassium), antibiotics, pesticides, heavy metals and pathogens, all of which are influenced by animal feed. However, this paper does not consider pollution from veterinary medicines or pesticides as they fall under the remit of other Scientific Advisory Committees.

49. Pollutants enter the soil and water bodies because of livestock production. According to the FAO (2006), watercourses can be contaminated directly from runoff from buildings, transport through soil or failure in drainage or storage facilities, or indirectly from overland flow or runoff from grazing areas. There are various forms of pollution; for example, eutrophication may be caused by water contamination by livestock waste. It is 'an accelerated growth of algae on higher forms of plant life caused by the enrichment of water by nutrients, especially compounds of Nitrogen (N) and / or Phosphorus (P), and inducing an undesirable disturbance to the balance of organisms present in the water and to the quality of the water concerned' (European Commission / WHO, 2002). It leads to an increase in toxins in certain algae and poses a risk to consumers as eutrophic water requires treatment for producing drinking water (FAO, 2006). Table 5 (Annex II) details percentages of water pollution attributable from livestock production. Table 4 (Annex II) also details the eutrophication potential of various animal products. The affects of eutrophication on biodiversity is considered in paragraph 63.

50. In his presentation to ACAF's March 2010 meeting, Professor Reynolds stated that N and P utilisation for ruminants is typically low, averaging about 25% for N utilisation in lactating dairy cows and 40% for P. He noted that '50% of agriculture's emissions of P are attributable to animal manures'. He informed the Committee that N and P have typically been overfed to livestock in the past in order to increase uptake of these elements, but the industry was coming under increasing pressure to reduce the levels of these nutrients in livestock diets.

51. The Soil Association produced a report on the use of P and threat to food security in 2009. The report stated that Europe has no deposits of rock phosphate (PO_4^{3-}) and there are threats to the security of current supplies. In 2007/8 the commodity price of phosphate (PO_4^{3-}) increased by 800% due to increase in oil prices, demand for fertiliser, increased demand for meat and dairy and short-term supply issues. The Soil Association stated that UK prices were approximately £310-320 per tonne in 2009, but were predicted to increase. The use of P has other environmental impacts due to the presence of naturally occurring radioactive elements and heavy metals in the product and the GHG footprint of mining.

52. Heavy metals, such as copper (Cu), zinc (Zn), selenium (Se), cobalt (Co), iron (Fe) and manganese (Mn), may be present at low concentrations in animal feed. As a

result, these elements will enter the environment from livestock waste. Bioavailability of inorganic forms of these elements in feed are often low, whereas organic forms are more bioavailable and therefore better for the environment in terms of pollution and the amount required. EFSA evaluates the environmental impact of feed additives (including trace elements) during assessment for authorisation.

Water stress

53. In 2006, the FAO estimated that the livestock sector accounts for more than 8% of global human water use, with 7% of this relating to feed production. Table 6 (annex II) shows drinking water requirements of various livestock. The requirement will be affected by other factors, including breed, health status and genetics. The FAO states that feed production makes a significant contribution to water use through crop irrigation for animal feed and subsequent loss of water through evapotranspiration of plants. It estimates that water evapotranspired during feed production represents 15% of water depleted each year. The amount of water used to raise livestock can represent a significant proportion of water use in some water stressed areas and will be exacerbated in future with changes in rainfall patterns caused by climate change. Water stress is a particular problem in the South East of England; in 2007 the Environment Agency identified most of the South East as seriously water stressed. Significant efforts are being made to reduce water use; for example, in a farmer water survey undertaken in 2009, DairyCo found that 40% of respondents stated an intention to make changes to improve management of clean water in the next year. Under the LINK programme, Defra is funding research on sustainable sources of water for livestock. For example, research has been carried out on development of productive and persistent high quality forage grasses and white clover with increased water-use-efficiency and resilience to summer droughts.

Land use change

54. The effects of land use and land use change (LULUC) have a significant effect on the sustainability of livestock feed production. Land use change includes land cover change as well as changing ways the land is managed (FAO, 2006). The FAO's report 'Livestock's Long Shadow' estimated that 33% of arable land is dedicated to feedcrop production and 70% of agricultural land is dedicated to livestock production. Livestock production is a significant driver for deforestation, particularly in South America where demand for soya and its high commodity value has driven significant land use change. Between 1993 and 2004, it was estimated that the area of land used to grow soya doubled to 39 million ha (FAO, 2006). In 2010, the FoE estimated that current soya production amounted to 250 mt per year and is expected to rise to 300 mt/year in 2020. Soya oil is in particular demand in America and China for cooking oil and increasingly, for biodiesel production. FoE estimates that soy oil based biodiesel production accounts for 15% of EU biodiesel production, but is as high as 40% in the UK.

55. FAO estimate that 70% of the Amazon forest has been changed to pasture, with feedcrops covering a large part of the rest and the main areas of concern for land degradation are in Africa, Asia and Latin America. According to the FAO (2006), grazing occupies vast areas of land and is shifting towards urban areas in order to get closer to consumers or sources of feed (either ports or feedcrop areas). However, improvements in efficiency of production mean less land used, but increase input and waste and concentrated areas of pollution.

