

GLOBAL WARNING:

Climate Change and Farm Animal Welfare

A Report by Compassion in World Farming – 2008

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GLOSSARY AND ACRONYMS

FAO	Food and Agriculture Organization of the United Nations
GHG	Greenhouse gas
GWP	Global warming potential, in carbon dioxide equivalent
Tonne	1000 kg (equivalent to 1.02 ton)
CO ₂	Carbon dioxide
CH ₄	Methane
N ₂ O	Nitrous oxide
N	Nitrogen
P	Phosphorus

EXECUTIVE SUMMARY

Livestock production is responsible for 18% of global greenhouse gas (GHG) emissions from all human activities. This is a higher share than transport, which accounts for 14% of global GHG emissions. Nitrous oxide and methane emissions from animal manure, methane emissions from the animals' digestion and nitrous oxide emissions from mineral fertiliser used to grow feed-crops for farmed animals make up the majority of this 18%. The livestock sector is responsible for the following proportions of global anthropogenic emissions of the main greenhouse gases:

- 37% of total methane (CH₄) emissions
- 65% nitrous oxide (N₂O) emissions
- 9% of carbon dioxide (CO₂) emissions.

In addition, 64% of ammonia emissions originate in livestock production and contribute to air, soil and water pollution, acid rain and damage to the ozone layer. According to the Food and Agriculture Organization at the United Nations (FAO), "The livestock sector has such deep and wide ranging impacts that it should rank as one of the leading focuses for environmental policy."

Meat and milk are currently underpriced in relation to their real environmental and carbon costs. It is essential that the true costs of the livestock industry in relation to climate change are reflected in costs and prices in developed countries.

Compassion in World Farming believes that high-income, developed countries have a situation of unsustainable overproduction and over-consumption of animal products (meat, milk and eggs). We argue that a planned and well-managed reduction in the production and consumption of meat and milk in developed countries, such as those of the European Union, is an essential step in

order to help stabilise climate change. We believe that this reduction will have many beneficial side effects for both people and animals and will open up new opportunities to reformulate our food production policies.

Unsustainable levels of animal production

The FAO predicts that between 2001 and 2050, global meat and milk consumption will approximately double. At present, nearly 60 billion animals a year are used globally to produce meat, milk and eggs. This figure could rise to 120 billion by 2050. Such a marked upsurge would have an overwhelming impact on climate change and the environment.

Most of the world's animal production is carried out in industrial systems that make very heavy demands on natural resources of land and water in order to grow feed crops for farmed animals. Industrial animal production also causes widespread pollution from animal manure and from the use of fertiliser, pesticides and herbicides. The FAO reports that industrial animal production systems are increasing at six times the rate of traditional mixed farming systems and at twice the rate of grazing systems. At least 50% of the world's pigmeat and over 70% of the world's poultry meat and eggs are produced in industrial systems.

Livestock-related GHG emissions are expected to continue to increase rapidly up to mid-century if no action is taken to curb them. The US Environmental Protection Agency (EPA) considers the key factors in the growth of nitrous oxide and methane emissions to be "the growth in livestock populations ... and the trend toward larger, more commercialised livestock management operations." Emissions from pig slurry and poultry manure are expected to grow strongly as industrialised pig and poultry production expands globally.

Environmental impact of industrialised animal production

Livestock production for meat, milk and eggs uses up an important share of world resources. One third of the world's total arable land is dedicated to animal feed-crop production; over 90% of the world's soya beans and 60% of maize and barley are grown for livestock feed. Deforestation is a major cause of CO₂ emissions and loss of biodiversity. Deforestation in South America is largely driven by livestock production; 70% of previously forested land has been converted to livestock pastures and much of the remainder is used to grow feed crops (soya or cereals).

Soya production for feed has tripled since the mid-1980s, often by expansion into new land. Feed-crops are taking over increasingly scarce pasture land, leading to overgrazing and potential desertification of existing and marginal grazing areas. Desertification already affects the livelihoods of more than 25% of the world's population. According to the FAO, "feed production consumes large amounts of critically important water resources and competes with other usages and users."

Overproduction of livestock will only exacerbate the damage to food production and the environment due to global warming, such as more frequent droughts, floods, storms and harvest failures. In addition, it damages animal welfare, as more animals are subjected to intensive (factory farm) rearing systems, and human health in those countries where there is over-consumption of animal-based foods.

High global warming potential of animal-based diets

Meat and dairy production account for 13.5% of total GHG emissions in the EU25. In the UK, meat and dairy account for 8% of total UK emissions, compared to 2.5% for fruit and vegetables. The real global warming potential of meat and dairy production in Europe is even higher than these figures suggest if we include important indirect effects such as deforestation in South

America to grow soya beans for animal feed. Diets high in meat and dairy products have much lower energy efficiency and a greater global warming potential compared to diets high in plant-based foods. The energy input for one portion of cooked pork can be three times greater than the energy input for a portion of cooked beans or pulses.

Choices about diet can affect an individual's carbon footprint as significantly as choices about transport. Increasing the proportion of meat and dairy products in an individual's diet can be equivalent to the difference between a year's use of a standard car versus an ultra-efficient hybrid.

These facts have implications for governmental GHG reduction strategies and targets and for the choices made by any individual consumer in order to reduce his or her carbon footprint. Diets high in animal products increase GHG emissions and increase an individual's carbon footprint. Diets high in plant products save energy and reduce an individual's carbon footprint.

Why a reduction in meat and milk production is essential

Strategies proposed by the Intergovernmental Panel on Climate Change (IPCC) to reduce livestock-related GHGs could probably only reduce emissions by less than 20%. These strategies include reforestation, restoration of carbon soils, more careful and targeted use of fertilisers and disposal of manure. Such measures are clearly necessary, but are unlikely to make a large enough reduction in GHG emissions in a short time period. Other proposed strategies aim at the digestion or excretion of the animals themselves, such as feeding more grain and less forage (to reduce methane production) or chemical treatment of the animals. These could be very problematic if they lead to adverse effects on the animals' digestion or health. In any case, they are unlikely to be feasible for the majority of small farmers globally.

The leading sources of livestock-related GHG emissions originate in the natural biological processes of each animal (digestion, excretion). A reduction in the size of the livestock industry in developed countries is therefore the simplest, quickest and probably the only effective method of cutting GHGs from animal production to the extent that is necessary to limit the future increase in global warming.

Why intensive animal production is the wrong answer

Some agriculturalists propose intensifying animal production in order to increase yield per animal and hence reduce the GHG emissions per unit of output. Compassion in World Farming considers that intensification is a deeply flawed strategy from the point of view of halting climate change and from environmental and animal welfare considerations. It would also be ethically and politically unacceptable to consumers in developed countries, where concern about the welfare and environmental effects of farming, and the demand for free-range and organic animal products, is fast increasing.

Intensification would almost certainly mean an increase in factory farming of pigs and poultry and a reduction in free-range animals, including grazing cattle and sheep. It would often be counterproductive as already high-yielding animals would be pushed even further for higher yields, leading to increased stress and ill-health, shorter productive lifetimes of dairy cows and breeding sows and increased potential for the spread of infectious disease. The increased demand for feed would put more pressure on land and water resources globally and increase pollution from manure and agrochemicals.

Compassion in World Farming believes that, rather than calling for “more of the same”, agriculturalists and policy makers should look afresh at the whole issue of how we should rear animals for food in ways that protect the nutritional needs of people, the livelihoods of farmers, the welfare of farmed animals and the global climate and environment.

Benefits for human health

Recent estimates from public health experts suggest that a reduction of around 60% in daily intake of meat in developed countries would help reduce excess weight and obesity and offer other health benefits to individuals and society. Reducing consumption of red and processed meats is also recommended by the World Cancer Research Fund in its 2007 Report, which cites these meats as convincing causes of colorectal cancer.

Proposed targets and strategy for meat and dairy reduction in Europe

In line with current UK and European GHG emission reduction targets, which may need to be increased in view of new scientific evidence, Compassion in World Farming believes that the European Union and other high-income, developed countries should reduce production and consumption of meat and milk to one third below current levels over the next decade (by 2020) and to at least 60% below current levels by 2050.

Under our proposals:

- Consumers would eat a lower volume of higher quality meat and milk, preferably from local farmers. Farmers would earn a premium for their products, and higher prices would reflect the carbon costs of consuming meat and milk.
- A reduction of one third would be roughly equivalent to an individual who eats meat daily, eating meat on only five days a week, or alternatively reducing portion sizes of meat and dairy products and substituting plant-based foods such as pulses, grains, vegetables and fruit.
- Farmers would be enabled to reduce stocking density, move from intensive to extensive methods and raise animal welfare standards up to the best free-range and organic farming standards of today, while protecting their livelihoods.

- Imported products should be required to meet the same standards. Governmental and intergovernmental targets and incentives for both producers and consumers would be needed to support this transition, including protecting the purchasing power of low-income consumers.
- Farmers in developing countries would be assisted in meeting similar animal welfare standards so that their own farming methods would avoid the pitfalls of industrialisation of livestock production and their surpluses could be exported.

The benefits of this strategy are many, in addition to going a long way to meet the urgent task of reducing GHG emissions:

- A significant reduction in meat and dairy consumption would improve public health and reduce the prevalence of obesity, certain heart conditions and cancers. This would have a positive impact on related health care costs.
- Localisation of animal production and consumption would support rural communities and businesses.
- Reduction in demand for animal feed would allow a reduction in the intensity of arable farming and increase farmland biodiversity.
- The strategy would also lead to the end of animal factory farming and enable a revolution in standards of farm animal welfare.

PART 1: HOW ANIMAL PRODUCTION IMPACTS ON CLIMATE AND ENVIRONMENT

1.0 Introduction: carbon counting for livestock production

A huge increase in the global use and consumption of farmed animal products is currently taking place and is predicted to continue up until the middle of the 21st century. Between 1995 and 2005, the number of mammals used globally per year to produce meat and milk increased by 22% to 4.1 billion and the number of poultry used to produce meat and eggs increased by 40% to 57.4 billion. Of the total net world increase in annual production (tonnes of product) 87% was in developing countries¹, where meat consumption per person is still on average only a tenth of that in high-income countries.² As the world population grows and affluence increases, global meat production is expected to double by 2050.

This continuing increase comes at a time of climate change, when it is recognised that we are experiencing a crisis in the impact of humans on the planet's climate. This report presents the evidence from climate scientists and agriculturalists showing that livestock production has made, and is making, a major contribution to the total human-induced (anthropogenic) global warming effect. While comparable in magnitude to emissions from transport, the livestock source has been so far neglected by current GHG reduction policies that focus on energy related CO₂ emissions. This report aims to re-balance the debate and sets out what should be done to halt the impact of animal production on our climate, while at the same time protecting the nutritional needs of people, the livelihoods of farmers, the welfare of farmed animals, the environment and biodiversity.

Compassion in World Farming believes that in high-income, developed countries we now have a situation of unsustainable over-production and over-consumption of animal

products (meat, milk and eggs). This is being brought even more sharply into focus by the reality of climate change. While low income countries and some fast-developing countries are expected to continue their rapid growth in animal production, it is essential that the growth of global livestock-related GHG emissions is curbed in the short term.

We argue that a planned and well-managed reduction in the production and consumption of meat and milk in developed countries, such as those of the European Union, is an essential step in order to help stabilise climate change. We believe that this reduction will have many beneficial side effects for both people and animals and will open up new opportunities to reformulate our food production policies.

1.1 The unsustainability of current levels of animal production

Current animal production is responsible globally for 18% of all human-induced GHG emissions, according to the FAO.³ This is higher than the 14% contributed by all transport⁴ which includes transport by road, air, rail and shipping. Of the three major greenhouse gases, animal production accounts for 65% of all anthropogenic emissions of N₂O, 37% of all anthropogenic emissions of CH₄ and 9% of all anthropogenic CO₂ globally⁵ (see Table 1). It is estimated that the emissions due to meat and dairy production and consumption account for 8% of total anthropogenic GHG emissions in the UK⁶ and about 13.5% of total EU25 emissions, according to the European Commission's 2006 Environmental Impacts of Products (EIPRO) assessment.^{7,8}

Table 1. Summary of the contribution of animal production to global GHG emissions.
Source unless otherwise stated: Steinfeld *et al*, 2006³

Source of emission	Percentage contribution of source to total global human-induced GHGs
Total GHG emissions from animal production	18% of total human-induced GHG emissions
Compare: GHG emissions from transport (road, air, rail and sea) ⁴	14% of total human-induced GHG emissions
Compare: GHG from all power works and generation (oil, gas, coal) ⁴	24% of total human-induced GHG emissions
Carbon dioxide (CO ₂) emissions from animal production	9% of total human-induced CO ₂ emissions
Methane (CH ₄) emissions from animal production	37% of total human-induced CH ₄ emissions
Nitrous oxide (N ₂ O) emissions from animal production	65% of total human-induced N ₂ O emissions
Ammonia emissions from animal production	64% of human-induced ammonia emissions (Not classified as a GHG but contribute to nitrous oxide, eutrophication, acidification and ozone depletion. See Further Information Box)

The environmental costs of our current and future levels of animal production come not only from the emission of GHGs but also from over-use of natural resources. These include over-exploitation of land and water, pollution by manure and fertilisers leading to such effects as eutrophication of soil and water, acidification and damage to the ozone layer; soil degradation and desertification of pastures; loss of biodiversity from pollution and habitat destruction. All these additional damaging effects can only exacerbate any inevitable effects of climate change (drought, floods, harvest failures, high cereal prices, etc.).

