World Society for the Protection of Animals

Eating our Future

The environmental impact of industrial animal agriculture

Foreword by Dr RK Pachauri, Chair, Intergovernmental Panel on Climate Change (IPCC)

WSPA

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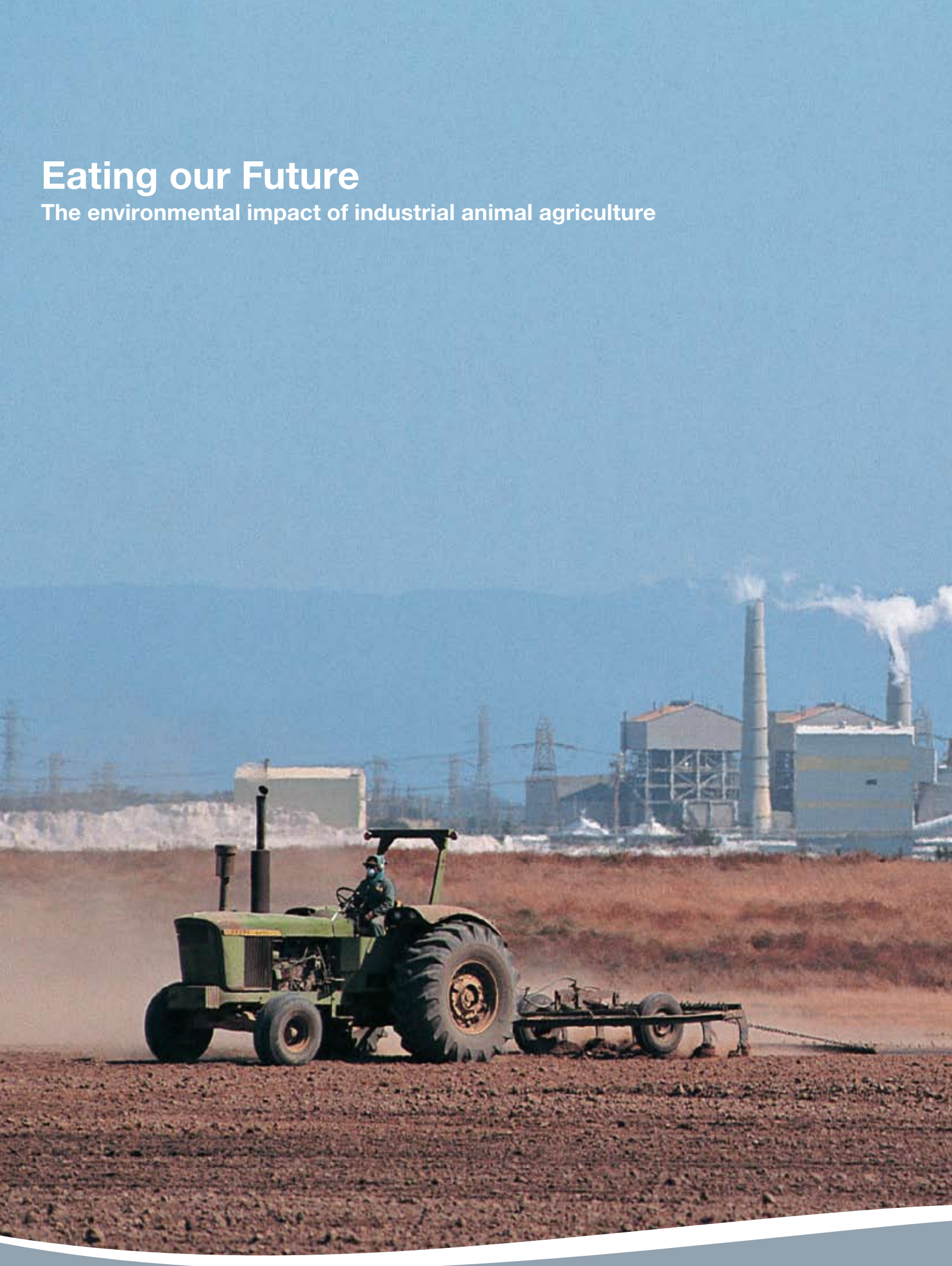

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Author's notes

Written by Dr Michael C Appleby for The World Society for the Protection of Animals (WSPA)

Dr Michael Appleby took a BSc in Zoology at the University of Bristol and a PhD in Animal Behaviour at the University of Cambridge. He then carried out research at the Poultry Research Centre in Scotland and the University of Edinburgh for 20 years on behaviour, husbandry and welfare of farm animals. Publications include six books as author, co-author or co-editor, most recently *Long Distance Transport and Welfare of Farm Animals* (2008). From 2001 to 2005 he was Head of Farm Animals and Sustainable Agriculture for The Humane Society of the United States in Washington, DC. He now works as Chief Scientific Adviser for WSPA.

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Amy Firth, Hélène O'Donnell, Dr Jennifer Lanier, Food Animal Initiative (Oxford)

WSPA International
1st Floor
89 Albert Embankment
London SE1 7TP
United Kingdom

T: +44 207 587 5000
F: +44 207 587 5057
E: wspa@wspa-international.org
W: www.wspa-international.org

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Foreword

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One of the major findings of the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report is the identification of changes in lifestyle and behaviour as a means for mitigation of climate change. Individuals can contribute significantly to reductions of Greenhouse Gas (GHG) emissions, because as consumers they can not only provide powerful messages to those responsible for supply of goods and services, but also impact significantly on emissions caused by their own households. One area of contributions is from the types of food that people consume. In this respect a reduction of meat consumption can have substantial benefits in reducing GHGs. The 2006 report of the Food and Agricultural Organization (FAO), *Livestock's Long Shadow*, found that the world's livestock production industry accounts for 18 per cent of all GHG emissions from human activities. Recent literature dealing with the subject highlights much larger emissions than the FAO report estimated, but even if these claims of higher emission levels are dismissed, the 18 per cent figure itself is large enough to require attention.

Even more important is the fact that this is one mitigation strategy, which has huge co-benefits in the nature of improved health. There is now adequate medical evidence published in prestigious journals to show that a reduction in meat consumption reduces the risk of several diseases that are prevalent in the world's most prosperous societies. Unfortunately, with increases in income several developing countries are also rapidly increasing their consumption of animal protein. This trend should be arrested and the two methods by which such an objective can be met would be firstly to create adequate awareness among the public on the benefits of lower meat consumption and secondly to place a price on carbon, which would then be added to the cost of meat and thereby create a market response in the form of lower consumption at higher prices.

It would also be very useful through regulation and fiscal measures to ensure that a much greater proportion of food consumed is produced within a small radius from the point of consumption. This would ensure a reduction in food miles, and therefore, a reduction in what can be termed factory farming of livestock in concentrated areas. It would be far more effective overall to have consumer response bring about changes that are required than to have governments enter this business for regulating and reducing consumption of meat worldwide. In this respect the report *Eating our Future* is a very valuable publication that will not only stimulate debate and discussion, but perhaps help convince consumers everywhere to rethink their diets to keep themselves healthy as well as the planet.

Dr RK Pachauri
Director General, The Energy and Resources Institute (TERI) and Chair, Intergovernmental Panel on Climate Change (IPCC)

Summary

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Current trends in animal production are literally unsustainable. Worse, animal production makes a major contribution to the climate change that is threatening the future of life on earth, to the scarcity of resources and instability of markets that underlie the worldwide food crisis of 2008 and to other global problems such as poverty and disease. Because of the increasing numbers we keep, the resources we use for them and their impact on the environment, farm animals are eating our future.

Farm animals (including poultry but excluding fish and invertebrates) already make up two-thirds of terrestrial vertebrates by weight, with most of the rest being humans and only three per cent wildlife. Yet at current rates of increase, meat and milk production will more than double from 2000 to 2050. Industrialisation of animal agriculture is an important factor in these trends, with massively increased scale of production and its effects in many countries.

In its 2006 report *Livestock's Long Shadow*, the United Nations Food and Agricultural Organization (FAO) emphasised that livestock production releases 18 per cent of human-produced Greenhouse Gas (GHG) emissions. It also releases ammonia and sulphur dioxide, which contribute to acid rain, and other air pollutants.

Farm animals use nearly 200 cubic kilometres of water per year, exacerbating water shortages particularly in water-poor countries. This use is extremely inefficient: it takes 990 litres of water to produce one litre of milk. Furthermore, manure contains nitrogen, phosphorus and other contaminants, leading to eutrophication and other forms of water pollution. Clearing of forests for grazing adds to GHG production and damages biodiversity. Growing grain for animal feed also increases GHGs and reduces availability of food to the people who need it most.

Sustainable food policy

Despite the paramount urgency of environmental issues, it is not politically or practically possible to address them in isolation from economics and social justice. A sustainable food policy must address all aspects of sustainability: it must be ecologically sound, economically viable, socially just and humane.

Humane treatment of animals is central to sustainability, because many of the world's people – particularly in developing countries – depend on animals for food, income and social status. Proper, humane management of animals improves their survival, growth and production. For such people, increased consideration of animal welfare helps to improve and safeguard food security, human health and social development. It is also critical for management of disasters and disease outbreaks, protecting human livelihoods as well as lives.

The problems of livestock production are getting worse, so it is urgent to challenge and restrain the expansion of that production and as soon as possible to reverse it. That

is a task for governments and society as a whole, not just for livestock producers. The worst problems for climate change are caused by raising ruminants and by feeding grain to animals. As such, the priorities are: to slow and reverse the growth in cattle production (beef and dairy), particularly grain-fed (this will apply more to developed countries); and to slow and reverse the growth in pig and poultry production, particularly intensive, grain-fed (this will apply more to developing countries).

Slowing and reversing the growth in animal production has inescapable implications for individual consumers, both in developed and developing countries. It must mean that consumers who eat large amounts of meat and other animal products (or who would have done so in future) should eat less.

Any comment on the diet of people in developing countries is a sensitive issue, but we are not saying that poor or malnourished people should be further disadvantaged. On the contrary, their nutrition should be safeguarded and improved. This may then need to be offset by greater reductions in consumption of animal products by those better off and better fed.

The best solution

Industrial, highly intensive farming as used in developed countries and now spreading to developing countries is unsustainable ecologically, economically and socially. However, many extensive livestock systems are also inefficient. The majority of GHGs are currently produced by ruminants in grazing systems in developing countries, so more efficient management of those livestock is needed.

Livestock kept in well-managed extensive conditions use local resources and recycle the productivity of the land. Indeed, grazing livestock can have positive effects on climate change, because pasture can contribute to carbon sequestration. The best solution is moderation: small to moderate farm sizes, moderate group sizes of animals on those farms and good conditions and health care for those animals.