Energy use

56. There is a clear drive for feed producers to reduce costs by reducing energy use. Feed manufacture requires energy for various processes such as weighing, grinding, mixing, steam treatment, conditioning, pressing, extrusion, pelleting, cooling and coating. In 2010, the Carbon Trust estimated that UK animal feed mills use 2 terawatt hours energy per annum and account for 620,000 tonnes CO_2 emissions annually. It also estimated that an average mill spends £750,000 a year on energy, typically costing £3 energy per tonne of product. The energy consumption for feed production varies considerably, but averages around 85 KWh per tonne feed produced.

57. In 2002, UKASTA (now the Agricultural Industries Confederation (AIC)) produced a guide providing methods and action plans for feed mills to reduce their energy consumption. Over the last 10 years there have been energy savings and CO_2 savings of 12% in UK feed mills, but there is still scope for improvement (FEFAC, 2009). Over 95% of the feed mill industry is now signed up to a Climate Change Agreement led by AIC.

58. Improvements in energy use must be balanced with safety requirements, nutrient availability and environmental benefits. For example, various processing methods can improve digestibility, palatability and handling of the feed and reduce waste and separation of ingredients. Additionally, heat treatment of animal feeds is used to reduce or eliminate pathogens such as *Salmonella*. Manufacturers appear keen to reduce energy costs by using alternatives, such as the antimicrobials as an alternative to steam treatment, but caution must be applied to ensure that feed safety is not compromised.

Biodiversity

59. Biodiversity describes the diversity of all life on the planet. There are three aspects: genetic, species and ecosystem diversity. Genetic (or intra-species biodiversity) is the amount of variety within a species; the genetic variation between individuals in a population or between populations of the same species. Species or inter-species biodiversity concerns the number of species on earth and their distribution. Ecosystem diversity regards the number of living species within a certain environment; this can be classed by biological, geographic or climate characteristics (such as topography, vegetation cover or structure) and can be of any scale (from a pond to an entire forest) (FAO, 2006).

60. According to Defra, the value of ecosystems is largely hidden and often not valued in decision-making, making them vulnerable to loss and degradation. Defra has produced a Natural Environment Narrative in 2010, providing the arguments for protecting the environment. It is important to protect biodiversity as the natural environment:
    - provides resources and raw materials (e.g. air, water, food, minerals for building and industrial processes and timber and fibre for building);
    - provides services to support society (e.g. flood management, storing carbon in peat soils);
    - offers personal health benefits: society's health and well-being is enhanced by the natural environment; and
    - offers economic benefits (e.g. ecotourism and recreation).

61. According to the FAO (2006), the most important drivers of biodiversity loss and ecosystem change are habitat change (land use change), climate change, invasive alien species, and overexploitation. Biodiversity loss is caused by a combination of processes, but feed production impacts on all of these drivers and so we consider these drivers below.

Habitat change

62. Livestock and the production of animal feed can have a large impact on the destruction, fragmentation and degradation of ecosystems. The intensification of farming through mechanisation, agro-chemical use and technological developments has caused habitat change and biodiversity loss in some areas (FAO, 2006). Habitat destruction is resulting in increased habitat fragmentation, where ecosystems become isolated in landscapes to form 'islands'. The further apart the islands become, the more difficult it is for populations to move between them, reducing intra- and inter-species mixture. This threatens species and population diversity and puts populations at risk from extreme events.

Invasive alien species

63. According to the FAO, the introduction of alien species to ecosystems may affect native species by providing competition for resources, introducing new diseases, or by destroying and degrading their ecosystem. The growth and distribution of animal feeds in non-native environments has been associated with distribution of alien plants (FAO, 2006).

Over exploitation of resources

64. Over exploitation relates to unsustainable use of resources for food, medicine, fuel, material use, cultural, scientific or leisure activities (FAO, 2006). According to the FAO, there are three causes of overexploitation from livestock production; competition with wildlife, reduction of living resources, and erosion of livestock diversity through focus on a small number of profitable breeds. Competition with wildlife can also lead to degradation of ecosystems or loss of populations or species if competing for specific resources.

65. One example of over exploitation is the extensive growth of soya in Latin America in response to increasing global demand for soybeans, and associated reduction of soil fertility. It is estimated that soya cropping extracted one million tonnes of N and 227,000 tonnes of P, which would cost $910 million to replace with fertilisers (FAO, 2006). There also any many other consequences, including deforestation and loss of biodiversity.

66. Another example is the use of fishmeal in animal feed. Fishmeal is an important source of protein for non-ruminants and aquaculture in the EU, which has raised the demand for fishmeal. In 2006, the FAO estimated that 52% of the world's fish stocks are fully exploited, with 19% over exploited and 7% depleted. In cases where species are fully or over exploited, this has lead to changes in their ecosystem. Seafish produced an annual review of feed grade fish stocks used to produce fishmeal and fish oil in September 2010; it estimated that 38% of fishmeal consumed in the UK is manufactured from food grade trimmings. Table 7 (Annex II) shows the fishmeal consumption levels of various livestock industries in 2008 and Table 8 (Annex II)

refers to fishmeal use in various livestock industries. The Seafish report states that fishmeal stocks in the UK are all sourced from fisheries subject to Government controls to conserve stocks and prevent over-fishing. Regular independent monitoring is carried out on the status of stocks and all stocks are subject to annual catch limits, which are set by Governments on a yearly basis. Additionally, there are number of certification and labelling schemes under development by several organisations to allow producers to demonstrate that they are offering fish from sustainable fisheries.