Apart from the environmental unsustainability of the current global level of animal production, it is widely accepted that a western diet, including over-consumption of energy-dense foods such as animal products, is fuelling a global crisis of overweight and obese individuals in both developed and developing countries.^{9, 10}

Climate change has a long timescale; unlike some other forms of pollution, past and current emissions of GHGs will continue to have an effect well into the future and the results will only become clear long after the emissions have occurred. This makes it essential for us to take action to reduce GHG emissions now rather than later. Livestock production has a major role to play in this, and its role in contributing to GHG emissions is summarised in Table 2. The evidence collected in this report shows clearly that it is impossible to control GHG emissions from this important sector and to conserve natural resources and biodiversity if developed countries maintain their current overconsumption of animal products. Similarly, it is clear that it would not be sustainable for developing countries to increase their meat, milk and egg consumption up to the current levels of developed countries, from the point of view of climate, exploitation of natural resources, protection of biodiversity or human health. The scale of the livestock industry's use of global resources is shown in Box 1, taken from the FAO's 2006 Review.⁵

Box 1. Overview of resource use and the associated environmental impacts related to animal production.^{3, 5, 11, 12} Source, unless otherwise stated: Steinfeld *et al*, 2006³

	Percentage of resource use or environmental impact
Land use for animal production	<ul style="list-style-type: none"> • 30% of the total Earth's land area is utilised for animal production, mostly for permanent pasture, but also for feed-crops. • Of the deforested area of the Amazon forest, 70% is used for animal grazing with a large proportion of the remainder used for growing feed-crops.¹⁴ • Of the total available cropland, 33% is designated for animal feed-crops which equates to 4% of the Earth's total land area. • 20% of the total pasture land, including 73% of dry rangelands, has been degraded as a result of overgrazing, soil compaction and erosion.¹⁴
Crop production destined for animal feed	<ul style="list-style-type: none"> • Around 33% of all cereals harvested globally³ are used for animal feed. • 60% of the total world production of maize and barley is used for livestock production (data up to 2001). • In the UK, estimates suggest over 50% of wheat and barley are utilised for animal feed.¹³ • 97% of soya meal (around 70% of soya beans) produced are fed to farm animals.
Water use for animal production	<ul style="list-style-type: none"> • 8% of total human water use is attributable to livestock production; of which 7% is needed for feed production, the remainder for drinking, cleaning and slaughter/processing.
Water pollution from livestock production	<ul style="list-style-type: none"> • Fertilisers and manure from livestock production contribute to water pollution, by the addition of nutrients (N and P) to water courses. • In China-Guangdong, 72% (N) and 94% (P) of nutrient emissions in water are from pig waste alone. • In the US, 33% of N pollution and 32% of P pollution originates from livestock farming.

Table 2. The role of livestock in emissions of carbon dioxide, methane and nitrous oxide including past and current concentrations of these gases.

Source: Steinfeld *et al*, 2006, Tables 3.1 and 3.12¹⁵

	Percentage contribution to total livestock related GHG emissions	Current concentration in atmosphere (troposphere)	Percentage increase since pre-industrial era (mid-18th Century)	Lifetime in atmosphere	Global warming potential (GWP) relative to CO ₂
Carbon dioxide (CO ₂)	38	382 parts per million	+38	5 – 200 years (ref. 16)	1
Methane (CH ₄)	31	1728 parts per billion	+188 (nearly trebled)	9 – 15 years	23
Nitrous oxide (N ₂ O)	31	318 parts per billion	Max. +18	114 years	296

1.2 The ongoing explosion in livestock production

Since 1980, the global production of pigs and poultry has quadrupled and the production of cattle, sheep and goats has doubled, according to the FAO. Even in the 10 years between 1995 and 2005, the global number of meat chickens reared annually increased by nearly 14 billion (an increase of 40%), the number of egg laying hens used increased by 2.3 billion (a 31% increase), the number of pigs reared for meat rose by 255 million (an increase of 24%) and the number of cows used for milk production increased by 12 million (an increase of 6%).¹ All these animals need to eat, digest and excrete and the production of their feedstuffs and disposal of their manure are increasingly challenging the global environment. The FAO predicts that this increase in animal production will continue and that meat production will double again and milk production will increase by 80% by 2050, on current trends.³

The intensification and industrialisation of animal farming has played a major role in this expansion of output. Industrial production has taken over, or is currently taking over, from backyard animal keeping, pastoralism or small commercial farmers around the world. According to the WorldWatch Institute, in 2004 industrial systems generated 74% of poultry meat, 50% of pigmeat, 43% of beef and 68% of eggs globally.¹⁷ The FAO's estimates for industrial pig and poultry production are similar, at 55% and 72% of total production respectively.⁵ The FAO reports that industrial animal production systems are increasing at six times the rate of traditional mixed farming systems and at twice the rate of grazing systems.¹⁸ The future problem of burgeoning GHG emissions from livestock

production will be fuelled by the growth of intensive and industrial systems that damage both the environment and animal welfare.

1.3 The consensus for reduction of livestock-related emissions

The FAO and the IPCC expect livestock-related GHG emissions to continue to increase rapidly up to the middle of the 21st century unless action is taken to reduce them.^{5, 19} As with other economic sectors, the majority of these emissions will come from developing countries as their production and consumption increases towards the levels of developed countries. The following are expert views on the impact of livestock production on climate change and the environment and the need to reduce that impact:

Food and Agriculture Organization of the United Nations (FAO)

The FAO concluded perhaps the most detailed study ever made of the environmental impact of livestock production by stating that 'business as usual' is not an option and that:¹⁴

- 'The environmental impact per unit of livestock production must be cut by half, just to avoid increasing the level of damage beyond its present level.'
- 'The livestock sector has such deep and wide ranging impacts that it should rank as one of the leading focuses for environmental policy.'
- 'A top priority is to achieve prices and fees that reflect the full environmental costs [of livestock production], including all externalities.'

Table 3. Global industrialised animal production as a proportion of world supply of pig and poultry products. Source: Steinfeld *et al*, 2006; Halweil *et al*, 2004.^{5,17}

Product	Percentage from industrial systems ^{5,17}
Poultry meat	72 – 74
Pigmeat	50 – 55
Eggs	68

Intergovernmental Panel on Climate Change (IPCC)

The IPCC's 2001 Technical Summary of Working Group 3 (mitigation) report states:

- 'A shift from meat towards plant production for human food purposes, where feasible, could increase energy efficiency and decrease GHG emissions (especially N₂O [nitrous oxide] and CH₄ [methane] from the agricultural sector).'²⁰

The IPCC's 4th Assessment Mitigation report concluded in Chapter 8 on Agriculture:

- 'Greater demand for food could result in higher emissions of CH₄ [methane] and N₂O [nitrous oxide] if there are more livestock and greater use of nitrogen fertilizers ... Deployment of new mitigation practices for livestock systems and fertilizer applications will be essential to prevent an increase in emissions from agriculture after 2030.'²¹

UK (Westminster) Government

The 'Greener Eating' website advises consumers that:

- 'The production of meat and dairy products has a much bigger effect on climate change and other environmental impacts than that of most grains, pulses and outdoor fruit and vegetables.'²²

The current consensus among climate change scientists and policy makers is that emissions need to be cut sufficiently to keep the future global temperature rise to around 2°C and that this will require reducing global GHG emissions by mid-century by well over 50%.²³ Some UK experts believe that reductions of up to 90% by 2050 and 70% by 2030 are required.²⁴ Currently the UK and the EU are not on track to meet these targets.

1.4 An opportunity for positive change

The urgent need to reduce GHG emissions and the other environmental impacts of animal production will require big changes in the livestock industry of developed countries such as those of the EU and North America. Compassion in World Farming believes this should be seen as an opportunity rather than as a threat.

In Europe, during the 20th century, the intensification of agriculture was strongly encouraged by governments in order to increase food supply, and did so very successfully. Throughout the 20th century, farmers in developed countries have continued to focus on the goals of increasing production and reducing costs in ways that made both them and the general public increasingly uneasy. In the livestock production industry, this drive for efficiency also led to the adoption of the battery cage, the veal crate, the sow stall (gestation crate) and the broiler shed that are now symbols of the unacceptable face of factory farming. Evidence has piled up about the damaging environmental and animal welfare impacts. Public pressure has led to the legislative phase-out of barren battery cages, veal crates and sow stalls throughout the EU and the start of an industry-led phase-out in North America. In the current global market, the route of competing with developing countries for lowest cost per unit output is almost certainly a dead end for European livestock farmers.

Many farmers would prefer to be able to farm in a more animal-friendly and environmentally-friendly way but the current market climate of low costs often makes that seem impossible. Meanwhile, consumers in developed countries are increasingly looking for animal products from free-range and organic systems. Compassion in World Farming believes that the urgent need to reduce GHG emissions and other environmental damage due to livestock farming offers a way to break with the past and offer both farmers and consumers a route to an animal production system that respects both animal welfare and the global climate.

2.0 Main sources of (GHG) greenhouse gas emissions from animal production

2.1 Global sources

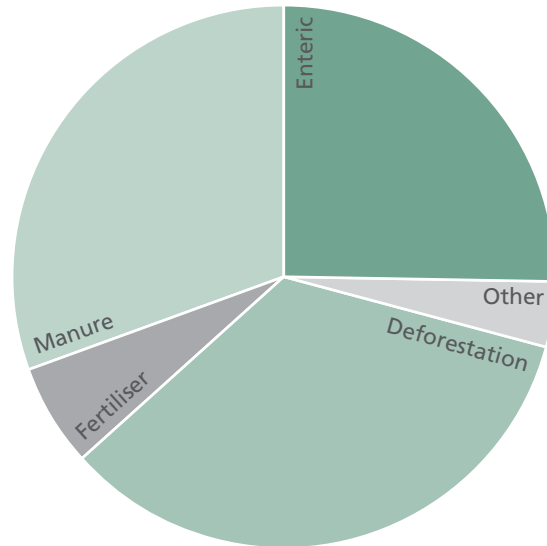
The major global warming potential of livestock production worldwide results from deforestation, followed by emissions from manure and from the animals' digestive processes (enteric fermentation).

Unlike other economic sectors, CO₂ emissions from animal production-related fossil fuel use are much lower than the non-CO₂ emissions from the natural and unavoidable bodily functions of animals (feeding, digestion and excretion).

Livestock-related GHG emissions arise mainly from the following sources (also see Summary Table 7 for further details):⁵

- Production of animal manure that is deposited in fields or in animal housing by the animals stored on farm and then disposed of by being spread on fields or pastureland. Manure releases both methane (CH₄) and nitrous oxide (N₂O). According to the FAO, '[M]anure-induced soil emissions are clearly the largest livestock source of N₂O [nitrous oxide] worldwide'.⁵ All manure related emissions are about 30% of livestock-related emissions and over 5% of total anthropogenic GHGs.
- The digestive processes of the animals, particularly ruminants such as cattle, sheep and goats. The 'enteric fermentation' process by which ruminant animals digest fibrous feed releases large amounts of CH₄. Enteric fermentation emissions account for about 25% of livestock-related emissions and about 4.5% of all anthropogenic GHG emissions.
- The production of animal feed (crops and grassland). Around one-third of the world's total cereal crop and over 90% of the world's soya crop is grown for animal feed. Feed-crops require the use of land, fertilisers, machinery and transport. Carbon dioxide is emitted during the manufacture of mineral (N) fertiliser and nitrous oxide is emitted from mineral fertiliser used on land. The manufacture and use of fertiliser for producing animal feed accounts for over 6% of all livestock-related GHG emissions.
- Deforestation (currently mainly in South America) for cattle grazing and/or for the production of soya beans or cereals for animal feed. Deforestation releases large amounts of CO₂ previously stored in vegetation and soil. Deforestation for animal production accounts for 34% of all livestock-related GHG emissions and over 6% of all human-induced GHG emissions.

Figure 1. Emissions as percentage contribution to total livestock-related GHG.
Source of data: Steinfeld *et al*, 2006, Table 3.12⁵



Enteric	25.3%
Deforestation	34%
Fertiliser	6.2%
Manure	30.4%
Other	4.1%

Globally, the most important single contributions to livestock-related GHGs are deforestation (34% of total) followed by CH₄ from enteric fermentation and manure-related N₂O (each around 25% of total); see Figure 1 above. It is notable that livestock manure and enteric fermentation alone account for 10% of all anthropogenic GHG emissions (Table 4), five times the proportion of global emissions due to air transport.⁴

Table 4. Relative importance of different sources of GHGs from animal production.

Adapted from Steinfeld *et al*, 2006, Table 3.12⁵

Livestock-related GHG or source	GHG	% of all human emissions for GHG specified	% of all livestock related GHGs	% of all human-induced GHGs
All livestock GHG		18		
CH ₄		37	31	5.5
N ₂ O		65	31	5.5
CO ₂		9	38	6.8
Deforestation	CO ₂	7.7	34	6.1
All manure related, of which:		-----	30.4	5.5
Manure management (esp. slurries)	CH ₄	6.3	5.2	0.93
Manure (deposition, application, manage etc.)	N ₂ O	52.6	25.2	4.5
Enteric fermentation	CH ₄		30.5	25.4 4.5
All N fertiliser related, of which:		-----	6.2	1.1
N fertiliser production	CO ₂	0.13	0.56	0.1
N fertiliser use [1]	N ₂ O	11.8	5.6	1.0
Desertification of pastures	CO ₂	0.32	1.4	0.25
Soil cultivation for feed	CO ₂	0.1	0.42	0.08
Fossil fuel use on farm	CO ₂	0.29	1.27	0.23
Processing	CO ₂	0.16 max.	0.7 max.	0.13 max.
Transport	CO ₂	0.003	0.01	0.0025

[1] Includes leguminous feed-cropping (e.g. soya, clover, alfalfa.)

