Energy Flow, Environment and Ethical Implications for Meat Production

Draft report prepared by the following persons:
Robert A. Kanaly*, Darryl Macer,
Lea Ivy O. Manzanero, Sivanandam Panneerselvam;

Members of Working Group 13 (*chair),
Ethics of Energy Technologies in Asia and Pacific (EETAP) Project

Ethics of Energy Technologies in Asia and the Pacific (EETAP) Project,
RUSHAP, UNESCO, Bangkok

Draft 3 of 3 June, 2009

For internal circulation and review inside EETAP

Comments to Dr. Robert A. Kanaly (rkanaly@yahoo.com) and Dr. Darryl Macer (d.macer@unesco.org)

Table of Contents

Executive Summary

Meat production is a complex and multifaceted issue that is deeply connected to matters of environment, politics, public health, economics, socioeconomics, and ethics. Future projections for the consumption of meat through 2050 indicate that an increase in demand by all countries will occur with the most significant increases projected to occur in the developing countries, especially in Asia. Countries that are considering creation, expansion, or integration of more intensive or industrialized modes of meat production into their current systems may want to consider the possible future environmental, energy, water, public health and socioeconomic effects of their investments.

In the developed countries, it is understood that the perceived successes of intensive meat production systems have been largely dependent upon the availability of relatively cheap fossil fuel energy as a foundation for their various models of production. In addition to cheap fossil fuel energy dependence, accumulating evidence indicates that these operations often result in numerous negative externalities that have serious and wide-ranging environmental, socioeconomic and public health consequences. At the same time, many of the negative cost externalizations are necessary for the success of intensive operations under current economic values. The societal implications of intensive animal production are also addressed.

This report[1] presents evidence from the Philippines, Japan and other countries to describe the situation and it is concluded that it may be prudent for both developing and developed countries to review carefully the costs of intensive meat production before promoting and investing in such operations. At the same time consideration of progressive and more sustainable approaches to energy efficient food production, decreasing subsidization practices, and movement towards internalizing more of the production costs shall be necessary.

An ethical analysis of principles associated with use of animals in intensive meat production is presented and, while recognizing a right to adequate access to food – that all people should be free from chronic hunger, should be free from food insecurity and should have access to safe food of nutritional value, the report also includes examination of the perspectives from the point of view of animals and the environment.

There are a range of policy options considered that countries may consider, including several internationally developed codes of good practice and codes of ethics that can improve the immediate situation for animal, environmental and human health in intensive animal production systems. There is also a call for reflection on the broader issues raised in the report by each institution and nation.

[1] This report draft is open to review to stimulate further improvement and encourage further contributions.

1. Environment, energy and demand for meat in Asia

1.1 Past and current trends

When one endeavours to include ethical issues related the environment in one's decision-making processes in regard to investment in and development of strategies to procure and use energy, an understanding of regional, country-wide and global energy flows is paramount. At the same time, careful consideration of the negative externalities borne through the processes of energy procurement and utilization is vital because they may have large impacts on the functioning and development of society in the short- and long-term. Policy-makers are faced with difficult decisions in these regards and an understanding of scientific, economic, political and ethical issues to support the knowledgeable evaluation of the most efficient use of valuable environmental resources is helpful for responsible energy security planning and management.

The availability and accessibility of food are issues of major importance for all countries and they place a high demand on energy resources. Food occupies the first position among the hierarchical needs of a human being. The Roman philosopher Seneca said: 'a hungry man listens neither to religions nor reason nor is bent by any prayer'. It is a widely held view that one of the largest threats to food production is climate change and that all elements of air, water, land, flora and fauna are inter-linked and interdependent. Today, human activities such as urbanization, industrialization and intensive agriculture have led to major environmental challenges and these challenges take on different forms in different parts of the world.

Food production taps into energy flow directly and indirectly, and depending upon the type of food production utilized, the differences in efficient use of energy will vary greatly. Shifts towards intensive meat production systems have been dependent upon the availability of relatively cheap fossil fuel energy as a foundation for their various models of operation. In addition to this cheap fossil fuel energy dependence, mounting evidence from the developed countries supports the notions that these systems have not operated in environmentally, economically and socially responsible manners through extensive negative cost externalizations. Based upon this information, it may therefore be prudent for developing and developed countries in Asia to consider alternative means of development in the meat production sectors before investing portions of their limited energy, economic and environmental resources in these systems. Although a country's energy requirements in the form of food may not necessarily be directly considered when discussing a country's energy budget, they may be worthy of consideration from this perspective due to the marked industrialization of the meat production sectors combined with future projections that indicate that intensification and industrialization will continue to increase.

