EXECUTIVE SUMMARY

BEYOND FACTORY FARMING

Sustainable Solutions for Animals, People and the Planet

COMPASSION in world farming

CONTENTS

UNITS USED IN THE TEXT

1 hectare = 2.47 acres

1 square kilometre (km^2) = 100 hectares = 247 acres

1 tonne (metric tonne) = 1000 kg = 0.98 ton

1 cubic metre (m^3) = 1000 litres

1 kilocalorie (kcal) = 1000 calories

1 gigajoule (GJ) = 1 billion joules = 278 kilowatt hours (KW hr) = 0.278 megawatt hours (MW hr)

WHY WE NEED TO END FACTORY FARMING BY 2050

'Well before 2050, the world will need farming systems capable of feeding 8 –11 billion people within a resource-light, low-carbon economy. '

Factory farming of animals for food is resource-hungry and carbon-intensive. A creation of the second half of the 20th century in the developed world, it depends on high inputs of global natural resources – energy, water and land. Sixty billion animals (poultry and mammals) are used to produce food annually[1] and over 50% of pigmeat and 70% of chicken meat is already industrially produced.[2, 3] Industrial systems have been increasing at six times the rate of traditional mixed farming systems.[4] Policymakers now predict that meat production will double by 2050, potentially doubling the number of animals used to 120 billion a year. The planet will not be able to sustain these huge numbers of livestock nor these methods.

Industrial livestock production is a highly inefficient use of global resources of land, water and fossil fuel energy when compared to plant crops such as cereals and vegetables. Every kilogramme of factory farmed meat requires several kilogrammes of grains for animal feed. Around 40% of the world's grain harvest is already used as livestock feed, and that proportion is around 70% in most rich countries.[5] Much of the land, energy and water used to grow feedcrops for intensively produced animals could be more efficiently used to grow food that is directly consumed by people. The United Nations Intergovernmental Panel on Climate Change (IPCC) in 2001 noted, 'A shift from meat towards plant production for human food purposes, where feasible, could increase energy efficiency and decrease GHG [greenhouse gas] emissions.'[6]

A number of economic pressures are now forcing a re-evaluation of how we use global resources: forecast population growth to more than nine billion by 2050, rapid industrialisation of developing economies, Peak Oil, higher energy prices, the demand for biofuel alternatives to oil, the impact of climate change on the availability of land and water for agriculture, people and industry, and the urgent need to reduce greenhouse gas emissions, starting now.

Livestock production globally is currently responsible for 18% of human-induced greenhouse gas emissions,[2] a higher proportion than all global transport (14%).[7]

Climate change could fundamentally change the conditions under which livestock can be produced in future, by reducing the availability of feedcrops, water and land. High temperatures may drastically reduce crop yields.[9] Large areas of the world's current cropland may become unusable or unproductive due to coastal flooding or drought. A rise in sea level of one metre is possible by the end of this century; this would flood one-fifth of Bangladesh and 2 million km^2 of land globally. As many as 150-200 million people could be permanently displaced by 2050 due to rising sea levels, floods and droughts and forced to settle on previously farmed land.[10] As we approach 2050, the huge resources of land, water and energy that our current intensive livestock production is based on may simply not be available. Factory farming would become both economically and ethically unsustainable.

With its high demand for resources and its high impacts, factory farming is the wrong model for feeding the world in 2050. In the next decades, we need to halve the environmental footprint of food production and free-up grain to feed people. A reduction in animal production, combined with lower-input, extensive farming, is the most effective response that farmers and policymakers in developed countries can make to achieve this goal. A reduction in consumption of animal products is also one of the most rapid and effective responses that an individual can make to the global problems of climate change, over-exploitation of the global environment and to free up natural resources for the use of the world's poor.

FACTORY FARMING'S IMPACT ON RESOURCES

Resource inefficiency: Factory farming gives a poor return on inputs of energy, land and water.