Climate change

67. Climate change is known to affect biodiversity in three ways: change in the mean climate, change in incidence or severity of extreme events, and changes in climate variability (FAO, 2006). At ACAF's 22 September 2010 meeting, Professor Tim Wheeler (DFID / University of Reading) gave a presentation on the effects of climate change on animal feed. He stated that some climate projections show a poleward shift in the geographic range that crops can be grown; it follows that the geographical range of livestock production may change too, which may mean a change in the carbon footprint of producing animal feed. For example, it may be possible to grow protein sources like soya more efficiently in Europe, reducing the need for imports from Latin America. Another point to consider is if more feed is sourced from within the EU, this may improve feed safety and reduce levels of non-compliance with EU legislation. On the other hand, it is thought that, in some areas, climate change may reduce productivity and make production more erratic (Stern, 2006).

68. Poleward shifts in the geographic ranges of crops and an expansion in production may mean that feed and livestock production moves into currently untouched areas and alien species are introduced into ecosystems. This may increase ecosystem fragmentation and may lead to a loss of diversity in some ecosystems.

Pollution

69. Pollution of the environment from livestock production can have drastic affects on biodiversity; it can directly affect species (e.g. by poisoning them), or can damage their habitats (FAO, 2006). Manure and fertilisers used in feed production can cause a nutrient excess of chemicals or contaminants in soils or watercourses. Excess levels of these chemicals in an ecosystem may result in a growth of one or more populations at the expense of others, or may result in the collapse of a species. In water, algal blooms caused by eutrophication are associated with mass mortality of fish and other aquatic life resulting in 'dead zones' of animal life, massively changing the ecology of an ecosystem and leading to a loss of biodiversity. Algal blooms may also include toxin-producing species, which can accumulate in shellfish, potentially resulting in a risk to other marine species and the consumer (FAO, 2006). The FAO also suggests that livestock may also have an effect on soil biodiversity through soil pollution.

Options for sustainable livestock and feed management

70. This section explores the ways that feed production can influence the sustainability of livestock production, such as reductions in carbon footprints and energy requirements.

Feed material use

71. There may be scope in the use of alternative home grown feed materials as protein sources for livestock. According to FEFAC (2008), the EU currently imports 77% of protein rich feed materials. FEFAC estimates that increased production and sourcing

of home grown or EU produced feed materials, could reduce to 64% or lower (dependent on whether non-ruminant processed animal protein (PAP) becomes available for feed use in the EU). European soybean meal trades at £300-330 per tonne (at the time of writing), but it is not grown successfully in the UK and there are limited amounts grown in the EU (mostly in Italy, France and Eastern Europe) (Soil Association, 2010). Ensus (2010) has shown that wheat DDGS from biofuel production offers a sustainable alternative to high protein imports, and several studies have shown that DDGS can be used in livestock diets with significant environmental benefit (Archibeque *et al*., 2008; Bonoma *et al.*, 2008; Ensus, 2010; Loar *et al*., 2010; Schroeder, 2010; Stein, 2009; Widmer *et al*., 2008 and Youssef *et al*., 2008). Additionally, production of animal feed can offset the land requirements of biofuel feedstock produced (Ensus, 2010). If wheat DDGS produced from biofuel production offsets soya in animal feed, this may result in avoidance of land use change and reductions in GHG emissions from biofuel production. Initial estimates suggest a single ethanol refining plant processing 1 mt wheat will product 330 kt DDGS, substituting 136 kt soya and avoiding deforestation of 47,000 ha of land (Weightman *et al.*, 2010). Lywood et al (2009) estimate that each tonne of wheat DDGS has the potential to replace 0.59 tonnes of soy meal and 0.39 tonnes of cereal in EU animal feed. It is also estimated that wheat DDGS from biofuel production can contribute land area reductions for cereal production; estimates are equal to 6% of gross land area used for wheat feedstock production (Lywood *et al*., 2009).

72. Alternatively, novel sources of protein could be utilised by monogastrics, such as potato protein, palm kernel, *Polychaeta* (marine worms), rapeseed meal or pulse crops bred to contain higher levels of essential amino acids (Soil Association, 2010). There are Defra sponsored industry-led LINK projects that are investigating alternative diets for pigs and poultry (Defra, 2010). There is also increasing interest in the production of biofuels from micro-algae and co-products from this could be used as a high protein feed for livestock. However, it remains to be seen how sustainable these solutions are as alternate sources of protein to the feed sector; any substitute will inevitably entail their own sustainability costs. In 2009, the Technology Strategy Board launched the Sustainable Agriculture and Food Research Platform; they currently have a research call on crop protection, but intend to issue a research call on sustainable livestock production, including protein sources, in the near future.

73. With the possibility of changes in the geographic range that crops can be grown and changes in centres of distribution due to climate change, it is possible that the sustainability of various feed types will change. On the other hand, productivity and production may become more erratic. Inevitably increased demands for commodities is likely to mean that the feed sector will have to manage demand with ever limited resources. The Soil Association report on Sustainable Animal Feed (2010) suggests that improvements in UK livestock production may be met by encouraging farmers to use UK and EU sourced feed materials, moving away from soya and introducing recommendations on sustainable feed sourcing. There appears to be a need to consider the barriers and incentives for UK farmers to indicate whether this is a feasible option.