Humane treatment of animals fosters sustainability and vice versa. What is more, sustainability cannot be achieved without proper, humane management and care of farm animals.

Recommendations

Recommendation 1

Intergovernmental organisations, national governments and the food supply industries (agricultural and retail) must urgently develop policies for sustainable food supply. For livestock production to have reduced impact on climate change and to be sustainable in other respects it must be biologically based, socially just and humane. Animal welfare must be included in all future discussions on agriculture and climate change.

Recommendation 2

The current acceleration in meat and milk production cannot be allowed to continue unchecked. National governments and intergovernmental organisations must develop mechanisms to slow and reverse this growth, especially in cattle production, grain feeding and intensive production methods that are not ecologically sustainable. They must also assist livestock producers, within the wider agricultural industry, to manage this slowdown in volume of production, by mechanisms including development of value-added markets such as that for humanely reared animal products.

Recommendation 3

Research is urgently needed to enable design of policies that reduce (or slow the increase in) meat consumption by people who consume more than others, while not causing hardship to poor or malnourished people in either developed or developing countries. As this addresses a ‘public good’ it will require support from public and philanthropic funding bodies.

Recommendation 4

Food production needs to move away from industrial, multinational systems towards moderate-scale, humane models with local supply chains and markets, contributing to greater national and regional self-sufficiency in food. This would reduce not only the environmental damage caused by livestock production, but also the unpredictability in global food markets such as that underlying the current food crisis.

Recommendation 5

Financial support for industrial livestock production methods (such as unseen subsidies for externalised costs) should be ended and economic mechanisms to support humane sustainable livestock production (for example research funding) should be prioritised. Governments should support these changes with high-profile, well-resourced public awareness campaigns.

Recommendation 6

An inevitable consequence of the previous recommendations is that consumers who eat large amounts of meat and other animal products should eat less of those products. The animal products that consumers buy should be sourced locally and reared in humane and environmentally and socially responsible ways.

1. Introduction

Why are farm animals invisible? In discussions and policies about many vital issues such as climate change, sustainability, development and disaster management – issues critical to our future – animals have hardly been mentioned until recently (e.g.[21]). Indeed, they are still rarely mentioned in discussion of the worldwide 'food crisis' of 2008.

In industrialised countries this may be partly because these animals are now largely kept indoors and their products of meat, milk and eggs are so packaged that they scarcely remind people of the animals themselves. In some developing countries farm animals are also kept in industrial systems, away from cities and population centres. In policy terms, they have been generally ignored as a 'non-land-use' sector.

Livestock has been literally out of sight and out of mind. (The terms 'farm animals' and 'livestock' are used here as equivalent and include poultry but exclude fish and invertebrates.) Yet farm animals are vastly important in number, land use and contribution in both positive and negative ways to our present and our future.

The facts

- At any given time, humans are greatly outnumbered by livestock worldwide (Figure 1, data from [60, 75]).
- The numbers are even more striking on an annual basis, with 133 million humans, 58 billion poultry and 4.3 billion other farm animals (mammals) born every year (Figure 2, data from [23, 75]).
- Farm animals make up two-thirds of terrestrial vertebrate biomass (weight), with most of the rest being humans. Wild mammals and birds are dwarfed (Figure 3, data from [66]).
- Land for livestock is the largest human use of land (Figure 4, data from [69]) and is growing while forests are shrinking. This land is used for grazing or feed crops, with 30 per cent of arable crops used for feed [33].
- The livestock sector employs 1.3 billion people [69]. About a billion of the world's poorest people depend on animals for food, income, social status or cultural identification, as well as companionship and security [21].
- Awareness of problems is finally increasing. See, for example, *Industrial Animal Agriculture – the Next Global Health Crisis?* [52], *Industrial Animal Agriculture – Part of the Poverty Problem* [17] and *Putting Meat on the Table: Industrial Farm Animal Production in America* [59].
- Farm animals were moved further up the agenda by the publication of *Livestock's Long Shadow* by the UN FAO [69], stating that the livestock sector is responsible for 18 per cent of human-induced (anthropogenic) GHG emissions.

The issue of food in general is, of course, highly visible and highly placed on political and other agendas – and never more so than in 2008 with the eruption of what is being called the 'food crisis'. Food prices have risen in both developed and developing countries, with serious effects particularly in the latter. Renton [64] gives the example of Cambodian rice farmers who cannot afford to feed their own families despite rice production being at an unprecedented high. Governments have begun to address these issues (e.g. the UK government [70]) but much more needs to be done nationally and internationally to develop sustainable food policies.

Unsustainable trends

We argue below that current trends in livestock production are especially unsustainable, for many reasons including rapid growth in production, competition with other agricultural sectors, reliance on fossil fuels, excessive international trade and hence volatile financial pressures.

Sustainability is not just a 'buzzword' but essential for our future survival. Yet despite the paramount urgency of environmental issues, it is not politically or practically possible to address them in isolation from economics and social justice. Hence the usual definition of sustainable agriculture: agriculture that is ecologically sound, economically viable and socially just. In connection with animals, 'socially just' is sometimes taken to include consideration of humane animal treatment – partly because humane treatment fosters sustainability and vice versa [5]. Alternatively that consideration is made explicit: sustainable agriculture is ecologically sound, economically viable, socially just and humane [28].

In this report we examine the implications for sustainability of key aspects of animal agriculture. One of the major issues is the industrialisation that has occurred in many developed countries and that is now occurring in many developing countries.

Industrial animal agriculture is a system of raising animals using intensive 'production line' methods that maximise the amount of meat or other products, while minimising costs. Industrial animal agriculture is characterised by high stocking densities or close confinement, rapid growth rates, high mechanisation and low labour requirements. Examples include battery cages for laying hens and veal crates for calf rearing. In recent years many different concerns have been expressed over the impact of such methods on animal welfare, the environment, food safety and quality, food security, family farms, farm workers, rural communities and developing countries [4, 17, 52].

Figure 1. Numbers at any one time

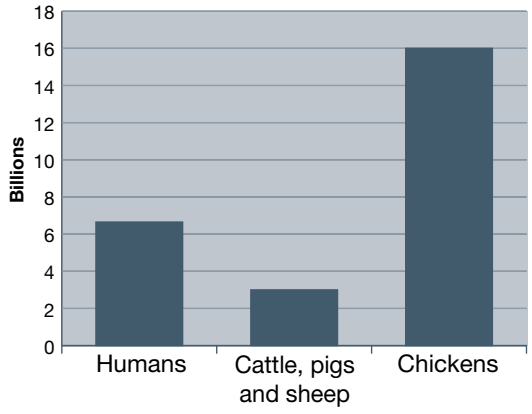


Figure 2. Births per year

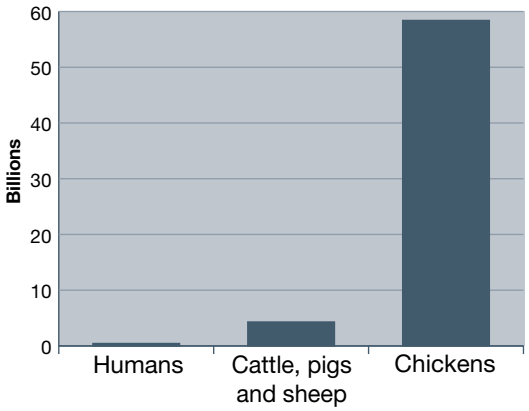


Figure 3. Global terrestrial vertebrate biomass

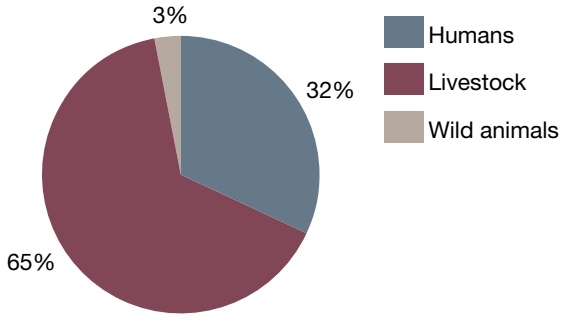
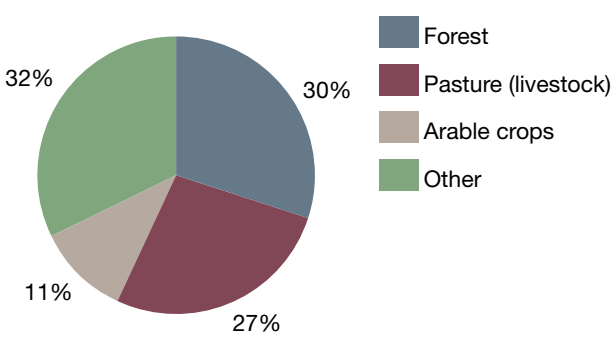


Figure 4. Global land surface



2.

Environmental impact

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2.1 Problems and solutions

Is farming of cows and pigs good for the environment? No, it is not – as we shall see – so the next question is: can livestock farming be made less environmentally damaging? There is considerable evidence that livestock agriculture as a whole is not ecologically sound and is getting worse.

We shall review the problems for climate change and air pollution, water use and pollution, land use and biodiversity. Then we shall consider solutions. We may note at this point that both problems and solutions depend on:

- numbers of animals
- type of animals, particularly ruminants (cattle, sheep, goats) versus non-ruminants (pigs, poultry)
- management: housing, feeding, manure treatment, etc.
- processing, transport, etc.

On the last point, there have been few analyses to date of the environmental consequences of food production 'from farm to fork'. One such analysis found that food-related activities account for 19 per cent of GHG emissions in the UK, with post-farm-gate processes contributing more than half of those [27]. Much of that contribution (from packaging, retailing and so on) is similar for animal and non-animal foods. Differences (particularly concerning transport) will be considered below.

2.2 Climate change and air pollution

Climate change is the most critical issue of our time, threatening the future of much of this planet's life, including humankind. Human-induced release of gases is disturbing the balances that would otherwise exist, trapping radiation from the sun in the atmosphere in the greenhouse effect and raising air and sea temperatures [34].

The principal GHG is carbon dioxide. Methane and nitrous oxide are released in smaller quantities but are also important because they absorb more radiation and persist longer in the atmosphere: they have Global Warming Potentials (GWPs) of 23 and 296 times that of carbon dioxide respectively [35].

Livestock production releases more than seven billion tonnes of carbon dioxide equivalent every year (i.e. gases with GWP equal to that amount of carbon dioxide). This is about 18 per cent of anthropogenic GHG emissions: nine per cent of carbon dioxide, 37 per cent of methane and 64 per cent of nitrous oxide (Table 1).