Livestock feed consumes nearly 43% of the food energy (kilocalories) produced by the world's total harvest of edible crops,[5, 11] after post-harvest losses. To produce 1 kg of edible meat by typical industrial methods requires 20 kg of feed for beef, 7.3 kg of feed for pigmeat and 4.5 kg of feed for chickenmeat.[11] On average, to produce 1 kg of high quality animal protein, livestock are fed nearly 6 kg of plant protein.[12] The production of just 1 kg of beef, as a global average, consumes nearly 15,500 litres of water,[13] the equivalent of 90 full bathtubs. This is nearly 12 times the quantity needed to produce 1 kg of wheat.[13]

One kcal of food energy from beef requires 40 kcal of fossil fuel energy input to produce.[14] Soya is 65 times as energy efficient as grain-fed beef and 73 times as energy efficient as farmed salmon, per unit of food energy (calories) consumed.[15] The production of 1 kg of beef requires 15 times as much land as the production of 1 kg of cereals and 70 times as much land as the production of 1 kg of vegetables. One kilogramme of pigmeat uses over six times as much land as 1 kg of cereals and 30 times as much land as 1 kg of vegetables.[16] Per cubic metre of water used in production, lentils and wheat produce up to 17 and 19 times more food calories respectively and up to five times more edible protein, compared to beef.[17]

The world's cereal harvest cannot support the world's population of 6.5 billion on a high-meat diet, let alone the 9.2 billion people who are forecast to be alive in 2050. At the level of the United States' consumption of animal products, we could feed only 2.5 billion people; at the level of Italy's consumption, only 5 billion people; but at India's current level of grain and meat consumption we could feed up to 10 billion people.[18]

Resource scarcity: Factory farming consumes large quantities of resources that will be scarce and costly by 2050.

Harvests

To feed people and livestock, the world will need to produce an additional 1 billion tonnes of cereals annually in the next decades, a 50% increase. A significant part of this increase will be used for animal feed.[19] Increasing food output will not be easy. The rate of growth in crop yields is slowing sharply, partly due to soil degradation and the over-use of agrichemicals[20] and climate change will almost certainly affect global food security. Heat stress could reduce crop yields in tropical and subtropical regions by 2.5% to 16% for every 1°C increase in temperature in the growing season, potentially destabilising world food markets.[9]

Biofuels are now adding to the competition between livestock producers and others for resources. These competing claims could reduce the calorie intake of the world's poorest. Biofuel expansion could decrease food calorie consumption by 5% or more in some regions such as Sub-Saharan Africa.[21]

Land

The demand for feedcrops for livestock will put intensive animal production in direct competition for land with people, biofuel production and forests.

For food production alone, an additional 2 million km^2 of land will be needed by 2030.[22] At the same time, over-exploitation of arable land and soil damage is causing the loss of millions of hectares of once-productive cropland.[23] The demand for land for feed grain is increasing the pressure on already scarce grazing land. Grazing is moving into marginal land, where it leads to desertification, and into forests or other ecologically valuable areas.[24]

Sea level rise and loss of land

Sea level rise will impact the world's harvest due to salination or total flooding of good low-lying agricultural land. Currently, 200 million people live in coastal floodplains, including 35 million people in Bangladesh and the inhabitants of 22 of the world's largest cities. Two million km² of land could be flooded if sea levels rise by one metre, a possibility during this century.[10] This is the same area as that of the extra farmland that the world needs to find by 2030. The doubling of livestock production by mid-century is therefore projected to take place at a time when crop production is actually decreasing due to climate-related losses.

Water

Up to 2 billion people currently suffer from water scarcity and this number is likely to increase to between 4 and nearly 7 billion by 2050, more than half the world's population.[25] Competition for water is already intense.

Water use for livestock production is projected to increase by 50% to 2025 and already uses 15% of all irrigation water.[26] The UN's Food and Agriculture Organization (FAO) has concluded: 'It is clear that feed production consumes large amounts of critically important water resources and competes with other usages and users.'[26] Increasing meat consumption has been identified as the main cause of the worsening water scarcity in China.[27] Reducing the proportion of animal-based food and increasing the proportion of plant-based food in the diet can almost halve an individual's water footprint.[28]

Peak Oil and the energy crisis

Peak Oil, the point at which world oil production reaches a maximum and then begins to decline, is likely to arrive between 2010 and 2020, signifying the end of the era of cheap and reliable energy supplies.[29a]

By 2050, oil and gas production may be half what it was at its peak.[29b] Intensive agriculture is based on cheap fuel, with two-thirds of agriculture's energy costs used for fertilisers and agrichemicals.[30] In developed countries, half of the total use of nitrogen fertiliser is used for growing animal feed.[26] Cutting meat and fish consumption by 50% and milk consumption by 40% in developed countries would make a major contribution to halving energy use in the food system.[23]

THE COSTS OF FACTORY FARMING: CLIMATE, ENVIRONMENT AND HEALTH

Factory farming produces 'cheap' meat, milk and eggs for retail sale but the hidden external costs of production are high. The costs include damage to the environment and climate, to animal and human health, and to animal welfare. If we want to create a livestock production system with lower external costs, it is essential that the true costs of production are reflected in prices. According to the FAO, 'A top priority is to achieve prices and fees that reflect the full environmental costs [of livestock], including all externalities.'[31] Lower-input animal farming can more than halve external costs per kilogramme of product.[52]

Climate change

Global greenhouse gas (GHG) emissions in 2050 need to be 85% below those of 2000 if we are to have a reasonable chance of limiting temperature rise to around 2ºC. To achieve this, global emissions must peak no later than 2015 and get down to the level of 2000 emissions by 2030.[32] The livestock sector is responsible for a large proportion (18%) of total global GHG emissions and therefore needs to make substantial reductions within a short timeframe.