The Asia region is projected to undergo unprecedented growth and transformation in the coming years, access to large amounts of energy in various forms will be necessary, and evaluation of the most efficient use of valuable energy flows while minimizing costly negative externalities that will affect public health and environment are priorities for responsible economic planning. Currently Asia has the fastest annual growth in energy demand, and among the non-OECD Asian countries, including India and China, energy demand is projected to grow at an average rate of 3.2% per year, more than doubling over the period from 2004 to 2030. This accounts for more than 65 percent of the projected increase in energy use for non-OECD countries overall through 2030 (EIA 2007). The World Energy Council (2007) projects that Asia's primary energy demand through 2050 will rise to approximately 15 billion tons of oil equivalents or 625 EJ per year, which is more than three times the current demand level. Perhaps not surprisingly, fossil fuel energy is projected to account for 70% of this demand increase.

On this backdrop of projections for steeply rising energy demand, policy-makers in the Asia region are facing challenging decisions in regard to the best paths to take to minimize threats to their energy and food security while protecting their natural resources. Invariably, these decisions will have direct impacts on their countries' local and regional economies, environments and public health conditions but will also include supra-regional and global impacts. Currently, investment in nuclear energy along with potential development in the areas of renewables such as hydropower, wind energy and biofuels are some of the major alternatives to fossil fuel energy that are under discussion, but even so, collectively they will not compete with fossil fuel energy in the near future. This is partly because fossil fuel energy will be required to power many sectors of society where alternatives are not possible or are not yet economically feasible. Considering the volatility and lack of transparency of some sectors of the fossil fuel energy markets, combined with the already large share of the total energy budget projected for this sector, countries that are planning to develop more sound energy policies may want to consider integrating investment from different energy sectors in an effort to reduce their heavy reliance on the fossil fuel energy sector - this, while charting paths to develop and maintain key industries such as food production.

Driven by global societal demand, meat production absorbs industrial levels of energy inputs. Smil et al. (1979) as cited in Jorgensen and Kay (2000) categorized anthropogenic sources of utilized energy into two types, namely: (1) direct energy inputs related to sources such as coal, peat, fuels (diesel, petroleum, oil), electric energy, human labour; and (2) grey energy used in operating the system, such as mineral fertilizers, pesticides, machinery, agrosystems, and infrastructure. The total primary energy expenses determine the energy contents of the flows (Jorgensen and Kay, 2000).

The production of animal protein requires expending human and fossil energy to supply livestock with forage and grain. Energy is needed to produce feed, fertilizers and pharmaceuticals which are in turn are converted into animal tissue. However, most of the energy in livestock production is used to produce forage rather than contained in the forage (Tudge, 2004). Energy is also expended in the support of activities such as meat processing, transportation and refrigeration.

In the developed countries, fossil fuel energy requirements for the production of meat and animal products have become more intensive over the last 50 years through industrialized intensification. In the U.S. for example, the creation of concentrated animal feeding operations (CAFOs) has occurred rapidly. At the same time, significant industry consolidation in the three main sectors of the meat industry, the hog, poultry and cattle sectors, has also occurred rapidly. In the U.S., the number of hog-producing facilities decreased from 322,600 farms to 98,460 farms from 1988 to 1999 even though overall hog production increased from 90 million hogs to over 121 million hogs (Gillespie and Fulton, 2001). Consolidation in the U.S. broiler industry occurred whereby approximately 12 to 13 million pounds of broilers were produced on approximately 32,000 farms in

1977 but by 1992 approximately 29 million pounds of broilers were produced on approximately 21,000 farms (Walker et al., 2005). In the cattle sector, by the end of 1998, the top 30 cattle feedlot operations in the U.S. had pen space for 4.9 million head of cattle and the largest five companies accounted for almost one third (Heffernan, 1999) while just four meatpacking firms handled almost 80% percent of all cattle slaughter (MacDonald et al., 2000).

Not evident from these figures is the fact that a small number of very large companies also control many or in some cases, most aspects of the meat production process. In 1999, an American company was ranked as one of the three largest flour millers in North America and fourth in dry corn milling producing their own livestock feed. The same company ranked third in cattle feeding and second in slaughtering, third in pork processing and fifth in broiler production and processing. They also handled and transported grain through their subsidiary trading company (Heffernan, 1999). Data from recent analyses by Hendrickson and Heffernan (2007) that show the current state of consolidation in the agricultural markets are given in Figure 1.