Gas emissions

Carbon dioxide is released when fossil fuels are used in fertiliser and feed grain production, and when forests are converted into grazing or feed crop land [34, 69]. Methane is produced by digestion, particularly by ruminants: cattle, sheep and goats produce more methane per unit of feed consumed than monogastric animals. It is also released from manure, and pigs and poultry contribute relatively large amounts of methane through waste [76]. Nitrous oxide emissions result primarily from fertiliser and manure application [11, 69].

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Industrial disaster: During natural disasters such as Hurricane Floyd (1999), livestock waste from industrial farms is discharged into the environment.

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Dangerous release: Vast quantities of livestock waste from industrial farms are stored in manure lagoons.

Livestock also contributes to other aspects of air pollution. Where animals are kept or processed in large concentrations there may be considerable nuisance value and often significant health problems for local people. Release of ammonia, sulphur dioxide and other pollutants (as well as additional problems such as flies) lead to poor quality of life and illness over quite large areas around industrial animal facilities [59]. These are serious effects, particularly when such facilities are in urban areas – as is common in developing countries. For example, in Ho Chi Minh City in Vietnam, most large pig farms and slaughterhouses are within 40 kilometres of the city centre [69, 72].

Ammonia and sulphur dioxide also cause the more widespread and serious problem of acidification. In the atmosphere they are oxidised to nitric and sulphuric acids respectively. They then produce acid rain and acid snow, damaging forests, lakes, freshwater and coastal ecosystems and soils, as well as helping to release heavy metals into groundwater [20]. The majority of sulphur dioxide is produced by fossil fuel combustion, but livestock is a major contributor of ammonia. In addition to about 50 million tonnes of ammonia nitrogen released from soils each year unconnected with vertebrate animals [13], human waste adds two million tonnes, wild animals three million and manure from domesticated animals as much as 23 million tonnes [69].

Table 1. Role of livestock in GHG emissions [69]

Gas	Contribution to climate change (%)	Livestock emissions (billion tonnes carbon dioxide equivalent)	Livestock emissions as % of total anthropogenic
Carbon dioxide	70	2.70	9
Methane	18	2.17	37
Nitrous oxide	9	2.19	64

2.3 Water use and pollution

Water shortages are widely predicted to be one of the major problems of the current century [66]. Against that backdrop, animal production is extremely inefficient: it takes 990 litres of water to produce one litre of milk [14].

Global requirements for livestock drinking water are an astonishing 16.2 cubic kilometres per year, with farm service requirements another 6.5 cubic kilometres, and processing requirements (for slaughterhouses, processers and so on) in addition. Yet these needs are exceeded sevenfold by feed production. About seven per cent of global water use is attributable to livestock feed production, out of a total use for livestock of about eight per cent [69]. So rearing farm animals uses nearly 200 cubic kilometres of water per year – 88 per cent of that being for feed production.

Regional variance

The acuteness of this issue obviously varies between regions and countries. For example, in Botswana, livestock accounts for 23 per cent of total water use. In the Kalahari area, use of boreholes for livestock is causing the water table to sink [18, 71]. Some water-poor countries import meat, animals or animal feed from other parts of the world. This has sometimes been described as 'importing virtual water'. This is not a sustainable arrangement, though, partly because increased trade and global transport cause problems for the environment, and partly because such commodities – especially water-costly feed for intensive production of monogastrics – often come from countries that are themselves not particularly abundant in water [69].

Intensive production uses more water than extensive management, with additional service water requirements for cooling and cleaning and additional drinking water. In intensive systems, animals get only 10 per cent of their water requirements (including servicing) from feed compared to 25 per cent in extensive systems, with the difference having to be supplied as drinking water [49].

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Water waste: Large-scale feed production for livestock puts significant pressure on global water resources.

Turning to water pollution, nitrogen and phosphorus excreted by animals increase the chance of nutrient surpluses in water resources, a condition called eutrophication. This leads to algal blooms, production of toxins, damage to fish stocks and other problems [19]. One cow excretes 18 to 20 times as much phosphorus as a human [53]. Livestock excreta in 2004 contained about 135 million tonnes of nitrogen and 58 million tonnes of phosphorus. Cattle contributed about 58 per cent of the nitrogen, pigs 12 per cent and poultry seven per cent [69]. Eutrophication is a particular problem for enclosed bodies of water affected by agricultural run-off, such as the Great Lakes of North America and the Baltic Sea [19].

Dangers to health

Manure run-off also sometimes includes disease micro-organisms, heavy metals or antibiotics. In many countries antibiotics are overused in animal agriculture, leading to the development of antibiotic resistance by bacteria dangerous to animal and human health [42].

Steinfeld et al. [69] state that in the USA, livestock is responsible for 32 per cent of nitrogen and 33 per cent of phosphorus pollution of freshwater resources, for 37 per cent of pesticides and 50 per cent of antibiotics, as well as causing 55 per cent of erosion. Other countries with similar industrial production systems, including developing countries, will have similar problems.

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Pollution flow: Livestock waste seeping into waterways supports the growth of algal blooms.

2.4 Production, land use and biodiversity loss

Around 60 billion animals are reared for food each year worldwide (Figure 2), excluding fish, invertebrates and many non-commercial animals. Where are they all kept? Steinfeld et al. [69] allocate livestock production to four types of systems, as shown in Table 2.

The large majority of ruminants, producing beef and mutton, are in grazing or mixed systems, while the majority of pigs and poultry are in what Steinfeld et al. [69] call landless/industrial systems. It should be noted that their definition for landless/industrial, with up to a hectare for 10 animals, includes systems much more extensive than are usually meant by terms like industrial, intensive or factory farming.

These figures are important because for the livestock sector to be environmentally and socially sustainable, policy decisions must favour the best use of available land. It has already been pointed out that grazing and feed crop production for livestock is the largest human use of land. In many places livestock competes with the food crop, forestry and energy sectors, among others, for land resources. Figures available for North America show that in 2005, 60 per cent of total grain produced in the USA was fed to livestock and 73 per cent in Canada [81].

Biofuel increase

Competition from biofuel production is increasing, in North America and elsewhere. Worldwide fuel ethanol production increased from under 20 billion litres in 2000 to over 30 billion in 2004 and is expected to pass 60 billion litres in 2010 [9]. Use of land for livestock feed and for biofuels are together squeezing the production of grain for feeding people directly, pushing up the price of that grain in a world where the population continues to grow rapidly. In February 2008 the UN warned that it can no longer afford to feed the millions of undernourished people in its care, because of a dramatic increase in world commodity prices [10].

Large-scale animal production is also damaging biodiversity, necessary for balance of the world's ecosystems and for diverse human benefits [73], at the level of genes, species and ecosystems. According to the Millennium Assessment Report [47], the most important direct drivers of biodiversity loss and ecosystem change are habitat change, climate change, invasive alien species, overexploitation and pollution. Livestock contribute directly or indirectly to all of those drivers at the global and local level – inevitably so, given the huge numbers, biomass and land use (Figures 1 to 4) and the effects outlined in sections 2.2 and 2.3. Indeed, livestock are themselves invasive species. Furthermore, they can cause invasion of other species, for example when grazing degrades land and makes it more susceptible to plant invasions. Finally, livestock contribute to overexploitation of the seas as well as the land, because fishmeal and fish oil are often major components in feed. In 2004, 24 per cent of world fishery production was used in this way for livestock [77].

The World Wildlife Fund [83] has identified 825 'ecoregions' globally; 306 are under threat from livestock agriculture. Similarly, Conservation International has identified 35 global 'hotspots' with large numbers of endemic species and serious habitat loss; 23 of these are reported to be affected by livestock production [69].

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Large-scale destruction: Forests such as the Amazon are cleared for livestock feed crop production and grazing.

Table 2. Livestock production (million tonnes) [67, 69]

System	Beef	Mutton	Pork	Poultry meat	Meat total	Milk	Eggs
Grazing (>10% dry feed matter produced on farm, <10 livestock units/ha)	14.6	3.8	0.8	1.2	20.4 (8%)	71.5	0.5
Rainfed mixed (>90% non-livestock farm production from rain-fed land use)	29.3	4	12.5	8	53.8 (22%)	319.2	5.6
Irrigated mixed (>10% non-livestock farm production from irrigated land use)	12.9	4	29.1	11.7	57.7 (24%)	203.7	17.1
Landless/industrial (<10% dry feed matter produced on farm, >10 livestock units/ha)	3.9	0.1	52.8	52.8	109.6 (45%)		35.7

2.5 Numbers, type and management of animals

We have said above that environmental problems of animals and their solutions depend on animal numbers, type (particularly ruminants versus non-ruminants) and management. Numbers that already seem astronomical (Figures 1 and 2) are rising rapidly and are expected to continue doing so. This is one of the most shocking predictions of *Livestock's Long Shadow* [69]: "Global production of meat is projected to more than double from 229 million tonnes in 1999/01 to 465 million tonnes in 2050, and that of milk to grow from 580 to 1,043 tonnes." The vital need to reduce that growth will be covered in section 4.

Most of this growth is in developing countries. Figure 5 (data from [23]) shows this for the four most important meat species: cows and sheep (ruminants) and pigs and chickens (non-ruminants or monogastrics). The large majority of ruminant animals are found in developing regions: 79 per cent of cattle/buffaloes and 78 per cent sheep/goats [69]. Ruminant production causes environmental problems because of clearing of forests for grazing and emission of methane. Monogastrics cause more problems associated with growth of feed grain and water pollution.

Inefficient production

These problems are affected by management and are worst at the extremes. For example, cattle on very poor diets digest them inefficiently, while those on high energy feeds produce manure with more volatile materials [69]. Similarly, pigs and chickens eating inadequate or unbalanced feed do not produce meat or eggs efficiently. Yet intensive farming of those species requires huge growth of feed grains (using fossil-fuel-based fertilisers), transport of feed and water and disposal of massive quantities of manure, which all too frequently result in soil and water pollution [62]. Livestock kept in well-managed, extensive conditions use local resources and recycle the productivity of the land.

In addition to the impact of using fossil fuels on climate change, such use is unsustainable in the long term as these fuels run out. Oil supplies are already unpredictable: some commentators suggest that 'Peak Oil' has already been passed and that supplies will now decline continuously. This uncertainty over oil supplies leads to volatility in availability and prices. This, in turn, contributes strongly to volatility in availability and prices of food and hence to the worldwide 'food crisis' of 2008 [64].

Intensive problem: Industrial pig farms, where sows are often kept indoors in individual stalls, require large quantities of feed grains.

As an illustration of changes in a developing country, South Korea has an increasing number of pigs on a decreasing number of farms (Figure 6, data from [40]), a rising proportion of which hold more than 1,000 or even more than 10,000 pigs. Recognising the problems of this development, the South Korean government has introduced an 'environmentally friendly payment scheme' for farms to reduce the number of pigs held, the antibiotics used and the manure produced. However, uptake of this voluntary programme is so far small [40].