Livestock production is responsible for 37% of global methane (CH_4) emissions, 65% of global nitrous oxide (N_2O) emissions and 9% of global carbon dioxide (CO_2) emissions. In addition, 64% of ammonia emissions originate in livestock production and contribute to air, soil and water pollution, acid rain and damage to the ozone layer.[2] Globally, the most important sources of livestock-related GHGs are enteric fermentation (methane produced by digestion), animal manure and fertilisers used for feed production. A major driver of deforestation in South America is soybean production for factory farms in Europe and elsewhere.

The predicted global doubling of animal production by 2050 will generate large increases in livestock-related GHG emissions in the next decades. Nitrous oxide emissions are projected to increase by up to 35-60% by 2030 due to increased manure production by animals and increases in nitrogen fertiliser, much of which will be used to grow feed.[33] The expansion of large-scale commercial production of pigs and poultry is predicted to raise global emissions of methane from pig slurry and nitrous oxide from poultry manure.[34] Some developing regions will have very steep increases in livestock-related GHG emissions, making it even more essential that developed countries cut their own emissions rapidly.

Instead of seeking alternative solutions, many official responses to livestock-related GHG emissions have been to advocate further intensification of animal production. This would merely increase the waste of global resources devoted to animal feed production, with its associated problems of resource demand, alongside increased suffering of farmed animals. The most effective and fairest solution for reducing global livestock-related GHG emissions is to reduce the consumption of factory farmed products.

Biodiversity

Animal production-induced damage to wildlife habitats is one of the major threats to biodiversity globally. According to the FAO, 'Livestock play an important role in the current biodiversity crisis, as they contribute directly or indirectly to all these drivers of biodiversity loss, at the local and global level' through habitat change, climate change, overexploitation and pollution and 'over 70% of globally threatened birds are said to be impacted by agricultural activities'.[35a]

The impacts of intensive farming on biodiversity contribute to an already precipitous situation. The International Union for Conservation of Nature (IUCN), which monitors endangered species, believes that we are currently living through an extinction crisis. Current extinction rates are estimated to be at least 100 – 1000 times higher than natural background extinction rates.[35b] Global warming of 2ºC could result in the extinction of 15% to 40% of land species and an eventual rise of 3ºC or more, which is now thought to be likely, could see the extinction of up to half of all land species.[1]

Water and air pollution

Factory farming depends on crowding animals together in a relatively small space, often indoors. This breaks the link between livestock and the carrying capacity of the land and thus its ability to recycle wastes. Long before there was widespread concern over climate change, environmentalists and policymakers have been struggling to prevent pollution due to agricultural emissions of nitrogen and phosphorus globally. In water, these pollutants cause eutrophication and oxygen depletion, damaging biodiversity and killing fish. Around 30% of the nitrogen that pollutes water in the EU and the US is due to livestock (72% in China).[26, 37]

Nitrogen pollution is caused by both animal manure and the use of excessive quantities of fertilisers to produce animal feed. Two hundred dairy cows can produce as much manure as a town of 10,000 people.[38] Cattle and pig slurry and silage effluent are even more polluting to water than raw domestic sewage from human wastes.[39] Livestock production additionally pollutes freshwater by sediments (through soil erosion), pesticides, antibiotics, heavy metals and pathogens such as *Salmonella, Campylobacter and Escherichia coli (E. coli)* (all of which can cause foodborne disease in people).[26] Factory farms are sources of aerial pollutants that can damage the health of workers and those living near them. A chicken shed holding 100,000 broiler meat birds can emit up to 77 kg of polluting dust per day.[40]

Risks to human and animal health

Intensive livestock production methods, where large numbers of animals are kept together in confined spaces, increase the potential for infections to be spread between animals and from animals to humans. The stresses of factory farming and their reduced genetic diversity damage animals' natural capacity to resist infection and maintain health.[41a-c]