2.2 Livestock-related emissions in developed countries

It is an important fact that even in industrial countries the majority of livestock-related GHG emissions arise from the digestion and excretion of the animals. Developed countries tend to have a much higher proportion of intensive animal production which results in higher emissions of carbon dioxide from fossil fuel energy use. The use of concentrate animal feeds, based on cereals and soya, and the manufacture of fertiliser for feed crops and pasture, increase the GHG emissions from intensive farming in developed countries compared to developing countries.

In spite of this, the majority of emissions from animal production in developed countries are methane from enteric fermentation and methane and nitrous oxide from manure, as the following examples show.

In the EU, methane and nitrous oxide from agriculture make up 9% of total anthropogenic emissions of GHGs. These come mainly from the animals' enteric fermentation and manure and from the use of N fertiliser (typically half of this is used for animal feed production in developed countries and the remainder for crops used directly for human food).²⁵

Table 5. Relative importance of sources of GHG emissions from milk production in the Republic of Ireland. Source: Casey and Holden, 2005²⁷

Source during production (up to farm gate)	% of total emissions for dairy production
Enteric fermentation	49
Fertiliser-related	21
Concentrate feed, including imports	13
Manure management	11
Electricity and diesel	5

In the UK, methane and nitrous oxide make up over half of total GHG emissions related to animal products (pigmeat, poultry meat, beef, sheep meat, milk and eggs). For pigmeat, poultry meat and eggs, which are all likely to be produced in intensive systems, carbon dioxide emissions make up a relatively higher proportion (45-47% of the total).^{6, 26}

In the Republic of Ireland, studies of typical milk production on dairy farms have also shown that digestion and manure account for around 60% of total GHG emissions related to animal products, rather than from fossil fuel energy use (5%) or concentrate feed production (13%).²⁷

In Belgium, methane and nitrous oxide make up 76% of the total GHG emissions related to

meat production.²⁸ In the US, well over 95% of agricultural methane and nitrous oxide emissions originate from animal digestion and manure or fertiliser use²⁹ (and about half of all US fertiliser use is for animal feed production⁵). In the Netherlands, 70% of agricultural methane emissions are from enteric fermentation and 30% from liquid manure management (nearly all Dutch pig production uses slurry systems).³⁰

In Japan, a 2007 study of the lifetime GHG emissions in the production of a beef calf showed that methane from enteric fermentation alone accounted for over 61% of the total emissions of production, while feed production and feed transport accounted for nearly 27%.³¹

Table 6. Major sources of GHG emissions in US animal production. Source: US-EPA Greenhouse gas inventory, 2007²⁹

	% of all agricultural emissions for specified GHG	% of total US emissions for that GHG
N₂O		
Agric soil management (N fertiliser use and deposition or application of manure to land plus results of ammonia emissions)	97	78
Manure management	2.5	2
CH₄		
Enteric fermentation (95% from beef & dairy)	69.5	21
Manure management (slurries)	25.6	8

These examples emphasise that GHG emissions from animal production, even in developed countries where energy use in animal production is relatively high, mostly arise from the natural life processes of the animals and therefore are difficult to reduce other than by reducing the size of the animal production industry.

Table 7 on the next three pages summarises the livestock-related sources of GHGs globally.

Table 7. Summary of livestock-related sources of GHGs globally.

Source: Steinfeld *et al*, 2006⁵

Livestock-related source of GHG	Global quantity of livestock-related GHG emitted per year For methane & nitrous oxide (CH ₄ & N ₂ O) see Table 4 for CO ₂ equivalents	Further details on source & effects
Fossil fuel use for N fertiliser manufacture for feed production	41 million tonnes CO ₂	The Haber-Bosch process [1] uses 1% of world's energy to produce mineral nitrogen fertiliser (for all uses, not only for animal feed). Mostly natural gas used, but 60% of China's fertiliser production is coal-based.
Fossil fuel use for on-farm animal rearing	60 million tonnes CO ₂ for feed production; 30 million tonnes CO ₂ for on-farm livestock management	Includes feed production and transport, forage, concentrates, seed, herbicides/pesticides, diesel for machinery (land preparation, harvest, transport, electricity (irrigation pumps, drying, heating, cooling)). In US, more than half of energy is for feed production.
Deforestation & other land use changes related to livestock production	2.4 billion tonnes CO ₂	Destruction of forests or other wilderness for conversion to pasture or feed-cropping. The main drivers are cattle grazing and soya production in South America. ³³
	Also CH ₄ oxidation 'greatly' reduced	The carbon in CH ₄ in soils is utilised by soil micro-organisms (by oxidation) and hence removed from soils; this is greatly reduced in pastures compared to forests. ⁵
Cultivation of land for feed crops, mostly large-scale intensive management	28 million tonnes CO ₂	C stored (sequestered) in soils is twice that stored in vegetation or in the atmosphere. C in soils is lost naturally by mineralisation and decomposition, but this is increased by human disturbance, when natural cover is changed to managed land. Tillage reduces soil organic (carbon) material and emits CO ₂ .
Desertification of pastures	100 million tonnes CO ₂	Due to decline of soil organic carbon and erosion; (In Argentina, desertification resulted in 25-80% decrease in soil organic carbon in areas with long-term grazing. ⁵)

Livestock-related source of GHG	Global quantity of livestock-related GHG emitted per year For methane & nitrous oxide (CH ₄ & N ₂ O) see Table 4 for CO ₂ equivalents	Further details on source & effects
Respiration by livestock	—	E.g.: animal breathing. Not considered a net source of CO ₂ under Kyoto Protocol. Animal bodies could be considered a carbon store (carbon sequestration) but this is 'more than offset' by methane emissions which increase correspondingly. ⁵
Enteric fermentation (part of digestive process)	86 million tonnes CH ₄	Methane is created as by-product in the fore-stomach (rumen) of ruminants (cattle, sheep etc.) and is also produced to lesser extent by pigs (monogastrics). 'Enteric fermentation' refers to the process by which stomach bacteria convert fibrous feed into products that can be digested by the animal. This can be a large contribution to total CH ₄ emissions: over 70% of total CH ₄ (all sources) for Brazil in early 1990s and 70% of agricultural CH ₄ emissions in US (in both cases mostly due to beef and dairy production). ⁵
Animal manure (mainly liquid manure slurry) largely due to intensive and industrial systems (FAO 2006, section 3.5.3)	18 million tonnes CH ₄	CH ₄ created by anaerobic decomposition of manure (i.e. not in presence of oxygen, for example when liquid or wet. See Further Information Box) Arises from management of liquid manure in tanks and lagoons, which are typical for most large-scale pig operations over most of the world (FAO, 2006) and large dairy operations in North America and Brazil. Dry manure stored or spread on fields does not produce significant amounts of CH ₄ .
Mineral N fertiliser application for feed production	0.2 million tonnes N ₂ O-N (i.e. N in form of N ₂ O)	Plants assimilate at best 70% of added N (absorption better from mineral fertiliser than from animal manure) leaving 30% inherent loss of the added N to environment. Estimated that 20-25% of total mineral N fertiliser is used for feed production. ⁵ Mineral fertiliser is not used in organic farming.
Emissions from leguminous feed-crops	0.5 million tonnes N ₂ O-N (i.e. N in form of N ₂ O)	Includes growing of soya bean, alfalfa, clover. These crops are less likely to be fertilised with N fertiliser but produce the same level of N ₂ O emissions as non-leguminous N-fertilised crops.
Nitrogen emissions from aquatic sources due to use of N fertiliser	0.2 million tonnes N ₂ O-N	This results from about 8–10 million tonnes ⁵ N/year that is lost into water as a result of the use of N fertiliser on land used for animal feed and forage.
Ammonia (NH ₃) volatilisation from mineral N fertiliser for feed [2]	3.1 million tonnes NH ₃ -N (i.e. N in form of ammonia)	Can be converted to N ₂ O in atmosphere or when re-deposited. Also leads to eutrophication [3], acidification [4] and ozone depletion.

Livestock-related source of GHG	Global quantity of livestock-related GHG emitted per year For methane & nitrous oxide (CH ₄ & N ₂ O) see Table 4 for CO ₂ equivalents	Further details on source & effects
Stored animal manure (mostly dry manure but also emissions from slurries)	0.7 million tonnes N ₂ O-N (N in form of N ₂ O)	Excretion in animal houses, collection and storage. Emissions higher for dry manure (can be 15% of N content). Losses during storage from deep litter can be 150 times the losses from slurries. Includes N ₂ O emissions from surface of slurries and from slurries spread on land.
Ammonia from manure storage in intensive systems	2 million tonnes NH ₃ -N	Generated in 'confined animal feeding operations' (e.g. from poultry manure).
Manure-induced 'direct' N ₂ O emissions from soil	1.7 million tonnes N ₂ O-N	Excreta freshly deposited on land (either by animals or applied by spreading). '[M]anure-induced soil emissions are clearly the largest livestock source of N ₂ O worldwide'. ⁵
Manure-induced 'indirect' N ₂ O emissions	Up to 1.3 million tonnes N ₂ O	Indirect emissions following volatilisation and leaching of N unused by crops and intensive grassland. Majority from mixed systems.
Livestock processing	Several tens of million tonnes CO ₂	Transport, slaughter, etc. milk processing (pasteurisation, cheese and dried milk)
Transport and distribution	0.8 million tonnes CO ₂	Delivery of processed feed to animal production sites and transport of products to retailers and consumers. Soya bean is a notable long-distance feed trade; estimate of annual soya bean cake shipped from Brazil to Europe emission is 32,000 tonnes of CO ₂ . ⁵

[1] The Haber-Bosch process is an industrial chemical procedure using extremely high pressures and high temperature to produce ammonia from atmospheric nitrogen gas (a process known as 'nitrogen fixation'). The ammonia is then used to produce mineral fertiliser.

[2] Volatilisation is the process whereby a substance changes from a solid (or liquid) form to a gas form. Here it refers to the emission of gaseous ammonia from mineral N fertiliser (see Further information box on p23).

[3] Eutrophication refers to excessive enrichment of an environment (soil, water) by nutrients (in this case nitrogen but also can be phosphorus). See Further information box on p23.

[4] See Further information box on p23.

3.0 Animal production methods and greenhouse gases

Intensive animal production systems are taking over from small-scale, traditional animal production globally. Much of the global GHG emissions currently arise from enteric fermentation and manure from grazing animals and traditional small-scale mixed farming in developing countries. More than half of the world's pigs are reared in China, the majority still in non-commercial farms. By contrast, in developed regions and to a lesser extent in some rapidly industrialising countries, nearly all of the pig and poultry production and some milk and beef production are highly intensive and often industrialised.

According to the FAO, about 80% of the total growth in livestock production comes from industrial rearing systems.³² Therefore it is worth examining the effect these will have on future GHG emissions.

Intensive and industrial systems have increased enormously the numbers of animals farmed globally and will continue to do so. Being high-input, concentrated systems, they are very demanding of resources of land, water, fertiliser and feedstuffs and produce large quantities of manure on relatively small areas of land. The quantity of manure produced is likely to be very much more than the land can absorb usefully, leading to N and P pollution and nitrous oxide emission. If animal numbers and intensification continue to increase, we can expect these systems to become the dominant cause of GHG emissions from a global point of view.

3.1 Pig and poultry manure

Industrial production of pigs and poultry is an important source of GHG emissions and is predicted to become more so. On intensive pig farms, the animals are generally kept on concrete with slats or grates for the manure to drain through. The manure is usually stored in slurry form (slurry is a liquid mixture of urine and faeces). During storage on farm, slurry emits methane and when manure is spread on fields it emits nitrous oxide and causes nitrogen pollution of land and water. Poultry manure from factory farms emits high levels of nitrous oxide and ammonia.

In 2006, the EPA published a survey and predictions of global agricultural methane and nitrous oxide emissions. The report considers that: 'The key factors influencing both methane and nitrous oxide emissions in this category are expected to be the growth in livestock populations necessary to meet the expected worldwide demand for dairy and meat products and the trend toward larger, more commercialised livestock management operations.' The report anticipates a 'transformation of management systems from dispersed, pasture operations to larger sized, commercialised production... Such transformations are occurring now throughout the developing world and will likely increase emissions, particularly in Africa and Latin America.'³⁴ The transformation of pig production to commercialised units, especially in China and Brazil, will increase animal numbers and also the use of slurry systems for manure collection, so that 'the trend will likely be toward increasing methane emissions.'³⁴ According to the FAO, pigs and poultry currently account for 77% of the increase in animal production in developing countries.⁵

A survey and analysis of the emissions from the EU (15 Member States only) by the European Commission shows that the use of slurry systems for pigs and dairy have actually increased by a few percentage points since 1990, an indication of intensification. Pig production in Europe has a high potential for emitting methane from manure, due to the fact that 82% of pig production uses liquid (slurry) manure systems.²⁵

In poultry production, the EPA expects that: 'increases in worldwide poultry production, estimated to have the fastest rate of growth of all livestock types (over 26 %) over the next decade...., will in particular drive increases in nitrous oxide emissions because of the relatively high nitrogen content of poultry waste and the management systems used'. Increases in nitrous oxide emissions due to increased poultry production are expected in China, South and East Asia and South and Central America and also in the US.³⁴

3.2 Soya production

The demand for soya as a high protein feed is a major cause of livestock-related climate change. One of the most important causes of global warming is deforestation, estimated to account for approximately 20% of global anthropogenic GHGs.⁸² Of this, at least one-third is a result of deforestation and land change for livestock production. One of the two main drivers for deforestation in South America, particularly Brazil, is the demand for soya production for animal feed.³³ Well over 97% of soya bean cultivation is primarily for feed purposes (the soya meal left when oil has been extracted from the bean is used as animal feed). It is estimated that 70% of previously forested land is used for pasture and much of the remainder is used to grow soya,^{14, 33, 35} to be used in regions of intensive livestock production (such as in Europe and China).