Figure 5. World meat production

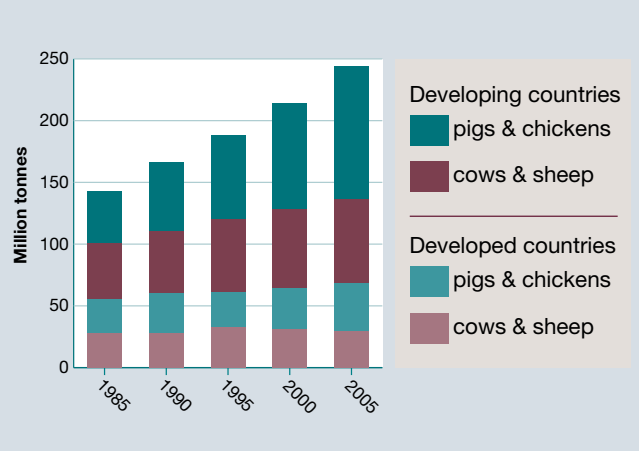
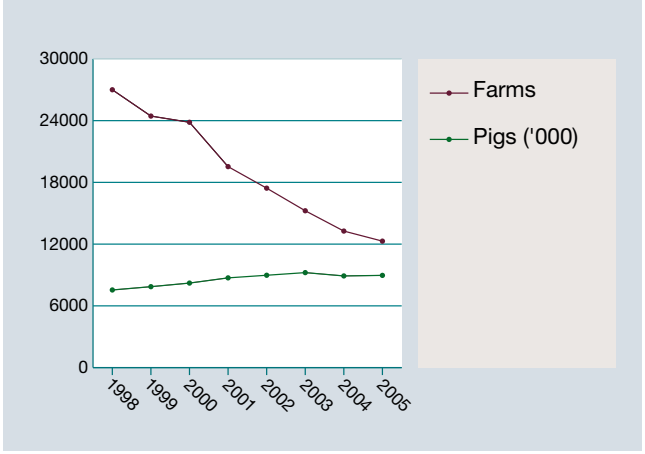


Figure 6. Pig farming in South Korea



3.

Economics, social justice and humaneness

3.1 Sustainability and animal care

If stopping climate change and achieving environmental sustainability was easy, it would have been achieved already, including ending the environmental problems of livestock agriculture. However, as Steinfeld et al.[69] point out:

> "The livestock sector is driven by other policy objectives. Decision-makers find it difficult to address economic, social, health and environmental objectives simultaneously. The fact that so many people depend on livestock for their livelihoods limits the available options to policy-makers, and involves difficult and politically sensitive decisions on trade-offs."

Similarly, the International Assessment of Agricultural Knowledge, Science and Technology for Development [36]:

> "...responds to the widespread realisation that despite significant scientific and technological achievements in our ability to increase agricultural productivity, we have been less attentive to some of the unintended social and environmental consequences of our achievements."

So how can sustainable livestock agriculture be achieved that is simultaneously ecologically sound, economically viable, socially just and humane? Appleby [5] has demonstrated that increased emphasis on animal care makes a major contribution to the other aspects of sustainability:

> "The fact that humaneness and sustainability overlap is not coincidental. Both approaches place a much greater emphasis on the animals themselves than do conventional methods. These alternative methods can be said to be animal centered, to recall that animal production is first and foremost a biological process rather than the technological approach that has become conventional."

This section will therefore examine associations between animal care and the following, while keeping ecological implications in the frame (these associations are shown in Figure 7, adapted from [6]):

- economics, including poverty and hunger reduction and food security
- management of disasters and disease outbreaks
- human health
- social development.

3.2 Economics and food security

As with all economic activities, the approaches taken to livestock production are determined partly at the initiative of producers and partly because of the needs or perceived needs of consumers. To address the latter first, meat and animal products are important in people's diets. However, that does not mean that either the rapid increase in animal products or the methods being used to accomplish this reduce hunger and poverty or achieve food security.

Much of the increase in animal production is in large, intensive farms – as in South Korea (Figure 6) – which cause the environmental problems outlined above. One rationale is that these are thought to have provided 'cheap food' in developed countries. All too often, though, they do not provide food security in developing countries: the meat they produce is too expensive for the really poor and hungry and such giant farms destroy the job structure and social stability of agriculture-based societies [17]. In Brazil, for example, intensification of the poultry industry is driving thousands of small, family farms out of business [26].

Undermining subsidies

Developing countries should also be wary of donations or exports of 'cheap food' from developed countries (only apparently cheap, because of subsidies), that undermine the ability of local farmers to feed their own country's people. As Hodges [31] explains:

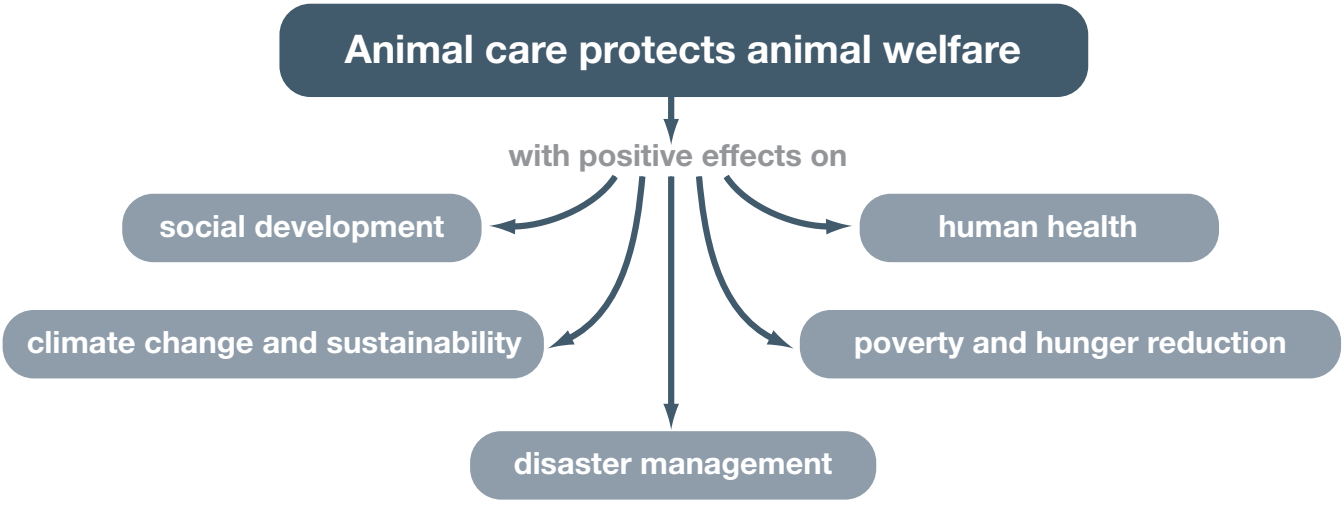
> "Today apparently cheap (but subsidised) Western food exports to poor countries mainly enter the cities of the developing world, thus competing in the only markets which small-scale domestic producers can reach. Rather than empowering the poor to get started on the economic ladder, capturing the national urban market with imported food removes the ladder."

Food security is best achieved by growing food on a local basis. For example, if people in rural areas are short of food, it is beneficial in the long term to promote food production in those areas rather than elsewhere where transport is required. If farms are fairly small, complex infrastructure is not needed and people can be helped to look after their animals well and productively, feeding themselves and their communities and also earning some income [61].

Animal welfare contribution

Intergovernmental organisations are recognising the contributions of animal care and animal welfare to economics and to poverty and hunger reduction, as well as to environmental sustainability. The International Finance Corporation, part of the World Bank Group, has issued two relevant publications: *Creating Business Opportunity through Improved Animal Welfare* [37] and *Animal Welfare in Livestock Operations* [38]. The World Organisation for Animal Health (OIE), realising the importance to animal health of other aspects of welfare, has drawn up welfare standards for transport and slaughter of farm animals (including for disease control) that have been agreed by the 172 member countries [54]. Standards for housing and treatment during rearing will follow.

Figure 7. Sustainability and animal care



3.3 Management of disasters and disease outbreaks

Disasters may be caused by either natural or human-made events, in combination with inadequate preparedness or responses that contribute to large-scale negative outcomes. Such outcomes for animals are important both in themselves and for their effects on human welfare and the environment. For example, if measures are not taken after an earthquake to protect livestock as well as people, the livelihoods of many people may be lost even though their lives have been saved. Facilities for livestock should be provided at refugee camps, because refugees often refuse to enter a camp if, in doing so, they must abandon their animals [39]. Furthermore, precautions in advance of earthquakes can reduce losses of life and property, thus also reducing the need for rescue operations.

Industrial livestock systems exacerbate the negative effects of disasters. They are vulnerable to weather-related or other disasters, extremely difficult to maintain when such disasters occur and liable to cause acute environmental problems. For example, in 1999 Hurricane Floyd hit North Carolina, one of the top states in the USA for industrial animal production, causing an economic and environmental disaster. About 2.5 million chickens, 500,000 turkeys and 200,000 pigs drowned, many rotting in the floodwaters, and manure lagoons overflowed into waterways [63].

System vulnerability

Disaster preparedness measures include comprehensive plans and framework activities at all levels to enable governments and civil organisations to protect and manage animals prior to, during and in the aftermath of disasters. For example, designing more effective early warning systems and practical evacuation routes and procedures [39]. These measures should also include avoidance of industrial systems. When they are involved in disasters (and it is 'when' not 'if') these systems cause more problems than dispersed production for animals, people and environment alike. Waste from a spilled manure lagoon can contaminate groundwater for 40 years [48].

Disaster management: The effects of natural disasters are better addressed in extensive livestock systems.

© Murdo Macleod

Burning issue: Disposal of carcasses during disease outbreaks poses serious environmental concerns.

Another aspect of sustainability in livestock production is control of disease. Outbreaks of disease are themselves often disastrous. Diseases that can affect both animals and humans are covered in the section on human health below. Many others, mostly confined to animals, nevertheless have huge economic effects for humans, such as Foot and Mouth Disease (FMD). The spread of FMD is often worsened by the extensive movements of animals and animal products that are common in large-scale animal production and the risk of spreading disease is even greater when live animals are transported long distances, including between countries [3]. Environmental concerns in such outbreaks include those associated with disposal of carcasses, often in enormous numbers, whether they are burned, buried or disposed of in other ways.