Factory farms commonly use antibiotics to prevent the spread of diseases that would otherwise occur among animals kept in unnaturally crowded conditions. It has been estimated that half of all antibiotics produced in the world are used for food animals, often for preventing disease rather than for curing sick animals.[45a] Over-use of antibiotics in intensive animal production is a major cause of the resistance of many common pathogens to the antibiotics used to treat humans.[45b] Factory farm use of antibiotics is also implicated in the spread of superbugs such as Methicillin-Resistant Staphylococcus Aureus (MRSA).[46a-b]

Factory farming has been implicated in the development of several significant human health challenges in the last 20 years. Bovine spongiform encephalopathy (BSE) emerged out of the intensification of the dairy industry. Highly pathogenic avian influenza, or bird flu, which now poses the threat of a global pandemic among people, emerged during a boom and rapid intensification in the global chicken industry. In 2006, the costs of controlling bird flu were estimated at 1 billion US dollars.[43] Reducing the size of the global-intensive chickenmeat industry would be one essential step towards controlling the disease. The 2009 human swine flu pandemic has also raised questions as to the role of factory farming in its origin and spread.

Of the new or currently emerging animal diseases, it has been estimated that 73% are transmissible to humans (zoonotic).[42] Global warming and global trade and transport can be expected to increase the rate at which animal diseases are spread and make infections in factory farms more difficult to control.

Food quality, nutrition and dietary choices

Factory farmed chicken has become a cheap meat, but at a cost in quality. Factory farmed meat chickens contain around one-third more fat than free-range organic chickens, and thus provide inferior nutrition.[44] Poultry are a common cause of food poisoning by bacteria such as *Salmonella* and *Campylobacter*. A diet lower in animal products would

benefit public health in countries where meat consumption is high. The World Health Organization European Anti-Obesity Charter of 2006 reported that 50% of Europe's adults and 20% of children are overweight.[47a] In the US, there are 'dramatic increases' in the number of overweight children (now at 16%), according to the United States Department of Agriculture (USDA). 65% of adults are overweight and 30% are classified as obese.[47b]

A 60% reduction in meat consumption, down to 90 g per person per day, would reduce the risk of colorectal cancer, breast cancer and heart disease, as well as the risk of becoming overweight or obese.[48] The World Cancer Research Fund's 2nd Expert Report recommends a diet composed mostly of 'foods of plant origin' and a public health goal of consumption of no more than 43 g red meat per day (300 g per week).[49]

In the interests of global equity, and in order not to disadvantage people in poorer countries who currently eat very little meat, Compassion in World Farming supports a strategy of 'contraction and convergence' in meat consumption.[48] A reduction of meat consumption in rich countries would allow poorer countries to increase their consumption according to their dietary needs.

SUSTAINABLE ALTERNATIVES TO FACTORY FARMING FOR 2050

Dramatic global benefits would be derived from reducing meat consumption and ending factory farming. The most effective way to reduce the impact of the livestock industry on the climate, environment, natural resources and health is to reorient the world's animal production towards lower-input, more extensive systems. At a time when land, energy and water are scarce and costly, lower-input farming would be more environmentally efficient than intensive farming and is capable of providing adequate nutrition for the nine billion people of 2050.[50]

Extensive animal farming can significantly reduce inputs of mineral fertilisers and other agrichemicals and save energy. Reducing meat consumption would enable many developed countries to reduce their intensive cereal production in favour of rotations that benefit the soil, and so end their dependence on energy-intensive and polluting synthetic nitrogen fertilisers.[51] Water resources could be used more efficiently, as animals reared on natural rain-fed pasture have a much lower impact on water resources.[5] Organic production can reduce the (normally hidden) external costs of pigmeat by 70% and the external costs of poultrymeat by 66% compared to the external costs of intensive production.[52]

A transition to a global low-meat diet would make an important contribution to reducing GHG emissions. In addition to reducing emissions of methane and nitrous oxide, it would act immediately to discourage deforestation for animal feed production. Pastureland and arable land released from intensive feedcrop production could be used to absorb large quantities of carbon dioxide. Studies have shown that a global low-meat diet implemented in the period 2010 to 2030 would reduce by 50% the expected costs of mitigating climate change up to 2050.[53]

A transition to a global low-meat diet has the potential to immensely improve the welfare of farmed animals. Free-range, organic and good semi-intensive indoor systems provide the animals with a number of very important welfare advantages that they are denied in intensive and industrial systems. These include: sufficient space for exercise; access to daylight and fresh air; opportunity for natural behaviour such as foraging, exploration and nesting; and reduction in the frustration, stress and injuries that result from overcrowding in sheds or feedlots or from close confinement in cages and crates. Animals that are under less pressure to grow rapidly and produce the highest yields are also likely to be more robust and to have longer productive lifetimes.