Soya meal makes up around 10-20% of the feed of chickens and pigs across a range of developed and developing countries, including China, Brazil, Japan, the US, Germany, Mexico, Thailand and the UK.³⁶ It is also used as a high-protein feed for dairy cattle, especially after the banning of animal protein from feed after the BSE epidemic.

Soya is part of a globalised animal feed trade. In response to demand for animal feed, soya bean production has tripled since the mid 1980s and half of the total increase took place in the five years up to 2006.³⁵ Much of this huge increase has been achieved by expanding the area of cropped land.

In 2003, the World Wildlife Fund (WWF) – Brazil reported on an export-led soya bean production boom that has taken place in the ecologically sensitive Cerrado (savannah) region of centre-west Brazil.^{35, 37} To set up the soya plantations, large production companies bought land from smallholders but WWF found that production ‘also involves expansion into significant areas of new land which must be cleared and prepared for soya production. Side effects of this process include deforestation, the destruction of species and habitats, removal of natural vegetation and the loss of ecosystem functions and services. Not only does the natural vegetation protect and sustain biodiversity, it also plays a role in regulating

climate and hydrological cycles’.³⁷

3.3 Animal feed production: land and fertiliser use

As animal production systems intensify, more land is needed to grow high-protein and high-energy crops for their feed, and more mineral fertiliser is used to obtain a high yield from the crops. Intensive methods are leading to the decline of the sustainable use of crop residues for feeding livestock.

Land use

The use of grain-feeding for livestock started in North America in the 1950s and is now common in much of East Asia, Latin America and West Asia as well as in all developed countries. It is also increasing rapidly in Sub-Saharan Africa and South Asia. The cereal component (such as wheat, maize, barley) is about 60% of chicken feed and 60-80% of pig feed across most countries, including China, Brazil and Thailand.³⁵

An estimated 33% of the world’s cropland is used to grow animal feed-crops. This is in addition to the estimated 26% of the world’s land area that is used for animal pasture. For some crops, such as maize (60%) and soya (97%), most of the world’s entire crop is used for animal feed.^{5, 35} Half the wheat and barley produced in the UK is used for feed.¹³

The FAO estimates that if livestock production increases as predicted, even more land will be taken over for feed-cropping. The share of cereals used for feed will increase still further as developing countries expand and intensify their animal production systems. Nearly 80% of the increased use of feed maize up to 2030 is expected to be in developing countries.³⁵ This is very likely to create immense pressure on land resources and result in CO₂ losses from degraded soils, fossil fuel use for tillage and fertiliser production and nitrous oxide emissions from fertiliser use.

N fertiliser use

Mineral fertiliser use requires large amounts of fossil-fuel energy to manufacture and creates nitrous oxide emissions and nitrogen pollution in use (eutrophication,

acidification, ozone layer damage). While most countries use natural gas to manufacture mineral fertiliser, the CO₂ emissions from China's production are relatively higher because coal energy is typically used for fertiliser manufacture.

The FAO estimates that globally 20-25% of the total mineral fertiliser is applied to feed-crops. In some countries the proportion used is very much higher and is typically over 50% in developed countries.⁵

3.4 Animal feed production and desertification of pastures

Intensive animal production with its demand for feed-crops contributes to overexploitation of grazing land and to desertification. Desertification is one of the most serious of global environmental challenges and one that often affects the poorest people. The demand for land for feed-grain for intensively-produced animals is increasing the pressure on grazing land. Feed-cropping is taking over pasture land and this is expected to continue in many developing countries.⁵ Pasture land is already under pressure.

According to the FAO, the world's pastures already have their 'backs against the wall'. Grazing is already moving into marginal areas where it has 'reached the limit allowed by climate and soil.'¹⁵

Any expansion of grazing is likely to be into forests or other ecologically valuable areas.³⁵

The loss of pasture land to feed-cropping is likely to lead to overgrazing of any remaining grazing areas, and hence to desertification. This is a particularly serious threat at a time of climate change. Already 73% of the world's dry rangelands are degraded to some extent.¹⁴ A study published in *Nature* commented in September 2007: 'Arid ecosystems are among the most sensitive ecosystems to global climate change. High grazing pressure pushes arid ecosystems towards the edge of extinction. Increased aridity can then lead to desertification in a discontinuous way, where the possibility of recovery will be low'.³⁸ According to the Millennium Ecosystem Assessment, desertification affects the livelihoods of more than 25% of the world's population.³⁸

Table 8. Percentage of mineral fertiliser used for feed-crops (and pasture).

Source Steinfeld *et al*, 2006, Table 3.3 (data from 2002 and 2003)⁵

	Percentage of total N fertiliser used for feed-crops and grassland for animal production, rather than for feed crops for direct human consumption (* indicates countries with significant grassland fertiliser use)
UK	70*
Germany	62*
Canada	55
France	52*
USA	51
Spain	42
Brazil	40
Argentina	29
Mexico	20
Turkey	17
China	16

3.5 Resource conflicts due to animal feed production

Cereals and water

The current huge expansion in the size and intensity of animal production worldwide looks particularly unsustainable in the light of the probable effects of climate change, because it makes such heavy demands on land and water for growing feed-crops. The disproportionate and growing demand for cereals for use as animal feedstuffs is already contributing to the worldwide cereal price increases caused partly by drought and reduced harvests. This is perhaps one of the first indications of the resource conflicts due to intensive animal production that are likely to become more serious in the future.

The demand for feed-crops will increasingly come into competition with the demand for land and water for other purposes, including energy production (biofuels), forestry, aquaculture (demand for cereal for feeding fish) and the need to grow crops for human food.

Intensive animal production is an inefficient use of water. The large majority of all the water used in livestock production is used to produce animal feed (90% in the case of beef production⁷⁸). Because each kilogramme of animal product requires several kilogrammes of feed crops, much more water

is consumed by animal products than is consumed by an equal quantity of staple plant foods. For this reason, livestock products typically have a very large 'water footprint' compared to plant foods. For example, the production of just 1 kg of beef, as a global average, consumes nearly 15,500 litres of water.⁷⁸ This compares with around 900 litres of water per kg of maize and 1,300 litres per kg of wheat.⁷⁸ Calculations have shown that reducing the proportion of animal-based food and increasing the proportion of plant-based food in the diet can almost halve an individual's water footprint.⁷⁹

With the use of water for livestock production projected to increase by 50% up to 2025, livestock production will be a likely contributor to human conflict over water resources. By that date, up to 64% of the world's population is likely to be living in water-stressed environments. In areas where water is used for irrigation, 15% of the water lost by evaporation and by transpiration (evaporation from plant pores) from plants can be attributed to feed crops.¹¹ The FAO has concluded: 'It is clear that feed production consumes large amounts of critically important water resources and competes with other usages and users'.¹¹

Box 2. GHG overview: methane, nitrous oxide and carbon dioxide

GHG emissions from livestock farming do not follow the same mix of GHGs as in other sectors of the economy. Of the three main greenhouse gases emitted by all human activities globally, carbon dioxide (CO₂) accounts for around 77% of total anthropogenic GHG emissions, methane (CH₄) for 15% and nitrous oxide (N₂O) for 8%, in CO₂ equivalents.⁴ CO₂ emissions due to generation and use of fossil fuel energy contribute over half of the total, although deforestation is another important source of CO₂ that is not related to fossil fuel energy use.⁴⁰

GHGs due to animal production are divided fairly evenly between CO₂, CH₄ and N₂O (38%, 31%, 31%). Of the 18% of total anthropogenic GHG emissions that can be attributed to livestock production, the three GHGs make approximately the same level of contribution (CO₂ 6.8%; CH₄ 5.5%; N₂O 5.5%).⁵

Most of the CO₂ emitted from animal production comes from livestock-related deforestation, not from fossil fuel use. CO₂ from fossil fuel use makes up a relatively small part of the total livestock-related emissions. On the other hand, CO₂ emissions due to deforestation and land use (e.g. loss of CO₂ stored in soil and vegetation) make up a relatively large proportion of all livestock-related emissions (see text and Tables 4 and 7). Deforestation for animal production makes up nearly 8% of all human-induced CO₂ emissions and 6% of total human-induced GHG emissions.⁵

Box 3. Further information box

Absorption of nitrogen from food, fertiliser and manure

A large part of the nitrogen that is applied to plants (in mineral fertiliser or manure) or eaten by animals in feed is not absorbed. Absorption is probably 59-60% for crops and less for animals. Global estimates for absorption of N (i.e. protein) by animals are: pigs globally, 20%; poultry globally, 34%; dairy products in US, 40%; beef cattle in US, 5%.⁵ The remaining N in animal feed is excreted in urine and faeces and is either deposited on land by the animals or stored on farm and subsequently spread on land. The manure in the environment that is not absorbed by plants produces large amounts of N₂O and ammonia (NH₃). The demand from intensive animal production for high-protein/high-nitrogen animal feed and the production of feed-crops therefore contributes to the production of N₂O, a greenhouse gas and ozone depleting substance (as well as resulting in pollution by ammonia).

Eutrophication (nutrient enrichment of ecosystems)

The elements nitrogen (N) and phosphorus (P) are essential to plant (and animal) life and growth but excessive concentrations in ecosystems act as environmentally damaging pollutants. N and P are supplied in animal feed and excreted in manure and are also supplied in mineral fertiliser for plants. The N in fertiliser and manure that is not absorbed by crops causes nutrient enrichment ('eutrophication') of ecosystems, including lakes, rivers and seawater. Those organisms that can use high levels of nutrients flourish at the expense of others, altering the balance of species. In water, eutrophication causes large growths of algae that can kill other organisms because they use up the oxygen in respiration and when they decay and because they block out light. Algae can also be toxic to fish and cause large-scale fish kills in polluted water.

Role of ammonia in acidification ('acid rain')

Ammonia (NH₃) contributes to acidification when ammonia and oxygen in the atmosphere combine to form nitrogen dioxide (NO₂). Nitrogen dioxide then combines with water and oxygen in the atmosphere to form nitric acid (HNO₃) which can be deposited as 'acid rain.' Dissolved ammonium ions (NH₄⁺) can also form nitric acid when deposited on soil.

The path is: ammonia , nitrogen dioxide , nitric acid.

Production of nitrous oxide (N₂O) from fertiliser or manure

Plants use nitrogen in the form of nitrate (NO₃), which can be obtained directly from mineral fertiliser or from decomposition of manure. Organic N in faeces and urine (urea and uric acid for poultry) is converted to NH₃ (ammonia) and NH₄⁺ (ammonium ions), followed by 'nitrification' to nitrite (NO₂) and nitrate (NO₃) in the presence of oxygen (i.e. aerobic conditions). If parts of the manure then become saturated or airless (anaerobic conditions) nitrates and nitrites are reduced (i.e. loss of oxygen) to nitrous oxide (N₂O) and ultimately to nitrogen gas (N₂) which returns to the atmosphere (referred to as 'de-nitrification').

The first stage of production of N₂O is aerobic (i.e. dry or open to air, oxygen present) and second stage is anaerobic (i.e. wet or airless conditions, little oxygen present).

The production of N₂O from animal manure globally is several times greater than the production of N₂O from use of N fertiliser on feed-crops.⁵

Methane and nitrous oxide emissions from manure

Manure is the largest single source of livestock-related GHGs after deforestation. CH₄ and N₂O are produced from manure that is collected and stored on farm by different methods. Slurry (liquid manure) produces more methane and dry manure produces more nitrous oxide. Hence attempts to reduce either CH₄ or N₂O by changes in manure management could result in increasing the other one. Apart from manure management, two thirds of total global manure-related emissions arise from nitrous oxide emitted after manure is deposited or spread on land.⁵ The problem is therefore one of excessive manure production.

Production of methane and oxidation (breakdown) of methane in soils

Methane is produced in lower layers of soil by anaerobic bacteria and atmospheric methane is assimilated into soil, in forests, grassland, tundra, heathlands and deserts. Soil bacteria can use up CH₄ as a source of carbon in a process known as methane oxidation. Soils thus act as a methane sink amounting to millions of tonnes per year. If soil becomes waterlogged, the balance of bacteria can change to anaerobic methane-producing bacteria. Increased nitrogen concentration in soil (usually through human activity) inhibits methane oxidation. Hence it is necessary to avoid excess N deposition on soil to maintain soil as a methane sink.

In addition, the intensified land use for feed crops and grazing can only exacerbate the environmental effects of climate change. Intensive animal farming is a significant cause of deforestation, the over-use of arable soils leading to loss of soil organic matter, erosion and soil compaction and the loss of traditional hardy animal breeds as they are replaced with higher-yielding but less well-adapted western breeds.³⁹

All these trends will only increase the damage caused to food production and the environment due to changes in climatic conditions such as more frequent drought, floods, storms and harvest failures. Although the detailed impact of future climate change on different world regions is still unclear, the intensive use of land and water resources for animal production may even become unviable in some regions of the world and is likely to add to existing environmental problems globally.

4.0 Diet, food production and GHGs in developed countries

Meat production is usually an inefficient way of producing human food except in marginal lands unsuitable for crops and only suitable for grazing. In modern animal production, at least some or all of the plant protein fed to animals could also be eaten by humans. Producing meat involves converting plant protein (fed to animals) at low efficiency to edible animal protein (meat). As the IPCC noted in 2001: 'A shift from meat towards plant production for human food purposes,

where feasible, could increase energy efficiency and decrease GHG emissions'.²⁰

Animal products have a high global warming potential per kg compared to most plant-based foods. There is now abundant evidence from recent studies in UK, Europe, US and Japan that meat and dairy production and consumption make very significant contributions to the GHGs of developed countries.