Disease outbreaks

Industrial animal agriculture keeps thousands of genetically similar animals, with reduced immunity, in crowded buildings in constant contact with their faeces. These conditions are intrinsically likely to promote evolution and spread of micro-organisms [52]. Major livestock disease outbreaks have apparently been more common than hitherto in the last years of the 20th century and the first years of the 21st [3]. These are one of the costs that the industry manages to avoid, or externalise, because compensation is generally paid by governments, adding further evidence of the unsustainability of practices that lead to such outbreaks. Of course small farms and backyard flocks often also have health problems. The best solution is moderation: small to moderate farm sizes, moderate group sizes of animals on those farms and good conditions and health care for those animals.

3.4 Human health

Similar problems arise with diseases that can be transmitted between animals and humans (zoonoses). Some such diseases are recent, such as mad cow disease (bovine spongiform encephalopathy [3]). Others are long-standing. A recurrent disease that is probably more dangerous worldwide than any other for both animals and people is Avian Influenza. Over the last 10 years outbreaks in poultry have increased considerably, leading to the culling of over 250 million birds worldwide [22]. It is expected that the virus will sooner or later evolve the ability to spread from human to human, causing a pandemic that may kill 1.5 billion people [51]. There is strong evidence that mutations in the virus have been increased by intensive broiler production [29], and international trade has probably contributed to spreading Bird Flu round the world [15]. Change in the poultry industry to keep fewer birds in better conditions would reduce these risks – to humans, animals and environment alike [52].

Poisoned food

Care of animals is also important in achieving food safety. Food poisoning is a considerable problem in most countries – for example, 76 million Americans are reported as becoming infected and 5,000 as dying from food poisoning each year [12]. A major source of these infections is animal products and this is strongly affected by how farm animals are treated. For *Escherichia coli*, the main route of human infection is contamination of meat by animal faeces. This is affected by whether livestock are given clean, dry bedding, whether they are given enough space (which helps them to avoid contact with each other's faeces) and whether they are handled carefully at slaughter [58]. Similarly, many people are probably infected by Salmonella from poultry and eggs [1] and the chance of infection is again affected by farm management. In some countries hens are feed-restricted to shock them into renewed egg laying ('forced moulting'). This increases infection of the eggs, because stress or changed gut activity or both affect mobility of the bacteria in the body cavity [7].

© Farm Sanctuary

Health hazard: Intensive broiler production increases mutations in the Avian Influenza virus.

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Overeating: Excessive meat consumption is a major contributor to the global rise in obesity.

Consumption of animal products itself has variable effects on human health. Adding moderate quantities to the diet of malnourished people has beneficial effects [50]. It is possible that similar benefits can be given by dietary protein from plants [65], but food crops may be difficult to grow in certain environments (e.g. arid areas) that support livestock more readily. However, it is also clear that much of the increase in consumption of animal products worldwide is not by poor people who previously ate none, but by more affluent people eating more. And excessive consumption of animal products – particularly meat – is a major contributor to the global rise in obesity [46]. This rise has been described as an epidemic and one of the worst health problems currently faced by the world. Practices that promote it, including the industrial production, international trade and marketing of meat, milk and eggs in excess of those required for reasonable balanced diets, are clearly unsustainable.

3.5 Social development

Compared to the economic, health and environmental objectives of decision-makers, social objectives often receive lower priority, but they may be key to achievement of the former. Policies are implemented by people.

One of the UN Millennium Development Goals [74] is promoting gender equality. An example of where this is relevant is in European farming, where decisions are generally taken jointly by husband/wife couples. Initiatives led by government or advisory agencies promoting new farming methods or approaches once addressed only the husband and not the wife. Involving both of the couple in discussions is socially appropriate and also increases the frequency with which proposals are implemented [78], including proposals to increase sustainability.

Addressing poverty

Consideration of animal care is also helpful in promoting gender equality and opportunities for social development of women and families, and hence in sustainability of livestock agriculture. Men, women and children often adopt different roles in owning and looking after animals. For example, in many developing countries women primarily care for small livestock such as poultry [44]. Perhaps partly as a result, there has generally been less advisory and financial support for husbandry of small animals than for more prominent species such as cattle. Yet poultry and other small animals are often important for family nutrition and contribute to poverty and hunger reduction. Support for their rearing [56] therefore helps to address poverty and hunger directly and indirectly through its social effects. In other developing countries, imports and foreign-owned businesses compete with local production and small, family farms [26].

Working together: In developing countries, sustainable animal husbandry promotes social development for women and families.

3.6 Animals, people and environment first

Of the criteria for sustainable livestock agriculture – that it must be ecologically sound, economically viable, socially just and humane – ecological soundness or environmental sustainability is arguably the most important. As stated above, a sustainable future is by definition essential for our survival. Yet addressing that first criterion independently while setting aside the others is impossible. Furthermore, addressing economics, social justice and humaneness in themselves help tackle climate change and environmental sustainability. Steinfeld et al. [69] emphasise that:

> "Policy-makers are faced with the quandary of achieving the multiple objectives of affordable supply of high value food, food safety, livelihoods and environmental soundness in a sector that, while industrialising, is still dominated by large numbers of small-scale producers in many parts of the world. In fact, concern for family-based farming is prominent in the livestock policies of many countries."

That is entirely appropriate, because local, family-based, relatively small-scale farming is the best framework in which to achieve all the desired objectives of food security, social stability and environmental sustainability [61]. And in livestock farming, a positive approach to animal welfare and animal care is an important means to those ends (Figure 7). Such a broad approach to animal welfare is already in motion in general terms, as governments and non-governmental organisations (NGOs) work towards the achievement of a Universal Declaration on Animal Welfare at the UN [82].

Viable future: Local, family-based farming protects food security.

4.

Reducing and reversing damage

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4.1 Urgency for change

Publication of *Livestock's Long Shadow* by the UN FAO [69] achieved the extremely valuable effect of drawing attention to the scale of the problems caused by livestock production. However, in some respects the report held out false hopes. One of its conclusions was that:

> "The livestock sector is responsible for a significant share of environmental damage. With these changes [recommended in the report], undertaken with an appropriate sense of urgency, the sector can make a very significant contribution to reducing and reversing environmental damage."

That is true, strictly speaking, but in placing responsibility for this huge and hugely important task on livestock producers it underplays an aspect of that task which those producers are ill-placed to promote: the slowing and reversal of growth in that sector. Indeed, on the premise that worldwide meat production is expected to double from 2000 to 2050 the report concluded that:

> "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."

Again that is logically true, but underemphasises the fact that such an outcome is probably unachievable. Worse still, if production does indeed increase that much, the target of doubling efficiency would have to be greatly surpassed for damage to be reduced. Using such an approach not just to reduce but to reverse damage is entirely inconceivable.

Expansion challenge

Consequently, in addition to making meat and milk production more efficient, the premise of greatly increased production must be vigorously confronted. The problems of livestock production are still getting worse, so it is urgent to challenge and restrain the expansion of that production and as soon as possible to reverse it – and that is a task for governments and society as a whole, not just for livestock producers. This last point is, of course, recognised by Steinfeld et al.[69]: "For the suggested changes to occur there is an urgent need to develop and implement effective policy frameworks."

As climate change is now happening, and as livestock are important for livelihoods and food security for the foreseeable future (although at least a partial move away from this is needed), it is also necessary to address and mitigate the effects of climate change on livestock [45]. However, climate change should not be accepted as inevitable where it is in fact reducible. The key aim must be to reduce it. Hence this report, which is mostly about impacts of livestock, not impacts on them.

As indicated earlier, achieving sustainable livestock production depends on animal numbers, type (ruminant or other), management, processing and transport.

4.2 Animal numbers

The need to slow and then reverse current growth in livestock numbers worldwide is inescapable, to protect both the environment and human health. This is usually expressed in terms of meat consumption, emphasised by intergovernmental organisations, governments, scientists such as medical specialists, and NGOs.

- The IPCC [34] says that "a shift from meat towards plant production for human food purposes, where feasible, could increase energy efficiency and decrease GHG emissions." The head of the Panel, Dr Rajendra Pachauri, speaking at a press conference after the IPCC had been awarded the Nobel Peace Prize for its work, highlighted this by asking the world: "Please eat less meat." [25] He has since repeated and strengthened this call [41].
- The Environment Minister for the UK government, Ben Bradshaw, warns that if people do not reduce their meat consumption, climate change may necessitate a return to rationing of animal products [2] and a government report endorsed by the Prime Minister [70] says "evidence on health and the balance of environmental analysis suggests that a healthy, low-impact diet would contain less meat and fewer dairy products than we typically eat today."
- A lead article in medical journal *The Lancet* [46] states that "the current global average meat consumption is 100g per person per day, with about a ten-fold variation between high-consuming and low-consuming populations. 90g per day is proposed as a working global target, shared more evenly."
- The Humane Society of the United States [32] concludes that "adopting consumptive habits less reliant on meat, eggs, and dairy products" is necessary, while Compassion in World Farming (CIWF)[16] proposes that developed countries should reduce production and consumption of meat and milk to one third below current levels by 2020 and to at least 60 per cent below current levels by 2050.

Changes in consumption are needed in developing as well as developed countries, because Figure 5 shows that production in developed countries is insufficient for any reduction to offset the current increase in developing countries. To comment on the diet of people in developing countries is a sensitive issue, but we are emphatically not saying that poor or malnourished people should be further disadvantaged: indeed, people who eat no meat cannot eat less.

Consumption reduction

On the contrary, if a modest increase in consumption of animal products by the poorest people in developing countries is the best way to improve their nutrition, this should be facilitated, and offset by greater reductions in consumption by those better off and better fed.

When McMichael et al. [46] speak of "variation between high-consuming and low-consuming populations" and say that meat consumption should be "shared more evenly" they are talking about variation within countries, not just between countries. Most animal products in developing countries are eaten by relatively well-off people and national and international policies need to address this consumption, as well as that in developed countries. Indeed, Steinfeld et al. [69] point out that:

> "Livestock actually detract more from total food supply than they provide. Livestock now consume more human edible protein than they produce … This is a result of the recent trend towards more concentrate diets for pigs and poultry, with nutritional requirements more similar to humans than ruminants."

In truth, to make any comment on people's diet is a sensitive matter. But it is important to do so when, for example, the average meat eater in the USA produces about 1.5 tonnes of carbon dioxide more every year than they would if they did not eat meat [57]. CIWF calculates that if the average UK household halved meat consumption that would cut emissions more than if they halved their use of cars [16].

This discussion obviously concerns primarily meat and other foods produced directly from animals. There is increasing interest in growing meat artificially, and consumption of such products would be much less problematic environmentally [55].

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Mass consumption: Cattle kept in feedlots are fed large quantities of grain, which threatens global food security.

4.3 Ruminants and non-ruminants

There are other reasons for restraining and reducing the numbers of pigs and poultry. As noted in section 2.2, their production contributes large quantities of GHGs: carbon dioxide from growing feed grains, methane from manure and nitrous oxide from application of both manure and fertiliser (which furthermore uses unsustainable fossil fuels). Intensive production of feed for monogastrics is water-costly and manure from these housed animals often causes water pollution (section 2.3).