THE FUTURE OF FOOD: FOR ANIMALS, PEOPLE AND THE PLANET

In the near future, food will need to be produced within constraints of less water, less land, less energy, conflicts over land policy, decreasing biodiversity and a changing climate.

We still have the choice: to continue on the path of high meat consumption and evermore intensified factory farming - or we could choose now to move to a food production system that is sustainable for people and the environment and that respects animal welfare. However, the global circumstances of population growth, Peak Oil and climate change are likely to make factory farming unviable by 2050, if not earlier, and thus make the choice for us. This could leave the world food system disrupted and struggling to adjust to the new circumstances, with drastic consequences for animals, people and the planet.

The situation is urgent – but the benefits of reducing meat consumption and moving beyond factory farming are profound:

Food supply: A reduction in meatconsumption in developed countries, starting within the next 10 years, will make an important contribution to freeing up global resources of land and water, reducing global food prices and increasing the world supply of food energy available for human use.

Climate change: The most effective way to start to bring global livestock-related emissions under control within the next 10 years is a managed reduction in the production and consumption of meat and dairy products in developed countries.

Peak Oil: A reduction in the volume of meat production and consumption in rich countries over the next 10 to 20 years would enable farmers to move to more extensive, low-input animal farming and would make a significant contribution to reducing agrichemical and energy use in agriculture.

Deforestation: A reduction in the size and intensification of the livestock industry in developed countries, starting within a decade, would make an immediate impact on discouraging deforestation.

Biodiversity: The transition to a low meat diet in developed countries would reduce pressure on land and start to reverse damage to habitats and species globally. Well-managed extensive systems can be beneficial to maintaining biodiversity.

Public health: An increase in the proportion of plant-based foods and a corresponding reduction in the proportion of animal products in the diet of people in rich countries would make an immediate contribution to improving the health of current and future generations.

Food inequality: A more equitable global food system, including a proportionate reduction in meat consumption in developed countries, needs to be developed within the next 10 years.

Animal welfare: A reduction in the production and consumption of animal products in rich countries, such as those of the EU, would enable farmers to switch to a range of less intensive, more welfare-friendly production systems and develop world-leading animal welfare standards.

TOWARD A HUMANE AND SUSTAINABLE FUTURE

Compassion in World Farming recommends that the following approaches adopted in developed countries would enable us to create a sustainable, fair and humane animal production system by 2050:

- The production and consumption of livestock in developed countries needs to be reduced. A realistic target for reduction by 2020 would be 30% below current levels. A realistic reduction by 2050 would be 60-80% below current levels. These proposed reductions are in line with EU and UK greenhouse gas reduction targets up to 2020 and are also in line with dietary targets. These steps should be taken in addition to other essential livestock-related climate mitigation measures, such as halting deforestation, better fertiliser and manure management and switching to renewable energy sources on farm. These will help to meet the total UK climate target applicable to livestock by 2050 (a reduction to 80% below 2005 levels).
- Governmental and intergovernmental targets and incentives for both farmers and consumers are needed to support the transition to sustainable livestock production. These would include the agreement of international standards for the welfare of farmed animals and protection for the purchasing power of low-income consumers. Imported products would need to meet the welfare standards of the importing country.
- A recognition is needed that meat and milk are currently underpriced in relation to their real environmental and carbon costs and their impact on public health. Fiscal disincentives to over-production and factory farming need to be introduced, according to the 'polluter pays' principle. These could include green taxes and the pricing of factory farmed products to take full account of all external costs such as greenhouse gas emissions, deforestation, land and water use, pollution, soil damage and public health.
- A government-supported meat reduction strategy is needed which would enable farmers to reduce animal stocking densities and move from intensive to more extensive methods. Farmers need to be supported in raising animal welfare standards to the best free-range and organic farming standards of today, while protecting rural livelihoods.
- Encouragement is needed for food manufacturers, retailers and caterers in the food industry to support extensive high-welfare animal farming, to educate consumers about saturated fat in animal products and to partially substitute for meat in processed foods and undertake other meat-reduction strategies.
- All proposed climate mitigation measures should be screened for their impact on animal health and welfare. These measures include the various interventions intended to reduce digestive methane emissions (such as feeding more concentrates, feed additives, antibiotics, vaccinations and genetic engineering) and the intensification of animal breeding and management. It is unacceptable to make animals pay with their welfare for the climate impact of factory farming and the over-production of livestock products. The acceptable and more effective alternative is to reduce the volume and intensity of animal production.