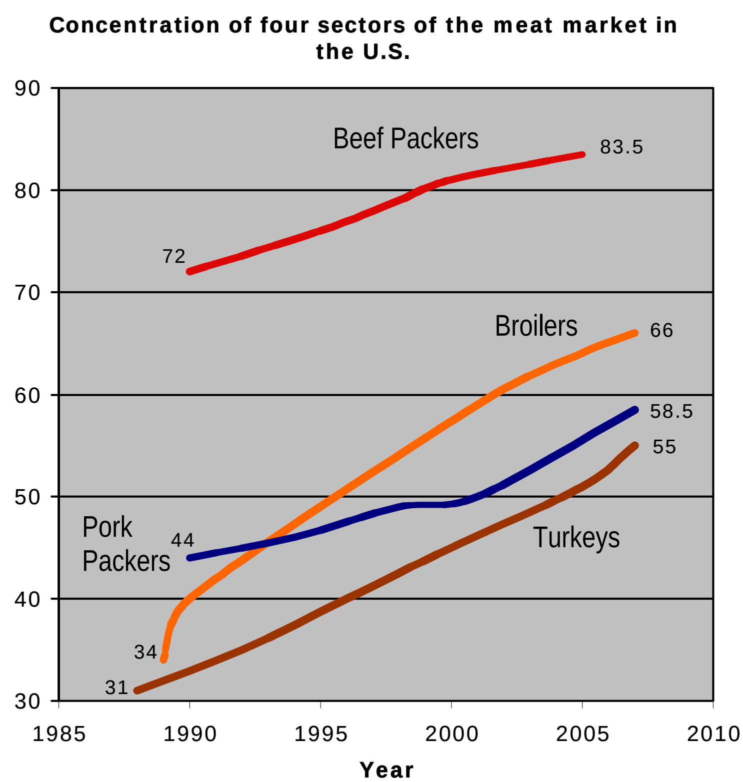

Figure 1. Increases in the concentration ratio of the top four firms (CR4) in a specific meat industry. The CR4 represents the amount of the total market that is controlled by the largest four firms. For example, in the beef sector, the top four firms controlled 83.5% of beef packing in 2007. In the broiler sector, it was noted that the CR2 was 47% in 2007, i.e. that two firms controlled almost 50% of the market. Adapted from tables in a report by Hendrickson and Heffernan (2007).

Throughout the world today, an estimated 2 billion people depend primarily on a meat-based diet (Pimentel et al., 1999) and they derive their nutrients from meat, but also from milk and eggs (Pimentel and Pimentel, 2007). The world's production of meat has surged fivefold in the second half of the twentieth century (Tudge, 2004) and developing countries such as China and Brazil are now playing a greater role in production (Windhorst, 2006). In recent years, the production of meat, milk and eggs has shifted from Europe, North and Central America to Asia and South America (Windhorst, 2006). Notably, by 2005, developing countries were contributing 54.7% to global meat production and 67.7% to egg production (Windhorst, 2006). In contrast, Windhorst (2006) pointed out that during the 1970s, China and Japan's combined production of 31% of the world's chicken were the only significant quantities produced in developing countries. By 2005 five developing countries were among the top ten producers, four of which were in Asia. Moreover five developing countries had also become dominant egg producers by 2005: India, Mexico, Brazil, Indonesia and Turkey (Windhorst, 2006).