Ruminants are potentially more appropriate for feeding people, because they convert plants and parts of plants inedible to humans into meat and milk, including straw from wheat and maize, and vegetation on land that is unsuitable for other crops. However, there are also strong reasons for stopping and reversing the current growth in numbers of ruminants. Most critical is the continuing conversion of forests into grazing or feed crop land [34, 69]. Furthermore, cattle, sheep and goats produce more methane per unit of feed consumed, in their digestive systems, than monogastric animals. So for both environmental and health reasons, when McMichael et al. [46] propose a target meat consumption of 90g per day per person, they recommend that no more than 50g per day should come from red meat from ruminants. Similarly, Weber and Matthews [79] state that:

> "Shifting less than one day per week's worth of calories from red meat and dairy products to chicken, fish, eggs, or a vegetable-based diet achieves more GHG reduction than buying all locally sourced food."

So numbers of both ruminants and non-ruminants should be reduced. Yet policies concerning numbers and management of livestock cannot just be as simple as that: they must take into account the complexities of livestock production and its impacts discussed in previous sections. However much meat and milk production there is – whether it continues to increase, levels off or declines – for sustainability to be achieved it must be made more efficient. The opportunities for mitigation of climate changing effects of livestock differ between ruminants and non-ruminants, and between production systems, as discussed in the next section.

The worst problems for climate change are caused by raising ruminants and by feeding grain to animals. As such, the priorities are:

- to slow and reverse the growth in cattle production (beef and dairy), particularly grain-fed. This will apply more to developed countries;
- to slow and reverse the growth in pig and poultry production, particularly intensive, grain-fed. This will apply more to developing countries.

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Spreading problem: Pig and poultry production contributes large quantities of GHGs from manure and fertiliser application.

4.4 Management

Achieving sustainable livestock agriculture – that is ecologically sound, economically viable, socially just and humane – clearly requires consideration not just of numbers and species of animals but of how they are managed. One of the key issues here is the degree of intensification of livestock production.

One conclusion of *Livestock's Long Shadow*, concerning intensification, has been widely quoted but also widely misinterpreted. The wording is as follows [69]:

> "There is a need to accept that the intensification and perhaps industrialization of livestock production is the inevitable long-term outcome of the structural change process that is ongoing for most of the sector."

First that conclusion has to be taken in context. As we pointed out in section 4.1, the report does not address the paramount need to slow and reverse growth in the livestock sector. Rather, it emphasises (e.g. in Map 30 on p.354) that the large majority of GHGs are produced by ruminants in grazing systems in developing countries and suggests that their numbers will continue to grow. Many of those animals have extremely low-quality diets and inefficient production, as well as causing other problems such as erosion of waterways and their management frequently could and should be improved. Secondly, the terms 'intensification' and 'industrialisation' are open to misinterpretation. Any 'intensification' of such grazing and browsing ruminants in those developing countries is starting from a very extensive basis, and as noted above in section 2.4, Steinfeld et al. [69] use the term 'industrial' very broadly, to include systems with up to a hectare for 10 animals. *Livestock's Long Shadow* is not recommending factory farming.

On the contrary, industrial, highly intensive farming as used in developed countries and now spreading to developing countries is unsustainable ecologically (section 2.5), economically and socially (section 3.2). Livestock kept in well-managed extensive conditions use local resources and recycle the productivity of the land. Indeed, pastured livestock is not just less bad for sustainability, but may have distinctly positive effects, because pasture can contribute to carbon sequestration.

Carbon storage or sequestration can be enhanced by soil management practices such as conservation tillage, in which 30 per cent or more of the crop residue remains on the surface after planting. The IPCC [33] estimates that conservation tillage can sequester up to 1.3 tonnes carbon/ha/year and could feasibly be adopted on 60 per cent of arable lands.

Improved grassland management is another major approach in which soil carbon losses can be reversed leading to net sequestration by the use of trees, more appropriate species and fertilisation techniques. Pasture is the largest anthropogenic land use and could therefore potentially sequester more carbon than any other practice [69].

Grassland degradation

Overgrazing is the greatest cause of degradation of grasslands. Thus, in many systems, improved grazing management (e.g. optimising stock numbers, rotational grazing) will result in substantial increases in carbon pools [33]. The introduction of trees in pasture areas can improve pasture productivity, increase nutrient recycling and promote soil stabilisation and species biodiversity. Soils under silvopastoral systems also have higher carbon content. Successful silvopastoral systems have been implemented in cattle and sheep production in Latin America and New Zealand [69]. Agroforestry may be especially successful in pasture with relatively low productivity, which is by far the largest sector of land used for livestock production.

The total potential sequestration of carbon associated with livestock management (Table 3) is comparable to the total carbon emissions from livestock worldwide (Table 1). However, it is not enough to offset the total GHG release from livestock production, including methane and nitrous oxide, which is of the order of seven billion tonnes of carbon dioxide equivalent per year. This emphasises again the need to reduce livestock numbers and to adopt other improvements in management practices.

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Outdoor life: Livestock kept in well-managed extensive conditions, in silvopastoral systems, can have positive effects on the environment.

Table 3. Global terrestrial carbon sequestration potential from improved management (data from [33])

Carbon sink	Potential sequestration (billion tonnes carbon per year)
Arable land	0.85 – 0.90
Grassland and rangelands	1.7
Forests	1 – 2

4.5 Processing and transport

Livestock's Long Shadow [69] considers at length changes in livestock management that can improve sustainability – changes in areas such as feeding methods and land, water and manure management – and this report will not duplicate that coverage. However, there is one general issue that we must address, partly because this is the approach that has received most attention generally (although not from Steinfeld et al.): organic production.

The impact of organic methods of livestock production on sustainability is not straightforward, so it cannot simply be said that organic production is good or bad for sustainability. Two reports to the UK's Department for Environment, Food and Rural Affairs illustrate the complexity. Foster et al. [24] report that energy use is lower for organic beef, sheep and pigs than conventional but higher for poultry, while organic dairying uses less energy in absolute terms but more per litre of milk. That report draws on an earlier one [80] that considered the various impacts of a variety of management systems in more detail. To take beef as an example (Table 4), organic production uses less energy and resources in general than other systems, and no pesticides, but compares less well on other criteria such as potential for global warming and eutrophication, and land use. Some of these differences can be explained by slower growth of organic livestock.

The conclusion must be that organic methods should be used judiciously as part of a general conversion to sustainable livestock production – or rather, as that conversion must include reduced livestock production, a conversion to sustainable food production. One of the principles of the organic movement is that "organic agriculture should be based on living ecological systems and cycles, work with them, emulate them and help sustain them" [30], a principle which must, by definition, contribute to solving problems of unsustainability.

There have been few analyses of the sustainability of different approaches to processing of animal products: for example, we know of no comparisons of commercial processing and sale of 'value added' products versus sale of meat to be prepared for cooking in the home. It is known, though, that post-farm-gate processes account for more than half of the food-related GHG emissions in the UK [27]. Foster et al. [24] comment that "for chicken, energy and water impacts from processing [are] as significant as impacts in chicken rearing." Study of this issue, including a comparison of processing and cooking meat versus alternatives, would be valuable.

Indisputable conclusion

The issue of transport has received more attention, particularly in relation to food miles. The conclusion is indisputable: for reasons of fuel use, pollution, disease control and local food security, as well as animal welfare, there should be a reduction in movement round the world of animal feed, animals and food from animals [3, 8, 43]. This principle must take into account the fact that livestock production must increasingly be regarded as unacceptable in areas that are fundamentally unsuitable for reasons such as lack of water (the example of the Kalahari area of Botswana was given in section 2.3) and the need to address the protein requirements of people in such areas. However, it can no longer be assumed that those people should be supplied with imported meat. Providing people with adequate nutrition is rightly a priority for all governments. Providing them with meat is not.

Table 4. Environmental impacts of different beef production systems per tonne of carcass dead weight [80]
MJ megajoules, GWP global warming potential, CO_2 carbon dioxide, EP eutrophication potential, AP acidification potential, ARU abiotic resources used. For explanation of measures see source.

Impacts and resources used	Conventional	Organic	100% suckler	Lowland	Hill and upland
Primary energy used, MJ	27,800	18,100	40,700	26,800	29,700
GWP_{100}, kg 100 year CO_2 equivalent	15,800	18,200	25,300	15,600	16,400
EP, kg PO_4 equivalent	157	326	257	153	169
AP, kg SO_2 equivalent	469	711	708	452	510
Pesticides used, per ha	7.2	0.0	7.3	6.7	8.0
ARU, kg antimony equivalent	36	31	51	34	41
Land use, ha	2.3	4.21	3.85	2.28	2.41

5.

Conclusions and recommendations

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5.1 Sustainability in livestock production and more widely in food production cannot be achieved by simple measures. A sustainable food policy is likely to be as complex as the food production system itself.

5.2 A sustainable food policy has to address all aspects of sustainability: it must be ecologically sound, economically viable, socially just and humane. Despite the paramount urgency of environmental issues, it is not politically or practically possible to address them in isolation from economics and social justice.

5.3 Humane treatment of animals fosters sustainability and vice versa.

Recommendation 1

Intergovernmental organisations, national governments and the food supply industries (agricultural and retail) must urgently develop policies for sustainable food supply. For livestock production to have reduced impact on climate change and to be sustainable in other respects it must be biologically based, socially just and humane. Animal welfare must be included in all future discussions on agriculture and climate change.

5.4 Farm animals make up two-thirds of the terrestrial vertebrate biomass. They use an unsustainable quantity of water and other natural resources and contribute an unsustainable quantity of anthropogenic GHG emissions. The projected doubling of meat and milk production from 2000 to 2050 is unsupportable. It is necessary both (a) to reduce the net environmental impact per unit of livestock production and (b) to slow and then reverse current growth in livestock numbers worldwide.

5.5 The worst problems for climate change are feeding grain to animals and raising ruminants. However, increasing pig and poultry production is problematic too, for reasons of development and food supply, because they eat food that people can eat. By contrast, pastured livestock is not just less problematic, but may be beneficial, because pasture can contribute to carbon sequestration. So the priorities are: (a) to slow and reverse the growth in cattle production (beef and dairy), particularly grain-fed; this will apply more to developed countries; and (b) to slow and reverse the growth in pig and poultry production, particularly intensive, grain-fed; this will apply more to developing countries.

Recommendation 2

The current acceleration in meat and milk production cannot be allowed to continue unchecked. National governments and intergovernmental organisations must develop mechanisms to slow and reverse this growth, especially in cattle production, grain

feeding and intensive production methods that are not ecologically sustainable. They must also assist livestock producers, within the wider agricultural industry, to manage this slowdown in volume of production, by mechanisms including development of value-added markets such as that for humanely reared animal products.