4.1 The contribution of meat and dairy production to Europe's GHGs

A number of recent studies have shown that meat and dairy products are food choices with the highest global warming potential according to Life Cycle Assessment methods.

The European Commission's 2006 report on the Environmental Impacts of Products (EIPRO) found that in the EU25, all food production and consumption accounted for 31% of total emissions.⁷ Meat and dairy products accounted for 13.5% of total emissions, which is nearly half of all emissions relating to food.⁸ In addition, red meat contributed 11% and poultry meat 7% to eutrophication (nutrient enrichment of ecosystems, see Further Information Box) in the EU25. Meat production and processing was put in the top five products for environmental impact and milk was put in the top 10.⁶ The 13.5% of total EU25 emissions from meat and dairy should be compared with an estimated 3% due to civil aviation in the EU15 in 2005.²⁵

Table 9. Relative contribution of meat and dairy and other food sources of GHGs in the UK.

Source: Garnett, 2007⁸

Food category	Contribution to total UK GHG emissions
Meat and dairy	8%
Fruit and vegetables	2.5%
Alcoholic drinks	1.5%
Food-related transport	2.5%
Food manufacturing	2.2%
Fertiliser manufacture	1%

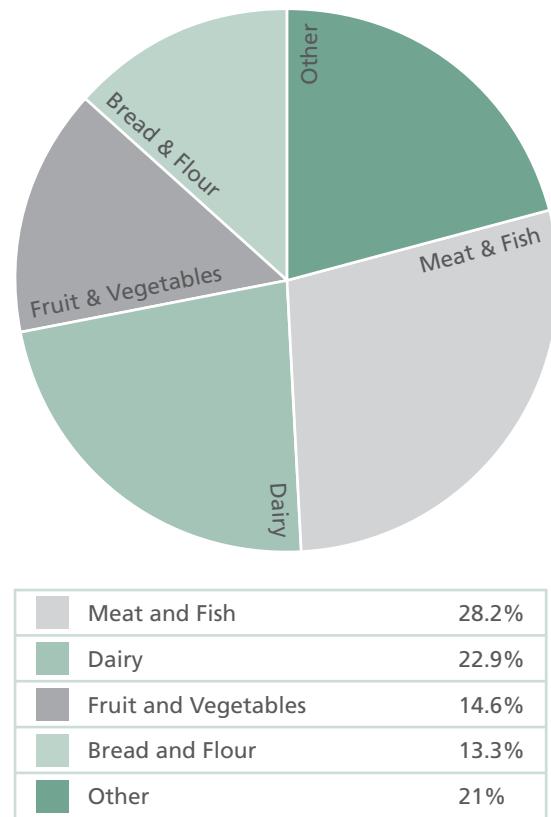
In the UK, the Food Climate Research Network has estimated that meat and dairy products contribute 8% of total GHG emissions, compared to only 2.5% for fruit and vegetables^{6, 8} (see Table 9). The 8% from meat and dairy should be compared with an estimated 6.5% contributed by UK aviation in 2005.⁴¹

A Netherlands-based study also found a high proportion of food GHGs are due to meat and dairy products. Meat and fish contribute 28.2% of all food-related emissions in the Netherlands; dairy contributes 22.9%; potatoes, fruit and vegetables contribute 14.6%; and bread, pastry and flour contributes 13.3%. Accordingly, meat, fish and dairy contribute half of all Netherlands food-related GHG emissions⁶ (see Figure 2).

A large majority of GHG emissions related to meat and dairy products (up to 96% in the UK) are the result of rearing the animals (i.e. up to farm gate) rather than the result of food processing, transport, retailing and consumption.⁶ The animal production on the farm therefore has to be the main focus of GHG emission reduction strategies.

As has been pointed out by the Food Climate Research Network, the true tally of GHG emissions due to meat and dairy products may be higher than has been calculated by straightforward Life Cycle Assessment studies because: 'They do not ...take into account some of the more complex issues, such as lost carbon sequestration potential (in the case of soya) or the opportunity cost of land use'.⁶ Therefore the real global warming potential of meat and dairy production in Europe is probably even higher than that calculated by published studies so far if we include important indirect effects such as deforestation in South America to grow soya beans for animal feed.

Figure 2. Relative contribution of products to Dutch food GHGs.
Re-drawn from Garnett, 2007⁸



4.2 Environmental impact of different animal-based foods

The global warming potential (GWP) of different foods depends on the amount of fossil fuel energy consumed (for example in concentrate feed production) and the amount of methane and nitrous oxide produced by enteric fermentation, manure and fertilisers, per unit of output. A unit of output could be 1 kg of meat, milk or eggs. There is a considerable difference in the global warming potential per unit output between ruminant animals (beef cattle, dairy cows, sheep and goats) and non-ruminants (pigs and poultry).

Table 10. GHG emissions due to production and consumption of different animal products in the UK.

Source: Garnett, 2007⁶ (based on GHG calculations of Williams, Audsley and Sandars, 2006²⁶)

Animal product	% contribution to total UK GHG emissions based on 2006 consumption	GHG emissions (kg CO ₂ equivalent) per kg of meat, eggs or milk
Beef	2.32	15.8
Pigmeat	1.12	6.4
Poultry meat	1.10	4.6
Sheep meat	0.85	17.4
Eggs	0.40	5.5
Dairy	1.89	10.6 [1]
Total to farm gate	7.69	
Total after farm gate	0.35	
Total pre- and post- farm gate	8.03	

[1] Given for milk dry matter

4.2.1 Ruminant and non-ruminant animals

Ruminant animals, such as cattle and sheep living in extensive conditions and getting their main nutrition from grass, can be reared with relatively little input of energy, as happens throughout the world in traditional farming systems. One kilogramme of beef produced on an intensive US beef feedlot has been estimated to have twice the environmental impact of 1 kg of beef produced on pasture in Africa. Grazing cattle and sheep also contribute to preserving the countryside and landscapes and they often provide livelihoods in regions that are unsuitable for arable farming. However, the fact that they can digest fibrous material such as grass means that they produce large quantities of methane from enteric fermentation. They deposit their dung on land (in developing countries this is an essential resource for fertiliser and often for fuel) where it emits nitrous oxide. Cattle and sheep normally give birth to young only once a year and also grow to their slaughter weight relatively slowly. When slaughtered, their carcasses yield a lower proportion of edible meat per carcass than is the case for pigs and poultry.

Pigs and poultry reproduce rapidly and grow to their slaughter weight very fast, particularly in factory farming conditions. As a result, the rearing of cattle and sheep produces more GHG emissions per unit of output than rearing pigs and poultry. Pigs and poultry, on the other hand, are fed on specialised feed-crops (such as cereals and soya) which require large resources of land and water and the use of fertilisers and pesticides. Studies of production and consumption in the UK^{6, 26, 42} have shown that the largest contribution to total GHG emissions comes from beef production, followed by milk, pigmeat, poultry meat, sheep meat and eggs (Table 10). Sheep meat production gives the largest GHG emissions per kg of meat but relatively little is consumed.

Different animal products therefore vary in the levels of GHGs emitted, but in nearly every case, animal production has a higher global warming potential than the production of plant-based foods. An exception is the production of greenhouse vegetables such as tomatoes, which also have a high GWP. A review of the environmental impact of UK food production conducted for

Defra at the Manchester Business School and published in 2006 summarised the situation as: 'Energy inputs [are] high for all meats' and that 'Legumes are a more energy-efficient way of providing edible protein than red meat'.⁴³

4.2.2 Organic and free-range farming

The difference in GHG emissions between ruminant and non-ruminant animals is true, even when cattle and sheep are reared in organic farming conditions. In organic farming, mineral fertiliser is not used and the use of concentrate feed is relatively low, which reduces the GHG emissions from these sources. Organic farming uses considerably less energy than non-organic farming (Table 11)⁴⁴ and UK studies have found that organic production of pigmeat and sheep meat emits lower levels of GHGs per kg of meat than non-organic pig and sheep production.²⁶

The percentage of organic production in the UK is currently not more than 1% for any animal product.⁶ There could therefore be considerable energy savings and reduction in GHG emissions from pigs and sheep (and possibly from beef and dairy production as well, although the situation is less clear) if the organic sector were greatly expanded. There is recent evidence from the University

of Michigan and Michigan State University, examining organic yields and resource use, that 'organic agriculture has the potential to contribute quite substantially to the global food supply, while reducing the detrimental environmental impacts of conventional agriculture'.⁴⁵

When meat chickens are reared in the best free-range and organic farming systems, the birds have a life-time twice as long as factory farmed chickens and a very much better quality of life, with access to an outdoor range, fresh air and exercise. But because the birds often live twice as long (eating and excreting) before they are slaughtered, organic and free-range chicken farming produces somewhat higher GHG emissions per kg of chicken meat than factory farming of chickens. However, the difference between the GWP of factory farmed poultry meat and free-range poultry meat is very small compared to the much higher GWP difference between any poultry meat and beef or sheep meat.²⁶

Table 11. Change in energy use for selected products as a result of organic farming, compared to non-organic farming.

Source: Soil Association, 2007⁴⁴

Product	% change in energy use in organic farming, compared to non-organic farming
Milk	-38
Beef	-35
Lamb	-20
Pigmeat	-13
Eggs	+14
Chicken meat	+32
Wheat	-29
Oilseed rape	-25

Table 12. Energy required per portion of food item.Source: Carlsson-Kanyama, 2003⁴⁷

Food item, provenance and preparation 'domestic' = originating from within the country (Sweden)	Energy per portion consumed (M joules per portion)
Animal products	
Beef, domestic, fresh, cooked	8.8
Lamb, domestic, fresh, cooked	5.4
Chicken, domestic, fresh, cooked	4.4
Pork, domestic, fresh, cooked	5.0
Mackerel domestic, (caught), cooked	4.7
Farmed salmon, domestic, cooked	11.0
Cod, domestic, (caught), cooked	13.0
Yoghurt, domestic, small pot	2.2
Eggs, domestic, cooked	1.8
Milk, domestic (full fat)	1.2
Cheese, domestic	0.9
Cheese imported from southern Europe	1.0
Non-animal products	
Brown beans, domestic, cooked	1.7
Peas, domestic, cooked	0.95
Soya beans, imported, cooked	1.51
Potatoes, domestic, cooked	0.91
Carrots, fresh, domestic	0.19
White cabbage, fresh, domestic	0.26
Broccoli, imported frozen, cooked	1.2
Tomatoes, domestic, greenhouse	4.6
Muesli with sun-dried raisins, domestic	0.69
Oat porridge, domestic, cooked	0.69
Rice, imported, cooked	1.1
Pasta, domestic, cooked	1.2
Pasta imported from southern Europe, cooked	1.3
Couscous imported from central Europe, cooked	1.1
Bread, fresh, from local bakery	0.44
Bread, fresh, from non-local bakery	0.48
Apples, domestic, fresh	0.44
Cherries, domestic, fresh	0.63
Raspberries imported from central Europe	0.9
Strawberries, domestic	0.77
Strawberries imported from southern Europe	1.1

4.3 Energy use and global warming potential associated with choice of diet

There is overwhelming evidence that a reduction in meat and dairy consumption in developed countries is an essential first step towards achieving a sustainable food system. A 2009 report on *The Feeding of the 9 Billion*, from Chatham House, the London think-tank, has concluded: 'People in developed countries need to recognise the huge impact that their lifestyles have on the rest of the world, especially in the context of global food markets. In addition to the growing use of biofuels, Western diets – full of meat and dairy products – are massively inefficient in terms of water, energy and grain use, and produce more CO₂ as well...Fundamental questions of fairness are at stake.'⁸⁰

A number of studies carried out in Europe, the US and Japan have shown that increasing the quantity of meat in a person's diet increases the global warming potential and decreases the energy efficiency of that diet. A more carefully chosen diet that is low in meat and is seasonal and local can greatly reduce an individual's carbon footprint – and can be a more important environmental choice than the means of transport.

A 2009 study carried out by climate scientists in the Netherlands has shown that reducing global meat consumption could free up one million km² of cropland and 27 million km² of pasture that could be used to store large amounts of carbon as the vegetation re-grows. The scientists estimated that if the world made a global transition to a healthy low-meat diet during the period 2010 – 2030, this would reduce by 50% the cost of the climate mitigation measures that we need to undertake in the period up to 2050. The low-meat diet was based on healthy eating guidelines from Harvard Medical School and would therefore also have significant global health benefits.⁸¹

Research in Sweden has compared various nutritionally-balanced meals consisting of 'domestic' and 'non-domestic' (i.e. imported) food items. It was found that a locally-produced vegetarian meal had only one

ninth the GWP of a meal that contained pork and a non-domestic food item. The 'domestic' vegetarian meal produced the lowest level of GHG emissions for the highest level of nutrients (protein, calories and beta-carotene) followed by the 'domestic' meal containing pork.⁴⁶

Calculations on a wide range of foods in Sweden show big differences between the energy inputs needed to produce portions of different food items. Portions of meat and animal products are nearly always more energy-demanding than plant-based products (pulses, grains, pasta, vegetables, fruit) and imported foods usually consume more energy than domestically-produced foods (Table 12). The highest energy input is required by beef, cod and farmed salmon. The energy input for domestic pork is over three times the energy input for imported soya beans.⁴⁷ (Soya is a significant component of commercial pig feed, illustrating the inefficiency of our animal food system.)