74. **The Committee could consider how increased demand with ever limited resources, and changes to the geographical centres of animal feed will affect feed safety.**

75. The feed industry is a primary user of co-products from other industries. FEFAC (2009) states that animal feed makes effective use of by-products from the starch, sugar, milling, dairy, brewery, distillery and juices industries and surplus food (e.g. out of date or misshaped produce). These are processed and returned to the feed chain. Examples of by-products include DDGS from whisky production, molasses from sugar production or whey from cheese production, or oilseed meals from oil production. In 2009, FEFAC estimated that 70 mt of by-products are diverted for feed use from the processing of grain, oilseeds, sugar beet, potatoes, meat and milk, which equates to about 45% of a pig or poultry diet. Benefits include lower food production costs, lower feed demand and lower prices for animal products (FEFAC, 2009).

76. The use of co-products also removed the need for disposing of them in other ways (e.g. landfill). Efficiency in food and feed production can be achieved by reducing waste during production. Some waste is unavoidable, but may be improved if more co-products from the food industry were diverted into animal feed. However, there may be some public concern regarding the acceptability of using co-products in animal feed.

77. **The Committee may wish to consider the sustainability benefits and safety implications of the use of co-products from other industries in animal feed.**

Energy use

78. Energy reductions offer feed business operators significant improvements in financial margins as well as environmental benefits. There may be various methods of doing this, although FEFAC believes that opportunities for energy savings during feed production are limited, there may be savings possible in operation and logistics. There are various schemes in place for improving energy efficiency in feed mills; for example TECALIMAN has delivered an average energy reduction of 20% in feed plants over 20 years (from 73 to just over 61 kWh per tonne feed produced) (FEFAC, 2009).

79. The Carbon Trust has recently updated this with an industrial energy efficiency accelerator that provides energy efficiency measures in animal feed production. The guide suggests energy savings can be achieved by improvements in process control (e.g. energy management, moisture control, production scheduling), product strategy (e.g. energy efficient formulations, low energy products by using larger pellets) or by the use of innovative equipment (e.g. energy efficient presses, or biomass heating). The Carbon Trust estimates that, if the above suggestions are implemented, it could save up to 15% of energy and CO_2 emissions per annum.

Nutrient management

80. In 2010, the Soil Association produced a report on the use of P and food security; the report suggests that improved management of nutrients will enable more efficient production. The report provides guidelines on how to reduce nutrient loss by managing the use of manure or slurry as a fertiliser or using alternative fertilisers, such as manure and slurry. Defra has also published guidance on their management and use as fertilisers (Defra, 2010). Alternatively, availability of P in soil can be improved by encouraging soil micro-organisms to turn organic phosphates to available inorganic forms, by using crops with high phosphorus uptake efficiency or by managing crop rotations effectively.

Livestock type

81. There appears to have been a move from ruminant production, to the production of monogastric species over the last 50 years (FAO, 2006). Friends of the Earth (2008) identified poultry as the fastest growing sector worldwide. According to the Soil Association (2010), high-protein diets allow birds to grow faster; most non-organic chickens reach their desired selling weight by 40 days. Although ruminants emit high levels of GHGs from ruminal digestion, non-ruminants consume higher levels of high protein imports.

Husbandry method

82. Some research suggests that husbandry methods may affect the carbon footprint of animal production. For example, Xin *et al.* (2010) published an article discussing environmental impacts and sustainability of egg production systems, suggesting various methods to reduce NH_3 production for example. There are also suggestions that dairy grazing systems have higher levels of GHG emissions compared to mixed systems; grassland systems contribute an average 2.72 kg CO_2e/kg milk, compared to mixed systems producing an average of 1.78 kg/CO_2e/kg milk (FAO, 2010). Other examples include the development of low-N wheat varieties, the use of high-sugar grasses to improve N utilisation by grazing livestock, thereby reducing N excretion and N_2O production, and the use of high tannin forages to reduce methane production.

Livestock productivity

83. A well known method to reduce the carbon footprint of food production is to improve feed conversion rates (FCR). FCR is the quantity of feed (in kilograms) required to produce one kg of animal product; the lower the figure, the better the conversion rate. It is dependent on other factors, such as breed, genetics and health status. There has been a dramatic improvement in FCR in the last 50 years due to improvements in diet formulation, breeding and health status. Table 9 in Annex II shows average FCRs for various meats.

84. Improving the FCR for production will invariably further improve the sustainability of production. There are various ways to improve the FCR or improve productivity shown below, but any improvements in production efficiency must ensure no adverse affects on animal welfare.
    - Increase the lifespan or production span of an animal;
    - improve health status (ensure all energy in the animal is used on meat/milk/egg production rather than repair or immune functions);
    - increase animal production levels; or
    - reduce the amount of feed required to produce 1kg product.

    (FEFAC, 2009).