5.6 Thus livestock numbers and efficiency will have to be addressed in developing as well as developed countries. This is not saying that poor or malnourished people should be further disadvantaged. If a modest increase in consumption of animal products by the poorest people in developing countries is the best way to improve their nutrition, this should be facilitated, and offset by greater reductions in consumption by those better off and better fed.

5.7 Information is scant on the number of people within countries that consume different amounts of animal products.

Recommendation 3

Research is urgently needed to enable design of policies that reduce (or slow the increase in) meat consumption by people who consume more than others, while not causing hardship to poor or malnourished people in either developed or developing countries. As this addresses a 'public good' it will require support from public and philanthropic funding bodies.

5.8 At the time of writing (mid-2008), food prices are increasing due to a variety of financial pressures, further exacerbating problems of food supply particularly for undernourished people and further underscoring the urgency of a sustainable food policy. Long-term food security is not promoted either by increased, industrialised meat supply or by transport of animal products round the world, as both depend on resources (including oil) that are unreliable and subject to inevitable decline, and do not guarantee food to those who need it most. Long-distance transport of animals for slaughter is particularly wasteful of energy, dangerous for disease transmission and inhumane. Food security is best achieved on a local basis, with local animal keeping as part of a biological rather than a technological approach.

5.9 As the majority of GHGs are currently produced by ruminants in grazing systems in developing countries, more efficient management of those livestock is needed. Yet highly intensive production causes many other problems. Mid-way between the extremes, livestock kept in well-managed extensive conditions use local resources and recycle the productivity of the land.

Recommendation 4

Food production needs to move away from industrial, multinational systems towards moderate-scale, humane models with local supply chains and markets, contributing to greater national and regional self-sufficiency in food. This would reduce not only the environmental damage caused by livestock production, but also the unpredictability in global food markets such as that underlying the current food crisis.

5.10 Livestock production also needs further adaptation in developed countries, away from the intensive systems that have externalised environmental and social costs, towards humane, sustainable systems. Organic methods make a helpful contribution for some species in some circumstances, although not all.

5.11 Industrial animal agriculture is no solution to climate change or to achieving environmental or social sustainability.

Recommendation 5

Financial support for industrial livestock production methods (such as unseen subsidies for externalised costs) should be ended, and economic mechanisms to support humane sustainable livestock production (for example research funding) should be prioritised. Governments should support these changes with high-profile, well-resourced public awareness campaigns.

Recommendation 6

An inevitable consequence of the previous recommendations is that consumers who eat large amounts of meat and other animal products should eat less of those products. The animal products that consumers buy should be sourced locally and reared in humane and environmentally and socially responsible ways.

Working towards global recognition of animal welfare

The international animal welfare community is working alongside governments from around the world to achieve a Universal Declaration on Animal Welfare (UDAW) at the UN.

Such a Declaration would support the inclusion of animal welfare in intergovernmental debates on environmental sustainability, food security and other issues at the heart of the international development agenda. To find out more, please visit www.udaw.org/gov

References

1. Altekruse SF, Cohen ML & Swerdlow DL (1997). Emerging foodborne diseases. *Emerging Infectious Diseases* 3: 285-318
2. Anon 2007 Britain could go back to rationing. www.thisislondon.co.uk/news/article-23383454-details/Britain%20could%20go%20back%20to%20rationing/article.do Accessed 13 August 2008
3. Appleby MC 2003 Farm disease crises in the United Kingdom: lessons to be learned. In Salem D & Rowan AN (ed) *The State of the Animals II: 2003* pp 149-158. Humane Society Press, Washington DC
4. Appleby MC 2004 Alternatives to conventional livestock production methods. In Benson GJ & Rollin BE (eds) *Production Animal Pain and Well-Being: Theory and Practice* pp 339-350. Blackwell, Ames, USA
5. Appleby MC 2005 Sustainable agriculture is humane, humane agriculture is sustainable. *Journal of Agricultural and Environmental Ethics* 18, 293-303
6. Appleby MC & Sherwood L 2007 *Animal Welfare Matters – to animals, people and the environment: The case for a Universal Declaration on Animal Welfare*. World Society for the Protection of Animals, London
7. Appleby MC, Hughes BO & Mench JA 2004 *Poultry behaviour and welfare*. CAB International, Wallingford UK
8. Appleby MC, Cussen VA, Garcés L, Lambert LA & Turner J (eds) 2008 *Long distance transport and welfare of farm animals*. CAB International, Wallingford
9. Berg C 2004 World fuel ethanol analysis and outlook. www.distill.com/World-Fuel-Ethanol-A&O-2004.html Accessed 29 February 2008
10. Borger J 2008 UN declares it cannot afford to feed the world. *Guardian*, February 29 – March 6
11. Bouwman AF, Lee DS, Asman WAH, Dentener FJ, Der Hoek KW & Olivier JGJ 1997 A global high-resolution emission inventory for ammonia. *Global Biogeochemical Cycles* 11: 561-588
12. Centers for Disease Control 2007 National center for infectious diseases: Infectious disease information. www.cdc.gov/ncidod/diseases/food/ Accessed 12 November 2007
13. Chameides WL & Perdue EM 1997 *Biogeochemical cycles: A computer-interactive study of earth system science and global change*. Oxford University Press, New York
14. Chapagain AK & Hoekstra AY 2004 *Water footprints of nations. Volume 1: Main Report*. Value of Water Research Report Series No. 16. UNESCO-IHE p76
15. Compassion in World Farming 2007 *The role of the intensive poultry production industry in the spread of avian influenza*. Compassion in World Farming, Godalming
16. Compassion in World Farming 2007 *Global warning: Climate change and farm animal welfare*. Compassion in World Farming, Godalming
17. Cox J 2007 *Industrial animal agriculture – part of the poverty problem*. WSPA, London
18. Els AJE & Rowntree KM 2003 Water resources in the savannah regions of Botswana. EU INCO/UNEP/SCOPE
19. European Environment Agency 2001 Eutrophication in Europe's coastal waters. reports.eea.europa.eu/topic_report_2001_7/en Accessed 13 August 2008
20. European Environment Agency 2008 About air pollution. www.eea.europa.eu/themes/air/about-air-pollution Accessed 13 August 2008
21. Food and Agriculture Organisation 2003 Livestock - a resource neglected in poverty reduction strategy papers. www.fao.org/AG/againfo/projects/en/pplpi/docarc/pb_wp1.html Accessed 20 February 2008
22. Food and Agriculture Organisation 2007 Questions & Answers: the facts of bird flu. www.fao.org/avianflu/en/qanda.html Accessed 12 Nov. 2007
23. Food and Agriculture Organisation 2008 FAOSTAT faostat.fao.org/site/569/default.aspx Accessed 3 March 2008
24. Foster C, Green K, Bleda M, Dewick P, Evans B, Flynn A & Mylan J 2006 *Environmental impacts of food production and consumption: A report to the Department for Environment, Food and Rural Affairs*. Manchester Business School. Defra, London. www.defra.gov.uk/science/project_data/DocumentLibrary/EV02007/EV02007_4601_FRP.pdf
25. Fricker P 2008 Care about the environment? Eat less meat. *Toronto Globe and Mail* www.physorg.com/news119636342.html Accessed 14 April 2008
26. Garcés L 2002 *The detrimental impacts of industrial animal agriculture*. Compassion in World Farming Trust, Petersfield
27. Garnett T 2008 Livestock and greenhouse gas emissions: exploring the relationship. Food Climate Research Network store.mlc.org.uk/articles/dodownload.asp?a=store.mlc.org.uk.30.1.2008.15.18.29.pdf&i=293775 Accessed 13 May 2008
28. Gips T 1984 What is sustainable agriculture? *Manna* July/August: 2
29. Greger M 2006 *Bird flu: a virus of our own hatching*. Lantern, New York
30. Hansen H & Sjouwerman P 2007 *Organic agriculture and animal health*. International Federation of Organic Agriculture Movements, Bonn
31. Hodges J 2005 Cheap food and feeding the world sustainably. *Livestock Production Science* 92: 1-16
32. Humane Society of the United States 2007 *An HSUS Report: The Impact of Animal Agriculture on Global Warming and Climate Change* www.hsus.org/archive/campaigns/temp/global_warming_animal_ag.html Accessed 18 August 2008
33. Intergovernmental Panel for Climate Change 2000 *Land use, land use change and forestry. A special report of the IPCC*. Cambridge University Press, Cambridge
34. Intergovernmental Panel for Climate Change 2001 *Climate change 2001: Impacts, adaptation and vulnerability. IPCC third assessment report*. Cambridge University Press, Cambridge
35. Intergovernmental Panel for Climate Change 2001 *Climate change 2001: The scientific basis*. Cambridge University Press, Cambridge
36. International Assessment of Agricultural Knowledge, Science and Technology for Development 2008 www.agassessment.org Accessed 18 August 2008
37. International Finance Corporation 2006 *Creating business opportunity through improved animal welfare*. www.ifc.org Accessed 12 November 2007
38. International Finance Corporation 2007 *Animal welfare in livestock operations*. www.ifc.org Accessed 12 November 2007
39. International Working Group on Animals in Disasters 2008 *Protecting animals from disasters*. World Society for the Protection of Animals, London
40. Jo H, Park Y and colleagues 2006 *Farm animal welfare in South Korea*. Animal Freedom Korea
41. Jowit J 2008 UN says eat less meat to curb global warming. *Observer* 7 September: 1
42. Keep Antibiotics Working 2004 The campaign to end antibiotic overuse. www.keepantibioticsworking.com Accessed 26 February 2008
43. Kitchen RD, Broom DM & Phillips CJC 2004 *Links between animal health and animal welfare: The effects of transport on animals.* Eurogroup for Animal Welfare, Brussels
44. Kusina JF, Kusina NT & Mhlanga J 2000 Poultry production in Mashonaland Central Province: the role of and opportunities for women. *Integrated Crop-Livestock Production in Smallholder Farming Systems in Zimbabwe, Proceedings of a Review Workshop in Zimbabwe* pp 247-264
45. Lanier JL, Nierenberg D, Bowles D, Sherwood L, Ståhle G, Huertas G, Mackensen, H & Roeder L 2008 *Farm animals and climate*

change. A report to the UN Secretary General called for in the Declaration of the 60th UN DPI/NGO Conference www.climatecaucus.net/livestock.htm Accessed 19 August 2008

46. McMichael AJ, Powles JW, Butler CD & Uauy R 2007 Food, livestock production, energy, climate change, and health. *The Lancet* 370: 1253-1263

47. Millennium Assessment Report 2005 *Ecosystems and human well-being: biodiversity synthesis*. World Resources Institute

48. Mills F 2000 Hog Tide - hurricanes brought vast environmental damage from North Carolina's pork industry. findarticles.com/p/articles/mi_m1525/is_1_85/ai_62828626 Accessed 11 March 2008

49. National Research Council 1981 *Effects of environment on nutrient requirements of domestic animals*. Subcommittee on Environmental Stress, Committe of Animal Nutrition, National Research Council p. 168. National Academy Press, Washington DC

50. Neumann CG, Bwibo NO, Murphy SP, Sigman M, Whaley S, Allen LH, Guthrie D, Weiss RE & Demment MW 2003 Animal source foods improve dietary quality, micronutrient status, growth and cognitive function in Kenyan school children: Background, study design and baseline findings *Journal of Nutrition* 133: 3941S-3949S

51. New Scientist 2005 Editorial: Bird flu outbreak could kill 1.5 billion people. *New Scientist* 2485: 5

52. Nierenberg D & Garcés L 2005 *Industrial animal agriculture – the next global health crisis?* World Society for the Protection of Animals, London

53. Novotny V, Imhoff KR, Olthof M, & Krenkel PA 1989 *Handbook of urban drainage and wastewater.* Wiley, New York

54. OIE (World Organisation for Animal Health) 2008 Terrestrial Animal Health Code, Section 3.7 Animal Welfare. www.oie.int/eng/normes/mcode/en_titre_3.7.htm Accessed 13 August 2008.