Research from the University of Chicago has shown similar results by looking at several variations on the average American diet. Variations included higher meat, higher fish, higher poultry or vegetarian (including dairy and eggs) diets. Food items differ widely in their energy efficiency, that is the quantity of food energy (calories) they provide, divided by the quantity of energy needed to produce them. The researchers found that increasing the animal-product component of any diet decreases the energy efficiency of the diet and increases the methane and nitrous oxide emissions from its production.⁴⁸

The results for the US showed that the energy efficiency of vegetable foods is very much greater than energy efficiency of animal products; for example, soya is 65 times as energy efficient as grain-fed beef and 73 times as energy efficient as farmed salmon, per unit of food energy (calories) consumed.⁴⁸

Box 4. Projected GHG emission increases if no action is taken.

Agricultural N₂O emissions are projected to increase by up to 35-60% by 2030 due to increased manure production and N fertiliser use. If CH₄ emissions grow in proportion to animal numbers, livestock-related methane production is expected to increase by 60% to 2030 (enteric fermentation and manure management).¹⁹

Some developing regions will have very high increases: East Asia, including China and India, is predicted to increase emissions from enteric fermentation by 153% and manure management by 86% between 1990 and 2020.¹⁹ Africa, Latin America (mainly Brazil and Argentina) and the Middle East are predicted to increase nitrous oxide emissions (mainly due to animal manure) by over 100%.³⁴ Increases in pig and poultry production globally are expected to contribute largely to these rises.³⁴

Developed countries in North America and the Pacific (mainly Australia and New Zealand) are also likely to increase emissions by around one-fifth, both largely due to increased quantities of animal manure.¹⁹

Western Europe is the only region where emissions are falling and predicted to continue to decrease by 2020.¹⁹ This is attributed to a reduction in animal numbers and environmental regulation.

The very large increases in developing regions, which are unlikely to be easily controlled, make it all the more essential that emissions are cut drastically in developed countries in order to reduce the global total.

The Chicago study concludes that the average American diet, when compared with an entirely plant-based diet of the same protein and calorific content, results in increased CO₂ emissions of 701 kg per person per year. This equates to roughly a third of the GHG costs of a person's use of a standard car for personal transportation. Considering the total GHG impact of different diets, the scientists comment:

'To place the planetary consequences of dietary choices in a broader context, note that at mean US calorific efficiency, it only requires a dietary intake from animal products of [approximately] 20%, well below the national average, 27.7%, to increase one's GHG footprint by an amount similar to the difference between an ultra efficient hybrid (Prius) and an average sedan (Camry).

For a person consuming a red meat diet at [approximately] 35% of calories from animal sources, the added GHG burden above that of a plant eater equals the difference between driving a Camry and an SUV [sports utility vehicle].⁴⁸

A study of beef production in Japan published in 2007 showed that the production of one beef calf emitted 4.5 tonnes of GHG (CO₂ equivalent) and required over 16 giga joules of fossil fuel energy.³¹

According to a calculation in *New Scientist* magazine, this means that the production of 1 kg of Japanese beef (excluding the farm infrastructure and transport) is equivalent to the amount of CO₂ emitted by the average European car driven for 250 km, and burns enough energy to run a low-wattage light bulb for 20 days.⁴⁹

A 2007 calculation based on Australia's National Greenhouse Gas Inventory estimated that average beef consumption in the Australian diet is equivalent to 1.45 tonnes of greenhouse gas per person per year. This is more than the difference between a year's emissions from driving a standard car compared to an energy efficient hybrid car.⁵⁰

The health risks of a diet high in beef burgers and other 'fast foods' are already well known. Public health experts also believe that there would be many health benefits to people in developed countries in adopting a diet much lower in meat and dairy products and higher in plant-based food.^{2, 51} Another major advantage of a reduction in meat consumption is that it is one of the quickest, easiest and least costly steps that any individual in a developed country can take to reduce his or her carbon footprint.

PART 2: BALANCING NEEDS & SOLUTIONS

5.0 How to reduce livestock-related GHGs globally

Livestock-related GHG emissions are now recognised to be a significant contribution to global warming. It is also agreed that large reductions in livestock-related GHGs are needed. According to the FAO, the environmental impact of livestock production must be cut by at least half.¹⁴ In spite of these concerns, most of the mitigation proposals put forward aim at relatively small adjustments and have so far avoided reassessing the goals and structure of the global animal production industry. The essential questions – what level of animal products are needed? What is the most environmentally and animal-friendly way to produce them? – have not yet been asked.

Various strategies and technical options have been put forward to cut emissions while maintaining or increasing current levels of production of meat and milk. These range from proposed changes to feed composition to manipulation of animals' digestive systems, to intensifying animal production. Compassion in World Farming finds these strategies unconvincing and inadequate to the task. Most of them are hardly realistic or cost effective in the context of practice on farm, especially among small farmers. Others are unacceptable on ethical or political grounds. Studies have in any case shown that the proposed mitigation routes could only succeed in reducing emissions by up to 20%;² very much less than is needed. Most importantly, none of the proposed management changes could be made effective in the short time scale that is essential to prevent further GHG emissions and limit future global warming.

The FAO has pointed out that it is essential that the animal production industry pays the external costs of their activities (such as climate change and other environmental damage).¹⁴

Compassion in World Farming agrees with the Stern Review that: 'The first essential element of carbon change policy is carbon pricing'.⁵² This policy must now be applied to the production and consumption of meat and other animal products.

5.1 Assessment of some mitigation strategies offered by experts

Mitigation refers to measures that could limit the eventual global temperature rise by reducing current and future GHG emissions. Measures relating to livestock-related GHGs by experts such as the FAO and IPCC;^{3, 21} include the following:

1. Reversal of deforestation and land degradation due to over-cultivation or overgrazing: these include incentives for conservation and re-forestation in the Amazon and other tropical areas; restoring organic carbon in soils, conservation tillage (i.e. leaving over 30% of crop residues on the soil surface, minimising disturbance of soil by ploughing, etc.), organic farming, reversing soil carbon losses from degraded pastures by better grazing practices, including optimising grazing animal numbers (i.e. to benefit from manure and vegetation management while avoiding overgrazing).
2. Better management of manure and fertiliser; better use of anaerobic digesters to produce methane for fuel from slurries; reduction of energy use in animal housing and use of 'green' energy sources.
3. Changes to feed or chemical treatment of animals to reduce both production of methane in digestion and losses of nitrogen (including nitrous oxide) from manure: these include optimising the nitrogen content of feed to increase absorption and reduce nitrogen excretion; using higher quality and less fibrous feed to reduce production of methane in the gut; dietary additives, including antibiotics, to reduce methane production; vaccination of animals against methane-producing gut bacteria.

Better targeting of fertiliser use and manure spreading are obviously good practices and arguably should already be normal farming practices in developed countries. Greener energy sources, including the use of waste organic matter, are also obviously necessary. But the dietary and chemical treatments proposed for animal management are unlikely to be feasible, either technically or financially, for most farmers.

Some of the strategies are likely to be self-defeating. Feeding cattle a diet that is lower in fibrous material and higher in grain does reduce the amount of methane the animals produce by their digestive processes because feed that is less fibrous requires less fermentation in the rumen. However, this would require even greater production of specialised feedstuffs, which is already one of the main causes of livestock GHG emissions. There would also be other environmental damage such as overuse of land and water and nitrogen pollution from mineral fertiliser.

From the point of view of the cattle the strategy is also very questionable, since cattle are designed to digest fibrous food and suffer (for example from acidosis) if they are fed too high a proportion of concentrate feed. Organic farming cattle standards, for example, require that at least 60% of the dry matter in cattle diet is in the form of fibrous foods (grass, silage, etc.) for this reason.⁵³ High-quality animal feed is out of the reach of poor communities and would compete with the much greater need of producing food for people, especially in the context of harvest failures due to climate change. Feed-crops are also coming into competition with the need to use land for biofuels.

In the opinion of Compassion in World Farming, whilst better management of land, manure and fertilisers are useful and necessary, none of the strategies offered has the realistic potential to achieve the large and rapid reduction in global GHG emissions that is needed. According to a 2007 report from an international group of scientists, 'available technologies for reduction of emissions from livestock production, applied universally at realistic costs, would reduce non-carbon dioxide emissions by less than 20%'.²

5.2 Why intensive animal production is the wrong answer

Most of the GHG emissions from livestock production, even in developed countries where concentrate feed, fertiliser and machinery are used, arise from the natural biological processes (i.e. methane and nitrous oxide from digestion and manure). They are thus to a great extent a 'given' for that animal.

For this reason, one strategy recommended by some agricultural scientists is to increase the yield per individual animal and thus reduce the GHG emissions per kg of product (meat, milk, eggs). This essentially means working the animals harder and getting more product out of them during their lifetimes, either by reducing their lifetimes or by increasing their output, or both. This could be done by growing young calves, piglets, chickens and lambs to their slaughterweight in a shorter time and being bred to have more muscle, cows producing more milk per year, breeding animals producing more young and with a reduced turnaround time between giving birth. The suggestion has even been made that more dairy cows should be injected with the growth hormone BST (bovine somatotrophin) to increase milk production.¹⁹ BST has been banned in the EU because of its risks to animal welfare, although it is quite commonly used in US dairy production.

Compassion in World Farming considers that the intensification of animal production would be a deeply flawed response to global warming, from the practical, environmental and animal welfare points of view. It would also be ethically and politically unacceptable to consumers in developed countries, where concern about the welfare and environmental effects of farming, and the demand for free-range and organic animal products, is rapidly increasing.

A Eurobarometer survey found that 58% of EU25 citizens in 2005 considered the welfare of hens in Europe to be 'fairly bad' or 'very bad' and 38% stated that they chose to buy eggs from free-range or outdoor systems (50% or more in seven countries, including

Germany, Sweden, Denmark and the UK). 42% said that the welfare of laying hens and meat chickens needed to be improved the most. In the same survey, 44% of EU25 citizens considered the welfare of pigs to be 'fairly bad' or 'very bad'.⁵⁴ The large majority of laying hens, meat chickens and pigs in the EU25 are kept in intensive systems and the survey shows that a significant proportion of public opinion is unhappy about this production method. Many people in developing countries may well take the same view.

Further intensification of animal production would almost certainly mean rearing more pigs and poultry (non-ruminants), probably in industrial conditions, and relatively fewer cattle and sheep (ruminants).

Exchanging pasture-based animal farming for an expansion of pig and chicken factory farms would be a very unpopular choice in many developed countries. Furthermore there is no reason to think that this unpopular strategy would deliver a rapid and adequate reduction in GHG emissions.

In developed countries, where many believe intensification of animal production has already gone too far, it is unrealistic to suppose that a further increase in yield per animal could take place rapidly enough and be large enough to meet climate targets.

Studies of dairy production have shown that the relationship between high yield, intake of concentrate feed and cow lifetime is far from simple and is unlikely to be easy to optimise to create a really significant reduction in GHG emissions.^{27, 55} Chickens, pigs and dairy cows are already very high-yielding and in some cases this has already led to health problems as the animals are pushed to their physiological limits in the drive to increase productivity; lameness and heart disease are common among fast-growing meat chickens, breeding pigs increasingly suffer from lameness and high-yielding dairy cows are more likely to suffer from lameness, mastitis and infertility.^{56, 60}

Conversely, pigs and poultry in organic and free-range systems are less stressed and generally somewhat less high-yielding than in factory farm pig and poultry production. Organic pigmeat production has a lower global warming potential per kg than does intensive pigmeat production and the GHG emissions for free-range poultry meat are only slightly higher than for factory farmed poultry meat.²⁶

Organic farmers, as well as scientific studies⁵⁵ and the IPCC 4th Assessment¹⁹ point out that increasing yield per animal can be counter-productive if it means that more replacement animals have to be reared because breeding animals are worn out sooner. On high-yielding dairy farms, the cows are replaced more frequently²⁶ as a result of infertility and ill-health. During the time that a replacement heifer is being reared (about two years to first lactation) she is eating, excreting and emitting CH₄ from enteric fermentation without producing milk, therefore reducing the overall production per animal and increasing the GHG emissions of the herd as a whole.⁵⁵

Intensification and the resultant stress on the animals are also regarded as significant factors in fast-spreading infections such as Porcine Reproductive and Respiratory syndrome (PRRS) and highly pathogenic avian influenza (HPAI). Such infections damage productivity and cause large financial burdens to the industry and often to taxpayers in costs of disease control and monitoring.^{61, 62}

Intensification of animal farming is a bankrupt strategy from the point of view of halting climate change and from environmental and animal welfare perspectives. Compassion in World Farming is disappointed that some agricultural scientists are approaching the livestock global warming conundrum by calling for 'more of the same', rather than looking afresh at the whole issue of how best our society should rear animals for food.

5.3 Why a reduction in animal production is the most effective solution

A reduction in the size of the livestock industry in developed countries is the simplest, quickest and probably the only effective method of cutting GHGs from animal production to the extent that is necessary to prevent the future increase of global warming.