85. It is difficult to tell how much it is possible to improve the productivity of animals or if this has reached a plateau. However, it is possible that breeding techniques may develop new breeds that are able to produce food more efficiently or animals that live or produce for longer. Improving health status is one way of insuring productivity, but also ensuring feed is free from contaminants will help an animal to ensure that energy is diverted to meat, milk or egg production, rather than used in maintaining the immune system. The use of additives (e.g. mycotoxin decontaminants, enzymes or

probiotics) may assist with improving health status or improving the digestibility of feed materials. Changes in management practices have also been shown to have the potential for reducing emissions; Garnsworthy (2004) showed that restoring dairy cow fertility to 1995 levels could reduce CH_4 and NH_3 emissions by dairy cows by 11% and 9%, respectively. There are various methods to improve the FCR by manipulating feed formulations, which are considered below.

Raw material selection and diet formulations

86. A key element of reducing the carbon footprint of animal feed is to reduce CH_4 production and N excretion in ruminants. According to Johnson *et al.* (1995), factors that influence CH_4 emissions include the level of feed intake, the nature of the carbohydrate, feed processing, addition of lipids or ionophores in feed, and the ruminal microflora. There has been significant research carried out to demonstrate various methods to mitigating CH_4 production in ruminants, for example by in/excluding a certain type of feed material, including feed additives (see below), or certain processing techniques. Reference has been made (paragraph 45) to the relatively low level of N utilisation, particularly by ruminants. The choice of feed materials used in diet formulations can also have an impact on N utilisation and excretion.

Feed additives

87. The use of certain feed additives can provide an effective way of improving digestibility, reducing pollution, prolonging or preserving feedingstuffs (and reducing waste), thereby reducing the carbon footprint of animal products. Table 10 (annex II) details potential sustainability benefits that can be achieved from the use of additive groups as set under EU Regulation 1831/2003.

88. According to *Feed Compounder*, July 2010, chemical additives and probiotics have shown potential applications for reducing methane production. A number of substances show antimethanogenic qualities (e.g. chloroform, bromoethanesulphonic acid (BES) and monensin), although none of these are authorised for this use in the EU. A number of plant extracts commonly used as flavourings in the EU (e.g. ginger and garlic) have been examined for their potential to reduce CH_4 production. An *in vitro* study by Bodas *et al.* in 2008 evaluated plant extracts for antimethanogenic properties in ruminant feeds; 35 plant extracts reduced CH_4 production by more than 15% and 6 extracts showed more than 25% reductions. However, probiotics and live microorganisms have yet to show demonstrable or consistent antimethanogenic properties (*Feed Compounder*, July 2010). Defra has funded work on dietary and nutritional reduction of CH_4 in ruminants, including the use of feed additives (Defra, 2010). Whilst the projects have shown promising results, Defra has concluded that the use of feed additives in extensive ruminant systems presents practical difficulties and are not economically viable (personal communication, Defra).

89. The use of additives can also lead to reduction in pollution. Farmers can consider reducing levels of phosphate, protein and trace elements by reassessing and monitoring the diets of their livestock. This may avoid dietary excess which may be excreted and pollute land or water. For example, the use of synthetic amino acids in non-ruminant diets allows lower N diets to be fed, resulting in lower N excretion and N_2O and NH_4 production. The use of exogenous phytase enzymes allows diets to be formulated with lower total P contents, resulting in lower levels of P excretion.

FEFAC's environmental report (2010) describes an agreement on the limitation of amounts of nitrogen and phosphorus in feed system in a region in Belgium. Compound feed manufacturers have committed to limit protein and phosphorus in pig and poultry feed, resulting in a 20% reduction in phosphorus and 5% decrease in nitrogen emissions. The FAO stated in 2010 that most of the N added to feed is eventually lost to the environment. There appear to be options to improve N efficiency, by managing crop fertilisation, animal feeding and waste management. Not only does increased management of feed additives reduce pollution, it will help preserve the limited stocks of elements and nutrients available and reduce the energy and carbon footprint of the feed. However, the public response to increased use of feed additives should be considered, as additives are viewed negatively by some members of the public.

90. **The Committee could consider safety implications of management and use of feed additives to improve sustainability.**

Contaminants

91. Consideration should be given to the environmental benefits that result from the control of contaminants in animal feed. A requirement of Directive 2002/32 on undesirable substances in animal feed is that feedingstuffs must not represent any danger to the environment. The maximum permitted levels set in Directive 2002/32 manage the presence of a number of contaminants, such as persistent organic pollutants (POPs) or heavy metals in the environment. The management of these contaminants in crops and animal feed therefore offers environmental benefits.

92. The decontamination of feedstuffs may offer environmental benefits. EU Directive 2002/32 states it is impossible to fully eliminate undesirable substances, but it is possible to reduce their content and therefore reduce their toxicity, bio-accumulation and degradability by decontamination. In the December SCoFCAH (animal nutrition section) meeting, Member States voted on a document to provide acceptability criteria for detoxification processes in order to standardise requirements across the EU. According to the proposal, detoxification or decontamination of feed can be performed by a physical, chemical or (micro-) biological process, but does not apply to a physical process where contamination is removed by cleaning, sorting or mechanical removal. It also requires that the criteria do not endanger animal and public health or the environment. Examples include chemical decontamination of aflatoxin B1 in groundnuts or physical removal of dioxins from fish via refining or distillation. However, there appears to be no quantitative information on energy or carbon savings associated with decontamination as yet. This may become possible when a tool for assessing the carbon footprints of feed becomes available (see paragraphs 94 - 96). However, any environmental benefits would need to outweigh added expenditure of energy, water or other resources.