55. Olsson A 2008 Grow meat, but off the bone. *New Scientist* 5 July: 18

56. Owen E, Kitalyi A & Smith T (eds) 2005 *Livestock and wealth creation: improving the husbandry of animals kept by resource-poor people in developing countries*. Nottingham University Press, Nottingham

57. Patel R 2008 Is meat off the menu? www.guardian.co.uk/lifeandstyle/2008/jun/22/foodanddrink.food Accessed 8 September 2008

58. Pennington Group 1997 *Report on the circumstances leading to the 1996 outbreak of infection with E. coli O157 in central Scotland, the implications for food safety and the lessons to be learned*. The Stationery Office, Edinburgh

59. Pew Commission 2008 *Putting meat on the table: Industrial farm animal production in America*. www.ncifap.org/index.html The Pew Charitable Trusts & Johns Hopkins Bloomberg School of Public Health. Accessed 13 August 2008

60. Pretty JN 2007 *The earth only endures: on reconnecting with nature and our place in it.* Earthscan

61. Pretty JN & Hine RE 2001 *Reducing food poverty with sustainable agriculture*. UK Department of International Development, London

62. Pretty JN, Brett C, Gee D, Hine R, Mason CF, Morison JIL, Raven H, Rayment M & van der Bijl G 2000 An assessment of the total external costs of UK agriculture. *Agricultural Systems* 65: 113-136

63. Randall K 1999 North Carolina hurricane flooding—the manmade component of a natural disaster. www.wsws.org/articles/1999/sep1999/nc-s28.shtml Accessed 11 March 2008

64. Renton A 2008 Rice crisis. *Observer Food Monthly* 88: 40-47.

65. Rivera JA & Habicht JP 2002 *Effect of supplementary feeding on the prevention of mild-to-moderate wasting in conditions of endemic malnutrition in Guatemala.* Bulletin of the World Health Organisation 80 www.scielosp.org/scielo.php?script=sci_arttext&pid=S0042-96862002001200005#a1 Accessed 14 August 2008

66. Second World Water Forum 2000 World water challenges for the twenty-first century www.waternunc.com/gb/secWWF.htm Accessed 12 November 2007

67. Seré C & Steinfeld S 1996 *World livestock production systems: Current status, issues and trends*. FAO Animal Production and Health Paper 127, Rome

68. Smil V 1991 *General energetics, energy in the biosphere and civilization*. Wiley, New York

69. Steinfeld H, Gerber P, Wassenaar T, Castel V, Rosales M & de Haan C 2006 *Livestock's Long Shadow: environmental issues and options*. Food and Agriculture Organisation, Rome

70. Strategy Unit 2008 *Food matters: Towards a strategy for the 21st Century*. www.cabinetoffice.gov.uk/strategy/work_areas/food_policy.aspx Accessed 18 August 2008

71. Thomas DS 2002 Sand, grass, thorns, and cattle. In Sporton D & Thomas DSG (eds) *Sustainable livelihoods in Kalahari environments: Contributions to global debates*. Oxford University Press, New York

72. Tran Thi Dan, Thai Anh Hoa, Le Quang Hung, Bui Min Tri, Ho Thi Kim Hoa, Le Thanh Hien, & Nguyen Ngoc Tri 2003 LEAD pilot project on the Area-wide integration (AWI) of specialized crop and livestock activities in Vietnam. In Narrod C & Gerber P (eds), *LEAD*, FAO, Rome

73. Turner WR., Brandon K, Brooks TM, Costanza R, da Fonseca GAB & Portela R 2007 Global conservation of biodiversity and ecosystem services. *BioScience* 57: 868–873

74. United Nations 2005 UN Millennium Development Goals. www.un.org/millenniumgoals Accessed 12 Nov. 2007.

75. US Census Bureau 2008 International Data Base www.census.gov/ipc/www/idb/ Accessed 20 February 2008

76. US Environmental Protection Agency 2007 *Inventory of US greenhouse gas emissions and sinks: 1990-2005.* Environmental Protection Agency, Washington DC

77. Vannuccini S 2004 *Overview of fish production, utilization, consumption and trade.* FAO Fishery Information, Data and Statistics Unit.

78. Vargas-Lundius R & Ypeij A 2007 *Polishing the stone: A journey through the promotion of gender equality in development projects* www.ifad.org/pub/gender/polishing/polishing.pdf Accessed 14 August 2008

79. Weber CL & Matthews HS 2008 Food-miles and the relative climate impacts of food choices in the United States. *Environmental Science and Technology* 42: 3508–3513

80. Williams AG, Audsley E & Sandars DL 2006 *Determining the environmental burdens and resource use in the production of agricultural and horticultural commodities*. Main Report, Defra Research Project IS0205. Cranfield University and Defra, Bedford. Available on www.silsoe.cranfield.ac.uk, and www.defra.gov.uk

81. World Resources Institute 2006 Nutrition: Grain fed to livestock as a per cent of total grain consumed. earthtrends.wri.org/text/agriculture-food/variable-2303.html Accessed 29 February 2008

82. World Society for the Protection of Animals 2008 Universal Declaration on Animal Welfare. www.udaw.org Accessed 28 August 2008

83. World Wildlife Fund 2005 About ecoregions. www.worldwildlife.org/ecoregions Accessed 3 March 2008

WSPA International
89 Albert Embankment
London, SE1 7TP
United Kingdom
T: +44 0207 587 5000
F: +44 0207 587 5057
E: wspa@wspa-international.org
W: www.wspa-international.org

WSPA Africa
PO Box 105476
Dar es Salaam
United Republic of Tanzania
T: +255 22 270 1032
F: +255 22 270 1033
E: enquiries@wspaafrica.org
W: www.wspa-international.org

WSPA Asia
19th Floor
Olympia Thai Tower
444 Ratchadaphisek Road
Huay Kwang, Bangkok 10310
Thailand
T: +66 2 513 0475
F: +66 2 513 0477
E: Thailand.enquiries@wspa-asia.org
W: www.wspa-international.org

WSPA Australia
GPO Box 3294
Sydney, NSW 2001
Australia
T: +61 2 9902 8000
F: +61 2 9906 1166
E: wspa@wspa.org.au
W: www.wspa.org.au

WSPA Brazil
Av. Princesa Isabel
323 – 8 andar
Copacabana
22011-901
Rio de Janeiro
Brazil
T: +55 21 3820 8200
F: +55 21 3820 8229
E: wspabrasil@wspabr.org
W: www.wspabrasil.org

WSPA Canada
90 Eglinton Ave. E. Suite 960
Toronto
Ontario
M4P 2Y3
Canada
T: +1 416 369 0044
F: +1 416 369 0147
E: wspa@wspa.ca
W: www.wspa.ca

WSPA Central America, Mexico and The Caribbean
Mall Paseo las Flores Business Center 5th Floor
Apartado Postal 516-3000
Heredia
Costa Rica
T: +506 2562 1200
F: +506 2260 1225
E: info@wspala.org
W: www.wspa.or.cr

WSPA China
501B, Dong Wai Diplomatic Building
No.23, Dongzhimen Wai Avenue
Beijing, 100600
China
T: +86 10 85325211 – 8008
F: +86 10 85324211
E: alyceyu@wspa-asia.org
W: www.wspa-international.org

WSPA Germany
Kaiserstraße 22
53113, Bonn
Germany
T: +49 228 956 3455
F: +49 228 956 3454
E: info@wspa.de
W: www.wspa.de

WSPA India
906, 9th Floor
International Trade Tower
Nehru Place
New Delhi – 110019
India
T: +91 11 46539341
F: +91 11 46539345
E: India.enquiries@wspa-asia.org
W: www.wspa-international.org

WSPA Middle East
89 Albert Embankment
London, SE1 7TP
United Kingdom
T: +44 0207 587 5000
F: +44 0207 793 0208
E: wspa@wspa-international.org
W: www.wspa-international.org

WSPA Netherlands
Benoordenhoutseweg 23
2596 BA Den Haag
The Netherlands
T: +31 70 314 2800
F: +31 70 314 2809
E: info@wspa.nl
W: www.wspa.nl

WSPA New Zealand
Private Bag 93220
Parnell 1151
Auckland
New Zealand
T: +64 9 309 3901
F: +64 9 336 1947
E: wspa@wspa.org.nz
W: www.wspa.org.nz

WSPA Nordic
Vesterbrogade 34, 1
1620 Copenhagen V
Denmark
T: +45 33 93 7212
F: +45 33 93 7210
E: info@wspa.dk
W: www.wspa.dk

WSPA South America
Carrera 13 #29-21 Of.234
Manzana 1, Parque Central Bavaria
Bogota
Colombia
T/F: +571 285 5472
T/F: +571 285 5748
E: wspa@wspa.org.co
W: www.wspa-international.org

WSPA UK
89 Albert Embankment
London, SE1 7TP
United Kingdom
T: +44 0207 587 5000
F: +44 0207 793 0208
E: wspa@wspa.org.uk
W: www.wspa.org.uk

WSPA USA
Lincoln Plaza
89 South Street
Suite 201
Boston MA 02111
USA
T: +1 617 896 9214
F: +1 617 737 4404
E: wspa@wspausa.org
W: www.wspa-usa.org

WSPA