REFERENCES

[1] FAOSTAT. Online database. Food and Agriculture Organisation of the United Nations (FAO). http://faostat.fao.org/default.aspx

[2] Steinfeld, H. *et al.*, 2006. *Livestock's Long Shadow: environmental issues and options*. Food and Agriculture Organisation of the United Nations. Rome. http://www.fao.org/docrep/010/a0701e/a0701e00.HTM

[3] WorldWatch Institute, 2004. *State of the World 2004: The Consumer Society*. http://www.worldwatch.org/node/1785

[4] FAO, n.d. Protecting Animal Genetic Diversity for Food and Agriculture. Time for Action. Animal genetic resources group, Food and Agriculture Organisation (FAO), Rome.

[5] Lundqvist, J., de Fraiture, C., Molden, D., 2008. *Saving Water: From Field to Fork – Curbing Losses and Wastage in the Food Chain*. SIWI Policy Brief. SIWI. http://www.siwi.org/documents/Resources/Policy_Briefs/PB_From_Filed_to_Fork_2008.pdf

[6] IPCC, 2001. *Climate Change 2001: Mitigation of climate change. Technical summary*. A report of Working Group III of the Intergovernmental Panel on Climate Change. Section 3.3.4 www.ipcc.ch/pub/un/syreng/wg3ts.pdf

[7] Stern Review: the economics of climate change. HM Treasury and Cabinet Office. 2006. Part III, chapter 7. http://www.hm-treasury.gov.uk/sternreview_index.htm

[8] Pachauri, R. K., 2007. *IPCC 4th Assessment: key findings*. Presentation to UN, New York City, 24 September. http://www.ipcc.ch/pdf/presentations/pachauri-un_nyc_2007-09-07.pdf

[9] Battisti, D. S. Naylor, R. L. Historical Warnings of Future Food Insecurity with Unprecedented Seasonal Heat. *Science 323*:240 – 244. DOI: 10.1126/science.1164363.

[10] Stern Review: the economics of climate change. HM Treasury and Cabinet Office. 2006. Part II, chapters 3 and 4. http://www.hm-treasury.gov.uk/sternreview_index.htm

[11] Smil, V., 2000. *Feeding the world: a challenge for the twenty-first century*. MIT Press.

[12] International Assessment of Agricultural Science and Technology for Development (IAASTD), 2008. Global summary for decision makers. http://www.agassessment.org/docs/Global_SDM_060608_English.pdf

[13] Hoekstra, A. Y. and Chapagain, A. K., 2007. Water footprints of nations: Water use by people as a function of their consumption pattern. *Water Resources Management*, 21:35–48. DOI 10.1007/s11269-006-9039-x

[14] Pimentel, D., 2006. Impacts of Organic Farming on the Efficiency of Energy Use in Agriculture: An Organic Center State of Science Review. *The Organic Center*. http://www.organic-center.org/reportfiles/ENERGY_SSR.pdf and http://www.organic-center.org/science.pest.php?action=view&report_id=59

[15] Eshel, G. and Martin, P. A., 2006. Diet, energy and global warming. *Earth Interactions*, 10: 1-17. http://geosci.uchicago.edu/~gidon/papers/nutri/nutriEI.pdf and http://geosci.uchicago.edu/~gidon/papers/nutri/nutri.html

[16] Gerbens-Leenes, W. and Nonhebel S., 2005. Food and land use. The influence of consumption patterns on the use of agricultural resources. *Appetite* 45:24-31. doi:10.1016/j.appet.2005.01.011

[17] Molden, D. et al., 2007. Pathways for increasing agricultural water productivity. International. *Water for Food, Water for Life. A Comprehensive Assessment of Water Management in Agriculture*. Water Management Institute Summary, ed. Molden D. Chapter 7. http://www.iwmi.cgiar.org/assessment/Water%20for%20Food%20Water%20for%20Life/Chapters/Chapter%207%20Water%20Productivity.pdf and http://www.iwmi.cgiar.org/assessment/Publications/books.htm

[18] Brown, L. R., 2008. Plan B 3.0: *Mobilizing to Save Civilization*. New York: W.W. Norton and Company, Earth Policy Institute. chapter 9. Feeding Eight Billion Well. http://www.earthpolicy.org/Books/PB3/PB3ch9_ss5.htm

[19] FAO, 2006. Global Perspective Studies Unit. *World agriculture: towards 2030/2050*. Interim report. http://www.fao.org/es/esd/AT2050web.pdf