Genetic modification

93. GM crops now occupy more than 9% of the world's arable land (FSA, 2010). Table 11 (Annex II) demonstrates the quantities of GM soya, maize, cotton and oilseed rape grown worldwide in 2009 as a proportion of the total harvests. GM varieties authorised in line with Regulation 1829/2003 undergo rigorous environmental assessment by EFSA to confirm safety before authorisation for food or feed use. However, there are differing opinions on whether GM offers sustainability benefits.

There are many detailed arguments on the sustainability effects of GM crops and each GM product will have its own risks or benefits. The paragraphs below provide a very brief overview of the claimed detriments and benefits relating to sustainability issues.

94. Several organisations claim that GM crops may pose a threat to the environment; for example, there are claims that GM crops may lead to a loss of farmland biodiversity, increased herbicide residues in food and animal feed and water courses, spread of herbicide tolerance, and a spread of GM crops as weeds in non-GM crops (FoE, 2004).

95. On the other hand, some organisations claim that GM varieties offer environmental benefits such as reduced soil erosion, reduced use of herbicides and insecticides, reduced CO_2 emissions, improved water quality and water conservation and improved biodiversity (US Soybean Board, 2010; CTIC, 2010).

96. The 'Future of Food and Farming' report by the Government Office for Science also considered the use of new technologies and suggested that it may have a role to play in the future and it is difficult to justify not using new technologies. However, evidence shows that no single approach is capable of delivering sustainable, resilient high levels of productivity and value.

Assessing carbon footprints of feed

97. There is an increasing shift towards assessing carbon footprints of animal feed. This area of work is under the remit of Defra and the Carbon Trust; both have co-sponsored the development of a Publicly Available Specification (PAS 2050) by the British Standards Institute; this allows the development of methods to reduce the GHG emissions of products and services. PAS 2050 is applicable across a wide range of industry sectors and products. The central focus of the project is food products, due to the way food is produced.

98. Ultimately the goal to calculating carbon footprints for animal feed is to produce a consistent and comparable model, whatever the source of the feed (Blonk *et al.*, 2009). Given that additives or feed materials are produced from various manufacturing methods and sources this is likely to be complex, and such calculations must also account for potential carbon savings to allow a comparison of various formulations.

99. The Product Board Animal Feed is developing a tool for assessing carbon footprints of animal feeds (Blonk *et al.*, 2009). The work is being undertaken in three stages: scoping of available information and design of the tool, development, testing and distribution of the tool and finally maintenance and further development. The first stage was finished in 2009 and a report 'Towards a tool for assessing carbon footprints of animal feed' was published. The report scoped the current methods of carbon footprints and data, parallel initiatives in other industries, possible methods of comparing footprints of different feeds, and the requirements, implementation and maintenance that would be required for the calculation tool. The report concluded that 'there are no obstacles to develop a carbon footprint assessment tool for animal feed', however the report recommended:
    - further development of the carbon footprint effects of feed additives;

- development of a database of background data on feed materials with the support of suppliers of feed materials;
- improved data and calculation models on conversion of feed into outputs (e.g. animal products, CH_4 emissions, urine and faeces); and
- that the database be developed by a consortium of international organisations.

Industry specific schemes

100. In order to assist dairy farmers to reduce the environmental impact of their sector the Environment Agency in liaison with the National Farmers Union, the Royal Association of British Dairy Farmers, the Milk Development Council and Dairy UK has produced guidance entitled 'Environmental Plan for Dairy Farming'. This encourages farmers to use tools and existing schemes to improve their environmental performance.

101. Another initiative that has been piloted by Defra and industry partners are ten roadmaps aimed at improving the sustainability of product groups, including food. The milk roadmap was published in May 2008 and provides guidance on reducing the environmental impacts of milk production. The roadmap noted various opportunities to reduce GHG emissions, through, for example:

- reducing CH_4 emissions per litre of milk produced;
- increasing milk yields;
- improving feed conversion efficiencies;
- reduction of high fibre forage in diets (increases methane production);
- increased use of anaerobic digestion (AD) to produced biogas and reduce methane production from manure and slurry; and
- nutrient planning to reduce nitrogen wastage and emissions of methane and nitrous oxide.

102. EBLEX, the organisation for the English Beef and Sheep Industry has produced a sustainability roadmap on English Beef and Sheep Production. Phase 1 of the roadmap was published in November 2010 and considered GHG emissions and energy use in the sector. The strategy provided in the paper aims to deliver reductions of 18% on 2008 levels of 610 million tonnes CO_2e per year by 2020. EBLEX states this is achievable by improving production efficiency in breeding, feeding and management.

103. Phase 2 of the EBLEX roadmap was published in December 2010 and considered water usage footprints, contribution to the landscape and biodiversity and energy and waste management of beef and sheep production. For example, the report found that there was a 50p/kg improvement in financial margin for beef producers per 5kg CO_2eq reduction/kg, and 28p/kg improvement in financial margin for sheep producers per 1kg CO_2eq reduction. This demonstrates that there are both financial and environmental benefits associated with reducing carbon footprints in ruminant production.

104. BPEX, the organisation for the English pig industry, will also be publishing a roadmap for the pig meat industry in the near future.