Evidence already exists from Europe that reducing meat consumption and animal numbers reduces GHG emissions. The IPCC's 4th Mitigation Draft Report on Agriculture notes that Western Europe is the only world region where emissions are falling and are predicted to continue to decrease by 2020. This decrease has occurred in large part because of a reduction in the size of the animal production industry in the EU, partly as a result of environmental regulation designed to reduce pollution. A 2001 study of ways to reduce GHG emissions from meat production in Belgium from the Federal Office of Scientific, Technical and Cultural Affairs, concluded that reducing meat consumption 'would have a significant impact on the global GHG emissions'.²⁸ According to the report, all studies show that a reduction in livestock numbers is always the most efficient measure to reduce GHG emissions. The study calculated that a 10% reduction in livestock numbers in the country would reduce annual GHG emissions by 0.242 million tonnes CO₂ equivalent.²⁸

Recent research from the public health departments of the Australian National University, Cambridge University, The London School of Hygiene and the University of Chile, has confirmed the essential role of reducing meat consumption in high-income, developed countries in order to reduce GHG emissions. Merely to prevent an increase in GHGs from the livestock production sector, the researchers calculated that an overall cut of 10% in global meat consumption is required, limiting consumption to 90 g per person per day.²

The target consumption of 90 g per person per day would be equal to a reduction in average meat consumption in rich countries of between 55% and 64%. For poorer and

developing countries, where average per capita meat consumption is one tenth of that in developed countries, the target would allow continued growth in consumption.² These public health scientists consider that this level of meat reduction would offer 'important gains to health' for people who currently consume more than the 90 g per day. The benefits would include a likely reduction in risk of colorectal cancer, breast cancer and heart disease, as well as the risk of becoming overweight or obese. The likely reductions in heart disease would be mainly due to reducing the consumption of saturated fat in meat.²

There is therefore abundant evidence that reducing meat production and consumption in developed, high-income countries has a number of benefits for society, besides the main goal of limiting future global warming. These benefits are very wide-ranging and include:

- Reducing the adverse environmental impacts of intensive animal farming
- Reducing the adverse animal welfare impacts of intensive farming
- Providing a market for higher-welfare meat, milk and eggs
- Improving public health through dietary changes and reducing medical costs
- Protecting biodiversity and landscape
- Reducing the economic costs of livestock diseases (Foot and Mouth Disease, Avian Influenza and Swine Flu).

5.4 Opportunities and benefits of a down-sized animal production industry

A reduction in the size of the animal production industry and in the consumption of meat and milk products would open new opportunities for both farmers and consumers. In the present culture of high consumption of animal products, many consumers who would prefer to buy high-welfare free-range or organic meat or milk cannot afford to do so. Similarly, farmers who would prefer to farm free-range or organically say that they cannot obtain the necessary price premium from retailers to enable them to do so.

Table 13. Why factory farming is not a solution.

Environmental impacts of factory farming	Animal welfare impacts of factory farming
Unsustainable pressure on land for production of high protein/high energy animal feed	Close confinement systems (cages, crates) or lifetime confinement in indoor sheds
Pesticide, herbicide and fertiliser manufacture and use for feed production	Pain and injuries caused by inappropriate flooring and housing
Pollution of soil, water and air by nitrogen and phosphorus from fertiliser used for feed-crops and from manure	Restriction or prevention of normal exercise and most of natural foraging or exploratory behaviour. Restriction or prevention of natural maternal nesting behaviour
Unsustainable use of water for feed-crops, including groundwater extraction	Lack of daylight or fresh air and poor air quality in animal sheds
Deforestation for animal feed production	Social stress and injuries caused by overcrowding
Land degradation (reduced fertility, soil compaction, increased salinity, desertification)	Health problems caused by extreme selective breeding and management for fast growth and high productivity
Loss of biodiversity due to eutrophication, acidification, pesticides and herbicides	Reduced lifetime (longevity) of breeding animals (dairy cows, breeding sows)
Worldwide reduction of genetic diversity of livestock and loss of traditional breeds	Fast-spreading diseases encouraged by crowding and stress in intensive conditions
Species extinctions due to livestock-related habitat destruction (especially feed-cropping)	

In a regime of lower production and consumption of animal products, society would consume less but consume higher quality meat and milk. We would buy a lower volume of products but pay more per unit consumed. The price difference would probably be similar to the current premium for best quality free-range and organic products. This would support the livelihoods of farmers to the same level as, or better than, the current high-production regime. It would empower farmers to produce fewer animals but to rear them to the same high welfare and environmental standards as the best free-range farms achieve today. It would revolutionise animal welfare standards and see the end of factory farming.

6.0 How much do we need to reduce animal production?

We have seen that a reduction in the level of animal production and the consumption of animal products would achieve very large gains in limiting climate change, protecting the environment and improving public health. This section examines the magnitude of each of these benefits in order to help determine the level of reduction in animal production that is required.

Scientific evidence shows that if nothing is done to reduce emissions, the level of GHGs in the atmosphere could be three times the pre-industrial levels by the end of this century and, that this could lead to a future rise in temperature of 5°C. Five degrees centigrade is the difference between the global temperature during the last ice age and the current global temperature, and therefore could have unknown and massive effects on the world in the coming century.⁶³

Because of past GHG emissions, a rise of 1°C is already inevitable. The EU and the UK are aiming to limit the eventual future temperature rise to 2°C. In order to achieve this, the GHG level in the atmosphere needs to be stabilised at 450 parts per million (ppm) CO₂ equivalent. This would require, according to the conclusions of the Stern Review, global emissions in 2050 being 70% below current levels.⁶⁴

EU Heads of Government have agreed a European target of 20-30% reduction compared to 1990 levels by 2020.²³ The countries of the UK (England, Scotland, Wales and Northern Ireland) are committed to a target of a 60% reduction in emissions compared to 1990 levels by 2050 and a reduction of around 30% compared to 1990 levels by 2020.²³ (1990 levels for the UK are slightly higher than current levels. The UK has reduced overall GHG emissions since 1990 but looks set to miss its domestic target for carbon dioxide reduction.)²³ Recent scientific research suggests that a 60% target is not nearly enough to limit global warming to 2°C. The Tyndall Centre for Climate Change has argued that UK cuts of up to 70% by 2030 and 90% by 2050 are required to stabilise atmospheric GHG levels at 450 ppm. A 2007 report by the House of Commons Environmental Audit Committee has criticised the government target of 60% cuts as too low and stated that it should be strengthened to take current science into account.²⁴ US scientists similarly argue that the US needs to cut emissions down to at least 80% below 2000 levels by 2050 in order to achieve the limit of 450 ppm.²⁴

As the Stern Review pointed out: 'Climate change is global in its causes and consequences, and international collective action will be critical in driving an effective, efficient and equitable response on the scale required'.⁶⁴ The livestock-related emissions in any one country or region affect the whole world's climate. Real cuts in livestock-related GHG emissions by high-income countries would therefore reduce the total of global emissions and benefit the whole world. This is particularly important because poor countries are those most likely to be damaged by global warming.⁶⁴

6.1 Meeting GHG emission reduction targets

Current research suggests that the UK and other developed countries need to reduce GHG emissions by well over half by 2050. It is possible that a 90% cut will be needed. These targets require immediate action if they are to be achieved.

The targets of 60% cuts by 2050 and 30% by 2020 are likely to become statutory in the UK and the rest of the European Union.

Compassion in World Farming believes that the livestock industry must take its share of these cuts by reducing livestock production in line with the targets. We have seen that a reduction in animal production is the only rapid method to lower GHG emissions from this sector.

6.1.1 Meat production in developing countries

The meat reduction target proposed would initially apply only to developed, high-income countries, where consumption is currently very high and there is the potential for substantial cuts without detriment to either consumers or farmers. It leaves at least half of global emissions that come from animal production in developing countries untouched.

As examples, the per capita meat supply in China is already nearly 80% of that in the UK¹ and Brazil has a very large export trade in animal products. These countries may need to re-assess their production levels in future, when their domestic nutritional needs have been met. Meanwhile, in both developed and developing countries all feasible mitigation measures such as reforestation, increasing soil fertility, reduction and better targeting of fertiliser use, minimisation of transport, reduction in fossil fuel energy use, use of green energy and better management of wastes should be pursued as rapidly as possible.

6.2 Additional targets for reducing animal production

There are additional important reasons why we should plan for a reduction in livestock production and consumption. These are related to human health (becoming overweight or obese) and to the protection of biodiversity (globally and on farmland).

6.2.1 Meeting targets to improve human health

The current epidemic of excess weight and obesity in developed countries (and among higher-income people in developing countries) has a number of causes, but a substantial contributor is the over-consumption of animal products (meat and dairy) and under-consumption of vegetables and fruits.

According to a World Health Organization (WHO) paper on social inequalities and food-related ill-health: 'An energy-dense diet high in saturated fat and low in foods of plant origin, together with a sedentary lifestyle, is the major cause of the pan-European epidemic in obesity and becoming overweight, with increased risk of non-communicable diseases including cardiovascular diseases, certain cancers and diabetes'.⁶⁵

The WHO's European Anti-Obesity Charter of 2006 reported that 50% of Europe's adults and 20% of children are overweight. 16.5% of adults and 7% of children are classified as obese.¹⁰ Over 20% of children are overweight in the following countries of the EU15: Spain, Greece, Portugal, England, Belgium, Italy, France, Austria and Sweden. More than a million deaths annually can be attributed to being overweight. Adult obesity and excess weight is responsible for up to 6% of the entire health care costs in the European region.¹⁰

In the UK, a government target to reduce adult obesity to 6% of men and 8% of women by 2005 has completely failed according to the 2007 Wanless report on health. In 2005, 23% of men and 25% of women were classified as obese.⁶⁶ The health costs of obesity were estimated at up to GBP £3.7 million (US\$1.9 million) in 2002 and have certainly increased since then. The National Audit Office has calculated the potential gains from reducing this problem; one million fewer obese people in England could mean around 15,000 fewer people with coronary heart disease, 34,000 fewer people developing Type 2 diabetes and 99,000 fewer people with high blood pressure. However, given current diets, the present situation

looks difficult to change. While the UK Government recommends consumption of five portions of fresh fruit and vegetables per person per day, only 28% of adults and 17% of children meet this target.⁶⁶

In view of this situation, it is clear that any improvement in diet that could reduce obesity and excess weight would bring enormous benefits to individuals and cost savings to society. Evidence from the US suggests very considerable overproduction and over-consumption of food, including animal-based foods. Total daily calorie consumption per person per day (including wastage) in the US is estimated at 80% more than the required daily calorie intake.⁴⁸ Recent estimates from public health experts in three countries suggest that a reduction in meat consumption in developed countries from the current 200-250 g per person per day to 90 g per person per day (i.e. a reduction of around 60%) would reduce excess weight and obesity and offer several other health benefits.²

In late 2007 the World Cancer Research Fund and the American Institute for Cancer Research jointly published a report on nutrition and cancer prevention, which reviewed all relevant research and made a series of recommendations for both public health goals and personal actions on diet. The report cited both red meat (i.e. meat from cattle, pigs, sheep and goats) and processed meat (meats preserved by salting, smoking, curing or the addition of preservatives, such as ham, salami, bacon and sausages) as "a convincing cause of colorectal cancer" and asserted that there is limited evidence linking both to a range of other cancers, such as pancreatic cancer.⁶⁷ Although milk may be a "probable" protector against colorectal cancer, the report stated that there is limited evidence suggesting that both milk and dairy products are a cause of prostate cancer and that cheese is a cause of colorectal cancer. Diets high in calcium are a probable cause of prostate cancer.⁶⁸ The report cites "a limited amount of fairly consistent evidence" suggesting that animal fats are a cause of colorectal cancer.⁶⁹

A study from the US National Institutes of Health, published in late 2007, showed that those who eat a lot of red and processed meat have a 20% greater risk of developing colorectal cancer and a 16% increased risk for lung cancer. This study also showed statistically elevated risks for oesophageal and liver cancers.⁷⁰

The World Cancer Research Fund report recommends a public health goal of consumption of no more than 300 g red meat a week, with a personal goal of less than 500 g a week, 'very little if any to be processed'.⁷¹ It recommends a diet composed mostly of 'foods of plant origin', with a public health goal of 600 g non-starchy vegetables and fruit daily and a personal recommendation of at least 400 g daily. In addition the report recommends consumption of relatively unprocessed cereals and pulses with every meal.⁷¹ The report states that obesity and being overweight increase risk of some cancers, but also risk of other conditions such as stroke, Type 2 diabetes and coronary heart disease.⁷¹ These strong recommendations, based on the best global scientific studies, add strength to arguments for a reduction in livestock production and consumption.

6.2.2 Meeting targets to protect and enhance biodiversity

Animal production-induced damage to wildlife habitats is one of the major threats to biodiversity globally. According to the FAO: 'Livestock play an important role in the current biodiversity crisis, as they contribute directly or indirectly to all these drivers of biodiversity loss, at the local and global level' through habitat change, climate change, overexploitation and pollution and 'over 70% of globally threatened birds are said to be impacted by agricultural activities'.⁷² Livestock are one of the major drivers of habitat change, whether for feed production or direct livestock production, and contribute directly by overgrazing and overstocking to deforestation and desertification.

The FAO notes that projected land use changes up to 2010 are likely to increase deforestation still further in protected areas of central and South America. These threatened countries and areas include Guatemala (mainly Laguna

del Tigre National Park), the eastern Venezuelan Amazon, the Colombian National Park Sierra de la Macarena and the Cuyabeno reserve in north-eastern Ecuador. The majority of this projected deforestation is linked to providing pasture for animal production.⁷²

Research by conservation organisations has also highlighted the threat from the expansion of animal production. WWF reports that livestock production is a current threat to 306 of 825 identified terrestrial eco-regions. Conservation International reports that 23 of 35 identified global biodiversity loss hotspots are 'affected by livestock production'. The World Conservation Union (IUCN) Red List of Threatened Species shows that 'most of these are suffering habitat loss where livestock production is a factor'.¹⁴

On the positive side, it has been shown that biodiversity is protected by organic farming methods, where the density of livestock is relatively low and mineral fertilisers and pesticides are not permitted. A survey of the European evidence published in 2005 showed that organic farming has major benefits for biodiversity: organic farms have on average 50% more plant species than intensive farms, twice as many skylarks, 40% more birds overall, twice as many butterflies, 60% more arthropods that comprise bird food, five times as many spiders overall and twice as many spider species.⁷³

The most serious threat to present and future biodiversity is climate change. A rise of 2°C in global temperatures could result in the extinction of 15% – 40% of land species and the destruction of coral reefs and tropical mountain habitats. Up to 60% of South African mammal species could be lost. A rise of 3°C or more, which is likely if GHG reductions are not made urgently enough, could see the extinction of up to half of all land species. Biodiversity 'hotspots' could lose thousands of species.⁷⁴

This evidence emphasises again the urgency of reducing the global warming potential of animal production, in line with current or future GHG reduction targets for other sectors of the economy. Reduction of livestock production and consumption is the only quick and effective way to achieve these reductions.