[20] FAO, 2009. Farming must change to feed the world. Press release 4 February 2009. http://www.fao.org/news/story/en/item/9962/icode/

[21] von Braun, J., 2008. *Food prices, biofuels and climate change*. Presentation. IFPRI. http://www.ifpri.org/presentations/200802jvbbiofuels.pdf

[22] The Rights and Resources Initiative (RRI), 2008. *Seeing people through the trees*. RRI Washington DC. http://www.rightsandresources.org/documents/files/doc_737.pdf ; *Science Daily*, 2008. Record land grab predicted. 15 July. http://www.sciencedaily.com/releases/2008/07/080714092746.htm

[23] Pimentel, D. *et al.*, 2008. Reducing energy inputs in the US food system. *Human Ecology* 36:459-471. DOI 10.1007/s10745-008-9184-3

[24] Steinfeld, H. *et al.*, 2006. *Livestock's Long Shadow: environmental issues and options*. Food and Agriculture Organisation of the United Nations. Rome. Chapter 2. http://www.fao.org/docrep/010/a0701e/a0701e00.HTM

[25] Bates, B. *et al.*, 2008. *Climate Change and Water*. IPCC Technical paper VI. IPCC, WMO and UNEP. http://www.ipcc.ch/pdf/technical-papers/climate-change-water-en.pdf

[26] Steinfeld, H. *et al.*, 2006. *Livestock's Long Shadow: environmental issues and options*. Chapter 4. Food and Agriculture Organisation of the United Nations. Rome. http://www.fao.org/docrep/010/a0701e/a0701e00.HTM

[27] Liu, J., Yang, H., Saveniji, H. H. G., 2008. China's move to high-meat diet hits water security. *Nature* 454:397.

[28] Liu, J., Yang, H., Saveniji, H. H. G., 2008. Food consumption patterns and their effect on water requirement in China. *Hydrology and Earth Systems Science* 12:887-898. 2008. www.hydrol-earth-syst-sci.net/12/887/2008

[29a] Association for the Study of Peak Oil (ASPO), 2008. (http://www.peakoil.net/). *Newsletter 91*, July 2008. http://www.energiekrise.de/e/aspo_news/aspo.html

[29b] UK Industry Taskforce on Peak Oil & Energy Security (ITPOES), 2008. *The Oil Crunch. Securing the UK's Energy Future*. http://peakoil.solarcentury.com/wp-content/uploads/2008/10/oil-report-final.pdf

[30] World Bank, 2007. *World Development Report 2008. Agriculture for Development*. Chapter 2. http://siteresources.worldbank.org/INTWDR2008/Resources/2795087-1192112387976/WDR08_04_ch02.pdf

[31] Steinfeld, H. *et al.*, 2006. *Livestock's Long Shadow: environmental issues and options*. Executive Summary. Food and Agriculture Organisation of the United Nations. Rome. http://www.fao.org/docrep/010/a0701e/a0701e00.HTM

[32] Pachauri, R. K., 2007. *IPCC 4th Assessment: key findings*. Presentation to UN, New York City, 24 September. http://www.ipcc.ch/pdf/presentations/pachauri-un_nyc_2007-09-07.pdf

[33] IPCC, 2007. *Climate Change 2007: Mitigation of Climate Change*. IPCC 4th Assessment report, Working Group III. Chapter 8, Agriculture. Final Draft pre-copy edit version. http://www.mnp.nl/ipcc/pages_media/FAR4docs/chapters/CH8_Agriculture.pdf

[34] United States Environmental Protection Agency (US-EPA), 2006. *Global Anthropogenic non- CO_2 Greenhouse Gas Emissions: 1990 – 2020*. http://www.epa.gov/nonco2/econ-inv/international.html

[35a] Steinfeld, H. *et al.*, 2006. *Livestock's Long Shadow: environmental issues and options*. Food and Agriculture Organisation of the United Nations. Rome. Chapter 5. http://www.fao.org/docrep/010/a0701e/a0701e00.HTM

[35b] IUCN News Release, 2007. Extinction crisis escalates: Red List shows apes, corals, vultures, dolphins all in danger. 12 Sept. http://cms.iucn.org/search.cfm?uNewsID=81 ;

[36] Sahney, S., Benton, M. J., 2007. Recovery from the most profound mass extinction of all time. *Proceedings of the Royal Society B*. Biological Sciences. 275:759-765. 2008. doi:10.1098/rspb.1370

[37] WHO and European Commission, 2002. *Eutrophication and Health*. http://ec.europa.eu/environment/water/water-nitrates/pdf/eutrophication.pdf

[38] *Animal waste pollution in America: an emerging national problem, 1997. Environmental risks of livestock and poultry production*. A report by the Minority Staff of the US Senate Committee on Agriculture, Nutrition and Forestry for Senator Tom Harkin.