105. The Pet Food Manufacturers Association (PFMA) represents 90% of UK pet food manufacturers. In 2010 it released an environmental ambition setting goals to

reduce the environmental impact of pet food and help tackle climate change. The PFMA is working with the Waste & Resources Action Programme (WRAP) to work towards the following targets:

- maximise use of surplus foodstuffs;
- achieve a 10% reduction in CO_2 emissions by 2020;
- send no food waste or recyclable packaging material to landfill by 2015;
- have all recyclable packaging by 2020;
- encourage owners to recycle their packaging; and
- reduce water use by 20% by 2020.

Industry uptake of schemes

106. There appears to be little to no data on industry uptake of the various sustainability schemes; this makes it difficult to measure how successful current initiatives are, what improvements can be made, and where efforts should be focused. Industry could focus on providing these measures in order that Advisory Committees and Government Departments can advise where improvements can be made and efforts should be focused.

Part III – CONCLUSIONS AND ACTION

108. Conclusions

- The issue of sustainability in animal feed is a far-reaching topic. We have only touched on some of the issues in this paper.
- There is no one simple solution to ensure sustainability of feed and food production; a multifaceted approach is required to achieve this.
- There appears to be substantial benefits for the livestock and food industry and consumers to make the sector more sustainable. Benefits may include improved financial gains, reduced costs, reduced pollution, improved biodiversity, improved food security, improved feed safety and possible social benefits such as green jobs and improved wellbeing.
- The UK feed sector has already made significant moves towards improving the sustainability of feed production. However, there appears to be no measure of industry uptake of various sustainability schemes. The feed industry could provide this.
- A number of the topics discussed are under the responsibility of other Scientific Advisory Committees and / or Government Departments. It is important that ACAF does not duplicate work carried out by other bodies.
- ACAF must stay within its remit on this subject and focus on the implications of improving the sustainability of animal feeds on feed safety.
- It would be useful for the Committee to consider this area of work, in liaison as necessary with other SACs.

Action

Points for Further Consideration

109. **The Committee could consider the feed safety implications of the options for sustainable livestock and feed management, focusing on one or more of the below issues:**
   - the use of co-products from other industries in animal feed;
   - management and use of feed additives; or
   - increased demand with ever limited resources and changes to the geographical centres of animal feed production.

110. The aim would be to produce guidance in the format of a position paper to advise the Government and industry on the safety risks and how these could be managed.

The Committee is asked to:

- consider if it wishes to consider this area of work, and if so;
- agree to take forward one or more of the points for further consideration in paragraph 109; and
- agree the desired outcome of this work given in paragraph 110.

ANNEX I - Glossary

Word/s		Definition
Biodiversity		The diversity of genetics, species and ecosystems of life on the planet.
Carbon dioxide equivalent (CO_2e) / Carbon footprint		The amount of CO_2 emissions that would cause the same warming influence over 100 years as an amount of GHG or a mixture of GHGs. It is obtained by multiplying the emission of a GHG by its GWP. Allows a standard to compare emissions of different GHGs, but does not imply the same climate change responses by the GHGs. (FAO, 2010)
Climate change		A long-term change to weather, either in average conditions or the occurrence of extreme weather events.
DECC		Department for Energy and Climate Change.
DDGS		Dried Distillers Grains Soluble
Deforestation		Destruction of forest or trees on a massive scale and land use change into non-forest use, often resulting in damage to land quality.
DEFRA		Department for the Environment, Food and Rural Affairs.
Ecosystem		An area of any size consisting of all living organisms, the climate and the landscape.
Eutrophication		An accelerated growth of algae on higher forms of plant life caused by the enrichment of water by nutrients, especially compounds of nitrogen and/or phosphorus and inducing an undesirable disturbance to the balance of organisms present in the water and to the quality of the water concerned. (European Commission/ FAO, 2002)
FAO		The Food and Agriculture Organisation of the United Nations.
Feed conversion ratio (FCR)		The quantity of feed required to produce one kilogram of animal produce.
FEFAC		European Feed Manufacturers' Federation
Global Warming Potential (GWP_{100})		A multiplication factor for GHGs to allow the calculation of CO_2e. Allows comparisons of various GHGs emissions over a set period of time to allow a combined warming effect to be calculated.
Greenhouse gas (GHG)		Atmospheric gas that absorbs and emits heat or infrared radiation and traps heat to cause a warming effect on the atmosphere.
Habitat fragmentation		The breaking up of a continuous habitat, ecosystem or land-use type into smaller fragments, which is considered to be one of several spatial processes in land transformation. (FAO, 2010).
Invasive alien species		A species that becomes established in natural or semi-natural ecosystems and threatens native biological diversity. (IUCN, 2000)
PFMA		Pet Food Manufacturers' Association
Persistent organic pollutant (POP)		Organic compounds which accumulate in the fatty tissues of organism and bioaccumulate in food chains where they can pose a risk to animal and human health and the environment. They are toxic, not readily biodegradable and can survive in the environment, and be transported by air and water currents. (Environmental Agency, 2010).

Annex II – Tables

Table 1: Top 5 Countries and Areas ranked by population: 2010, 2025 and 2050 Data from International Data Base – Country Rankings – US Census Bureau

Rank	Country or area	Population		
		2010	2025	2050
1	China	1,330 bn	1,394 bn	1,303 bn
2	India	1,173 bn	1,396 bn	1,656 bn
3	US	310 m	357 m	439 m
4	Indonesia	242 m	278 m	313 m
5	Brazil	201 m	231 m	290 m
22	United Kingdom	62 m	67 m	71 m

Table 2. Global warming potentials of various greenhouse gases. Data from DECC, 2010 and 3rd IPCC report (2001). The figures below have been updated, but are still used for reporting purposes.