7.0 How could meat reduction best be achieved?

The target of more than halving the production and consumption of farmed meat and dairy over the coming decades in developed countries should be considered the minimum action that is required. But this target will require careful management of change in order to protect the livelihoods of farmers and associated businesses, and the purchasing power of lower-income consumers. We propose that the following steps, involving individuals, industry, governments and international cooperation, need to be considered in order to achieve this necessary transition.

7.1 Incorporating carbon costs into production and consumption of animal foods

Compassion in World Farming agrees with the Stern Review that: 'The first essential element of carbon change policy is carbon pricing,¹⁵² and with the FAO that: 'A top priority is to achieve prices and fees that reflect the full environmental costs [of livestock production], including all externalities ...[E]conomic and environmental externalities should be built into prices by selective taxing and/or fees for resource use, inputs and wastes'.¹⁴

This requirement means that the production costs and consumer prices of meat, milk and eggs should reflect their real environmental costs in terms of their global warming potential. This adjustment would increase the price of animal-based foods relative to most plant-based foods. It would discourage over consumption of animal-based foods and encourage higher consumption of plant-based foods that have a lower global warming potential.

7.2 Support for consumer decision-making on diet and carbon footprinting

A significant proportion of consumers now believe that an individual has to take responsibility for his or her carbon footprint. For this to happen in relation to food choices, consumers need accurate and standardised information about the carbon footprint of meat and dairy products.

Calculations of the global warming potential of general classes of products have already been made by the European Commission.⁷ Organisations such as the Carbon Trust in the UK are coordinating industry and retailer efforts to calculate the carbon footprint of products and achieve standardised carbon auditing and labelling systems for consumers.⁷⁵ Again in the UK, the Royal Society of Arts has proposed an individual carbon credit scheme that could operate in a similar way to a bank debit card.⁷⁶ These organisations should be encouraged to include the majority GHG emissions associated with livestock products (methane and nitrous oxide) at an early stage. It is also important that auditing and labelling schemes include other important areas of consumer concern, such as Fair Trade, environment and animal welfare.⁷⁷

7.3 Targets for reduction in livestock production

Although action by industry and individuals will be important, we foresee that livestock reduction targets will also need to be set. These could be EU-wide and incorporated into a strengthened European Emissions Trading Scheme or coordinated by the OECD Trade and Agriculture Directorate.

7.4 Governmental fiscal incentives for meat reduction

Fiscal incentives will be essential to manage the transition to lower volume, higher welfare animal farming by supporting farmers while discouraging overproduction and over-consumption. These incentives could take the form of direct taxes on meat consumption and tax advantages or direct support for low-density, free-range and organic animal farming. They could include 'green taxes' on fertiliser, pesticide and herbicide use and on the production of human-edible crops that are used or sold for animal feed.

7.5 Protecting purchasing power of low-income consumers

Low density, high welfare animal farming generally involves some increase in production costs compared to intensive farming. However, it seems likely that retailers currently put a higher price premium on some free-range and organic products than is justified by the actual difference in production and distribution costs. It would be necessary to discourage any such practice and to make financial support arrangements for low-income consumers. The large savings envisaged in health care costs as a result of reduced meat and dairy consumption and increased consumption of vegetables and fruit could be used to finance these changes.

7.6 Strengthening statutory animal welfare standards

In order to support the transition to low-density, high welfare animal farming, the current legal animal welfare standards would need to be upgraded to bring them up to the current level of the best free-range and organic farmers. A number of possible benchmarks already exist internationally for high welfare livestock production standards (for example, in the UK, the Soil Association standards for livestock might be one possibility). In addition, all imported meat, dairy and egg products would need to be required to meet these welfare standards, in order to avoid intensively-produced imports from undermining the meat reduction strategy.

It will be important that consumers are made aware of the large improvement in welfare standards associated with the meat reduction strategy. The European Commission could take on the task of disseminating this information.

7.7 Localisation of production and consumption

It will also be necessary to reduce transport-related CO₂ emissions and discourage the import of human-edible animal feed, for example from deforested areas in South America. For this reason, the entire animal production chain should be localised as far as possible. This should include the use of feed

grown and processed locally, local slaughtering and short-range distribution and consumption of animal products. The popularity of 'farmers' markets' suggests that both farmers and consumers would support this policy. It would also be likely to bring economic and social benefits to local communities.

8.0 CONCLUSIONS AND RECOMMENDATIONS

Combating climate change through high animal welfare farming in Europe

The evidence presented in this report has shown that GHG emissions related to livestock production are one of the major potential causes of human-induced global warming. While comparable in magnitude of emissions to transport, the livestock source has not so far received the policy attention merited by its size and it has been relatively neglected by current governmental and intergovernmental targets and carbon pricing schemes that focus on energy-related CO₂ emissions.

If the projected doubling in global meat production takes place (mostly in poor and developing countries), methane and nitrous oxide emission from the digestion and manure of animals will continue to rise steeply, the demand for feed-crops will lead to further deforestation, overuse of scarce water resources, competition for arable land, damage to soil fertility and desertification of grazing land. These trends can only exacerbate the unavoidable effects of climate change, such as floods, drought and harvest failures. Resource conflicts, human conflicts and human and animal suffering are almost certain to be increased by current livestock production trends.

The majority of the GHG emissions due to livestock, even in developed countries where energy use is higher, come from the natural biological processes of farmed animals. Technical ways of reducing these types of emissions are limited, costly and unlikely to provide the short-term emission reductions in developed countries that are needed if eventual global warming is to be limited to 2°C.

Further intensification of animal production as a means of reducing livestock GHGs per unit of product would be unethical and politically unacceptable to the European public who are increasingly concerned about animal welfare

standards and environmental issues such as soil and water pollution, biodiversity on farmland and conservation of landscape. Intensification is also implausible as a short-term strategy, since pig and poultry production is largely already industrialised in developed countries.

Meat and other animal products are currently underpriced in relation to their real costs to the environment and to animal welfare and to their impact on climate change. An effective mitigation policy requires that the full carbon costs of the production and consumption of meat are reflected in prices.

Compassion in World Farming believes that there is now an opportunity for constructive change that will make a significant contribution to reducing global GHG emissions while also benefiting animal welfare, human health and nutrition and the environment:

- The most effective and fastest-acting strategy for reducing livestock-related emissions globally is a planned and well-managed reduction in livestock production and consumption in developed countries, where there is already considerable over-consumption of meat and dairy products.
- Meat and dairy are currently under-priced in relation to their real environmental and carbon costs. Under this proposal, consumers would eat a lower volume of higher quality meat and dairy products, preferably from local farmers. Farmers would earn a premium for their products and higher prices would reflect the carbon costs of consuming meat and dairy.
- A reduction in meat and dairy consumption is one of the quickest, simplest and least expensive ways in which an individual can reduce his or her carbon footprint in a developed society. Studies have shown that reducing meat consumption is equivalent to an individual cutting out hundreds of kilometres of car travel or switching to a carbon-efficient hybrid car.

- A meat reduction strategy would enable existing farmers to reduce stocking density, move from intensive to extensive methods and raise animal welfare standards up to the best free-range and organic farming standards of today, while protecting their livelihoods. Imported products should be required to meet the same standards.
 - Governmental and intergovernmental targets and incentives for both producers and consumers would be needed to support this transition, including protecting the purchasing power of low-income consumers.
 - In line with current European and UK GHG reduction targets, livestock production and consumption in developed countries should be reduced to one third below current levels by 2020 and to 60% below current levels by 2050. These reductions may need to be increased further in light of scientific evidence.
 - The increasing amount of evidence linking meat consumption with certain serious human health problems may require the adoption of a more stringent target for a reduction in meat consumption.
 - Fast-rising livestock emissions in developing countries, which on average consume a small fraction per capita of animal-based food compared to rich countries, would need to be re-assessed by those countries when their domestic nutritional needs have been met.
 - In both developing and developed countries, all technical and management options such as improved manure storage and spreading methods, reduction and better targeting of fertiliser use, restoration of soil carbon, re-forestation and use of renewable energy sources should be pursued urgently.
- prevalence of obesity, certain heart conditions and cancers, and related health care costs. (A reduction of one third would be equivalent to an individual who eats meat daily eating meat on only five days a week, or alternatively reducing portion sizes of meat and dairy products and substituting plant-based foods such as pulses, grains, vegetables and fruit.)
- Localisation of animal production and consumption would support rural communities and businesses.
 - Reduction in demand for animal feed would allow a reduction in the intensity of arable farming and increase farmland biodiversity.
 - The strategy would also lead to the end of factory farming of animals and facilitate a revolution in standards of farm animal welfare.

The benefits of this strategy are many, in addition to going a long way to meet the urgent task of reducing GHG emissions:

- A significant reduction in consumption of meat and certain dairy products would improve public health and reduce the

APPENDIX

Global production and consumption of animal-based foods

Table A.1: Regional increases in quantities of protein in human diets from 1980 – 2002
(% increase). Source: Steinfeld *et al*, 2006, Table 2.4³⁵

The amount of animal protein (meat, milk and eggs) in diets increased much more than the total protein in diets over the 20 years from 1980 to 2002 in Latin America, developing Asia (i.e. excluding Japan) and in industrialised countries and the world average. There are still large differences between average consumption in Africa, the Near East and developing Asia, including China, and industrialised countries, implying that very large growths in the global consumption of animal protein may occur in future.

	Protein from animal products (g/person/day) and % increase between 1980 and 2002		All protein (g/person/day) and % increase between 1980 and 2002	
	1980	2002	1980	2002
Sub-Saharan Africa	10.4	9.3	53.9	55.1
Near East	18.2	18.1	76.3	80.5
Latin America & Caribbean	27.5	34.1 (+24%)	69.8	77.0 (+10%)
Asia developing	7.0	16.2 (+131%)	53.4	68.9 (+29%)
Industrialised countries	50.8	56.1 (+10%)	95.8	106.4 (+11%)
World	20.0	24.3 (+22%)	66.9	75.3 (+ 13%)

Table A.2: Consumption of meat in selected countries
Source: FAOSTAT¹ 2005

Consumption in 2005: g per person per day					
	Brazil	China	India	UK	USA
Bovine meat	57.2	15.1	6.0	45.6	62.6
Chicken meat*	93.9	21.8	4.7	73.3	121.4
Pigmeat	36.5	104.5	1.2	59.3	48.1
Sheep and goat meat	1.8	10.5	1.7	16.2	1.4
Total in g/day	189.4	151.9	13.7	194.4	233.5
Total in kg/year	69	55	5	71	85

*Note: Duck, goose and turkey meats not included.

Table A.3: World consumption of animal-based food 2005 in tonnes.Source: FAOSTAT, 2006.¹ (FAOSTAT 2007)

Considering only meat and eggs, pigmeat is the most consumed (32.5% of total) followed by chicken meat (22.4%), followed by cattle meat (19%) and eggs (almost 19%). Milk consumed is mainly cow milk (and buffalo milk in India). Milk quantities given in the table below are for liquid milk and therefore tonnage is large compared to meat.

Animal product	Numbers of animals used in year 2005 [1]	Consumption 2005 (tonnes)	Consumption as % of total production of meat and eggs [2]	Consumption as % of meat, eggs and liquid milk [3]
Cattle meat (excl. buffalo)	299 million	60.2 million	19.1	6.5
Pigmeat	1.3 billion	102.4 million	32.5	11.0
Chicken meat	48.1 billion	70.5 million	22.4	7.6
Duck & goose meat	2.5 billion	5.8 million	1.8	0.6
Hen eggs	5.6 billion	59.4 million	18.9	6.4
Sheep meat	543 million	8.5 million	2.7	0.9
Goat meat	371 million	4.6 million	1.5	0.5
Buffalo meat	22 million	3.2 million	1.0	0.3
Total meat & egg consumption		314.6 million	100	33.7
Cow milk [3]	239 million	529.7 million [3]		56.8
Buffalo milk	54 million	67.4 million (mainly India)		7.2
Sheep milk	186 million	8.6 million		0.9
Goat milk	151 million	12.4 million		1.3
Total including milk		932.7 million		

Notes:

[1] The number of meat animals consumed per year is higher than the number of animals living at any one time, e.g. for commercial chickens there may be six 'crops' per year since the birds are slaughtered at around six weeks old. Some of the animals counted by FAO in each category are likely to be dual purpose (i.e. they produce both meat and eggs or meat and milk).

[2] Rabbit, camel and horse meat not included in Table A.3.

[3] The tonnage of milk is large but mainly consists of water (cow milk typically contains 34% fat, 4.5% lactose and around 3% protein by weight, i.e. around 88% water by weight). One tonne of milk dry matter approximately equals 10,000 litres of liquid milk. This means that dairy production requires large quantities of water, over 100 litres a day per cow and increasing in higher temperatures.¹¹

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NOTES

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Climate Change and Farm Animal Welfare

A Report by Compassion in World Farming – 2008

Revised 2009

“Please eat less meat – meat is a very carbon intensive commodity.”

Dr Rajendra Pachauri, 15 January 2008, Paris.

Chair of the Intergovernmental Panel on Climate Change (IPCC)

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CONTACT US

Compassion in World Farming

River Court

Mill Lane

Godalming

Surrey

GU7 1EZ

UK

Tel: +44 (0) 1483 521 950

Email: compassion@ciwf.org.uk

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