[39] Archer, J. R., Nicholson, R. J. 1992. Liquid wastes from animal enterprises. *Farm animals and the environment*, ed. Phillips C and Piggins D. CAB International. 1992

[40] Wathes, C. M. *et al.*, 1997. Concentrations and emission rates of aerial ammonia, nitrous oxide, methane, carbon dioxide, dust and endotoxin in UK broiler and layer houses. *British Poultry Science* 38:14-28.

[41a] Rauw, W. M. *et al.*, 1998. Undesirable side effects of selection for high production efficiency in farm animals: a review. *Livestock Production Science* 56: 15- 33;

[41b] Sørensen, A. C. *et al.*, 2006. Udder Health Shows Inbreeding Depression in Danish Holsteins *Journal of Dairy Science* 89:4077–4082;

[41c] Yunis, R. *et al.*, 2002. Antibody responses and morbidity following infection with infectious bronchitis virus and challenge with Escherichia coli, in lines divergently selected on antibody response. *Poultry Science* 81: 149-159.

[42] Greger, M., 2007. The Human/Animal Interface: Emergence and Resurgence of Zoonotic Infectious Diseases. *Critical Reviews in Microbiology*, 33:243–299. DOI: 10.1080/10408410701647594

[43] MacKenzie, D., 2006. Time to stamp out bird flu at source. *New Scientist*, 14 January 2006, p6-7.

[44] Wang, Y. Q. *et al.*, 2005. Changes in protein and fat balance of some primary foods: implications for obesity. Presented at the 6th Congress of the International Society for the Study of Fatty Acids and Lipids. 27 June – July 2004, Brighton.

[45a] Nathan, C., 2004. Antibiotics at the crossroads. *Nature* 431:899-902;

[45b] Shea, K. M., 2003. Antibiotic resistance: what is the impact of agricultural uses of antibiotics on children's health? *Pediatrics* 112(1):253-258.

[46a] MRSA found in US pigs, 2008. *Pig Progress*. July 14. http://www.pigprogress.net/news/id1602-59602/mrsa_found_in_us_pigs.html ;

[46b] Smith, T. C. *et al.*, 2009. Methicillin-Resistant Staphylococcus Aureus (MRSA) Strain ST398 Is Present in Midwestern U.S. Swine and Swine Workers. PLoS ONE 4(1): e4258. 2009. doi:10.1371/journal.pone.0004258

[47a] WHO Europe, 2006. *Draft European Charter on counteracting obesity*. EUR/06/5062700/8. 18 September. http://www.nepho.org.uk/view_file.php?c=1777

[47b] Dietary Guidelines for Americans 2005. US Department of Health and Human Services and US Department of Agriculture. http://www.health.gov/dietaryguidelines/dga2005/document/pdf/DGA2005.pdf

[48] McMichael, A. J., Powles, J. W., Butler, C., Uauy, R., 2007. Food, livestock production, energy, climate change, and health. *The Lancet*. Published online13 September. DOI:10.1015/S0140-6736(07)61256-2

[49] World Cancer Research Fund and the American Institute for Cancer Research, 2007. *Food, Nutrition, Physical Activity, and the Prevention of Cancer: a global perspective*. Chapter 12. www.dietandcancerreport.org

[50] Badgley, C. *et al.*, 2007. Organic agriculture and the global food supply. *Renewable agriculture and food systems* 22(2):86-108. 2007

[51] Crews, T. E., Peoples, M. B., 2004. Legume versus fertilizer sources of nitrogen: ecological tradeoffs and human needs. *Agriculture, Ecosystems and Environment* 102:279-297.

[52] Pretty, J. N. et al., 2005. Farm costs and food miles: An assessment of the full cost of the UK weekly food basket. *Food Policy* 30(1):1-19. d oi:10.1016/j.foodpol.2005.02.001 http://www.essex.ac.uk/BS/staff/pretty/Pretty%20et%20al%20Food%20Policy%202005%20%20vol%2030%20%20pp1-20.pdf

[53] Stehfest, E. *et al*., 2009. Climate benefits of changing diet. *Earth and Environmental Science*. Published online 4 February. DOI:10.1007/s10584-008-9534-6

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Sustainable Solutions for Animals, People and the Planet

A Report by Compassion in World Farming - 2009

ISBN 1-900156-46-6

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