Greenhouse gases (GHGs)	Chemical symbol	Global warming potential (GWP)
Carbon dioxide	CO_2	1
Methane	CH_4	21
Nitrous oxide	N_2O	310
Hydrofluorocarbons *	HFC	140 - 11,700
Perfluorocarbons *	PFC	6,500 - 9,200
Sulphur hexafluoride *	SF_6	23,900

* industrial gases, not involved in animal feed production.

Table 3. Estimated emissions from human activity and livestock production and percentage contribution of livestock towards emissions. (FAO, 2006).

Greenhouse gas (GHG)	Estimated total anthropogenic emissions (mt tonnes CO_2 equivalent)	Estimated total emissions from livestock production (mt CO_2 equivalent)	Estimated % contribution of livestock to global anthropogenic emissions
CO_2	24 (~31)	~0.16 (~2.7)	9
CH_4	5.9	2.2	35-40
N_2O	3.4	2.2	65
Total	33 (~40)	~4.6 (~7.1)	18

Values in brackets include emission from land use, land-use change and forestry. Imprecise estimates preceded by a tilde.

Table 4. Environmental burdens of animal of animal and crop production in England and Wales. (Data from Williams *et al*., 2007)

	Bread wheat (per tonne)	Oilseed rape (per tonne)	Beef (per tonne)	Lamb (per tonne)	Pork (per tonne)	Poultry meat (per tonne)	Eggs (per 20,000 eggs)	Milk (per $10m^3$)
Primary energy used (GJ)	2.5	5.4	28	23	17	12	14	25
Global warming potential (GWP) (tonnes CO_2e)	0.8	1.7	16	17	6.4	4.6	5.5	10.5
Eutrophication potential (kg PO_4^{3-})	3.1	8.4	158	200	100	49	77	64

Table 5. Water pollution contributions from livestock production in the US. FAO, 2006.

Pollutant/s	**% of water pollution contributed from livestock production in the US**
Nitrogen	32
Phosphorus	33
Pesticides	37
Antibiotics	50
Heavy metals	37

Table 6. Estimated drinking water requirements for various livestock . (FAO, 2006).

Animal type		**Water requirement at 15 ºC (Litres/animal/day)**
Cattle	Dry cows (large breed)	44.1
	Mid-lactation (large breed) – 35 L / day	102.8
Goat	Lactating – 0.4 L / day	7.6
Sheep	Lactating – 4.5 L / day	8.7
Poultry	Broiler (100 animals)	17.7
	Layer (100 animals)	13.2
Swine	Lactating (daily weight gain 200g)	17.2

Table 7. Fishmeal consumption, import and production figures. (Seafish, 2010)

	Fishmeal (Tonnes)
UK consumption	134,100
Imports from the EU	18,200
Imports from non-EU	73,900
UK production	42,000
EU production	450,000
Worldwide production	5,000,000

Table 8. Fishmeal use in various livestock industries. (FEFAC, 2009).

Livestock sector	**% usage worldwide**
Aquaculture	58.8
Poultry	9.1
Pigs	30.9
Other	1.2

Table 9. Estimated average feed conversion rates for various meat types. (FAO, 2006).

	Meat	**Estimated average FCR (kg feed/kg product)**
1950s	Pork	5
2003	Pork	3
	Poultry meat	2
	Fish	1
	Beef	6
	Lamb	8

Table 10. Feed additives and their potential sustainability benefits. (European Commission, 2003, European Commission, 2009).

Functional group	Potential sustainability benefits	Examples of authorised additives
Preservatives	Preserve feed and protect it against microorganisms and their metabolites. Reduce waste.	Sodium formate, acetic acid, lactic acid
Antioxidants	Prolong storage life of feeds and prevent deterioration caused by oxidation.	Sodium L-ascorbate, propyl gallate
Silage additives	Improve the production of silage, improving the digestibility of silage. Less waste, silage is less fibrous and animals will produce less methane.	Alpha-amylase, Beta glucanase, Cellulase, *Enterococcus faecium*
Digestibility enhancers	Increase the digestibility of feed materials, releasing sugar from polysaccharides. Improves weight gain and FCR.	3-phytase, endo-1,4-beta-xylanase, 6 phytase
Gut flora stabilisers	Provide a positive effect on gut flora. Improves weight gain, health status and FCR.	*Saccharomyces cerevisae, Bacillus subtilis, Enterococcus faecium*
Mycotoxin binders	Suppress, reduce the absorption, promote the excretion of mycotoxins or modify their mode of action. Mycotoxins are toxic and can reduce digestibility of feed.	None currently approved
Substances which favourably affect the environment	-	None currently approved

Table 11. Quantity of GM crops grown worldwide in 2009. (ISAAA, 2010).

Crop	Total grown (million hectares)	GM varieties grown (million hectares)	% of GM varieties grown of total
Soya	95	69.2	72
Maize	157	41.7	25
Cotton	34	16.1	44
Oilseed rape	30	6.4	22
Total	316	134	41

Annex III - References

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