Galloway et al. (2007) recently explained that global trade in livestock products is growing faster than production in developing countries such as Mexico, South Korea, Philippines and Malaysia who are becoming net importers. The volume of poultry exported worldwide reached 9.7 million tons and about 1.4 million tons in shell eggs (Windhorst, 2006). In 2004, the leading poultry exporting countries were the U.S. (2.6 million tons) followed by Brazil, Netherlands, France, Belgium, China, Thailand, Germany, U.K. and Denmark. For the same year, the 10 leading poultry meat importing countries were: Russia, China, Japan, U.K., Germany, Mexico, Saudi Arabia, Netherlands, Ukraine and France (FAO, 2005). Major poultry exporting countries such as the U.S. and Brazil are also major grain producers that are characterized by large-scale production and a high level of vertical, and more recently, horizontal, market integration (Chang, 2005). Indeed, consolidation in the agricultural markets continues worldwide and currently in Asia, meat production intensification and CAFO-type models are rapidly becoming more popular and are promoted and invested in by governments, multilateral financial institutions, large private investment firms and are supported through the consuming public (AgFeed Industries Inc., 2007; World Bank, 2004; World Bank, 2006). In 2008, for example, it was reported that Goldman Sachs invested 200 to 300 million U.S. dollars to purchase twelve pig farms and 300 million U.S. dollars to purchase ten poultry farms in Hunan and Fujian Provinces respectively in China (Tradingmarkets.com, 2008; Wang, 2008) while the global investment bank, Deutsche Bank, was reportedly investing 60 million U.S. dollars each in Hongbo and Baodi large-scale pig farms in Shanghai and Tianjin (Shi and Phee, 2008; UK Telegraph, 2008).

Even with the rapid movement to build, expand and adopt more intensive meat production operations in Asia, there is a lack of discussion of core issues such as their heavy reliance on the availability of cheap non-renewable fossil fuel energy combined with a large number of potentially serious environmental, socioeconomic and public health consequences and the ethical implications of these consequences. These of course are in addition to the serious ethical concerns that must be confronted in regard to the treatment of the tens of billions of animals that are grown and killed in these operations each year worldwide.

1.2 Future projections for meat demand in Asia

Population and population growth are major determinants in the overall demand for food, however the desire to eat more meat and animal products is influenced mostly by increase in urbanization which encourages people to adopt new diets and increase in per capita income which increases purchasing power (Delgado, 2003; Pretty et al., 2006). Now, increases in both urbanization and per capita income are rapidly occurring in Asia and large increases in Asian countries' demand for meat and animal products are expected.

Future projections for the consumption of meat and animal products through 2050 were published through the FAO by Steinfeld et al. in 2006 and they indicated an increase in demand by all countries with the most significant increases projected to occur in the developing countries and especially in Asia. In China for example, where both urbanization and greater per capita purchasing power are on the rise, per capita meat demand is projected to grow to 60 kg by 2020 and represents an increase of 82% from 33 kg in 1993. To put this in perspective, this level of meat consumption is higher than the projections for Japan (49 kg per capita) and is approaching the level of consumption occurring in developed countries where a projected increase from 78 kg to 83 kg is expected by 2020 (Rosegrant et al., 1999). The significance of per capita figures for China is especially concerning when one considers China's huge population (Delgado, 2003). Currently, new consumers in China's economy are shifting to strongly meat-based diets and account for 28% of the world's total meat consumption, which is already almost twice as much as U.S. consumption (15%). From 1990 to 2000 meat consumption almost doubled and per capita feed grain consumption increased by 20% however per capita food grain consumption decreased by 9% (Myers and Kent, 2003).

Indeed, as the current trends continue, developing countries' demand for cheap meat and animal products that originate from land-, lagoon- and sea-based meat production systems will increase and shifts toward more intensive and industrialized meat production models will occur. Worldwide, industrialized production grew at twice the annual rate of mixed farming systems and at more than six times the annual rate of grazing-based production – mostly in the hog and poultry sectors due to relatively short reproductive cycles and higher feed efficiency conversion compared to ruminants. As of 2001, industrial enterprises accounted for 74%, 68%, and 40% of the world's total poultry, egg and hog meat production respectively (Steinfeld, 2002). Recently, Fiala (2008) estimated that if the current global meat consumption trends continue, that the total meat consumed worldwide by the year 2030 will be 72% more than the amount consumed in 2000 with current livestock inventories expected to double by 2050 (Steinfeld et al., 2006).

1.3 Energy inputs

The availability of relatively cheap fossil fuel energy in some developed countries has allowed for the development of highly mechanized cereal production systems that, combined with high-yield cereal varieties, have resulted in increases in world cereal production. However, this production was not possible without enormous increases in fossil fuel and electrical energy consumption and consequently, overall energy use efficiency was markedly reduced. Mineral fertilizers, especially nitrogen fertilizers and agricultural chemicals have large energy requirements for production and transportation and are significant contributors to these energy inefficiencies. In a Canadian production system, it was determined that the energy required for the manufacture of inorganic fertilizer represented the single greatest energy input for no-till grain maize production for example (McLaughlin et al., 2000). At the same time, shifts towards intensification and industrialization of meat production overall require large external inputs in order to achieve the high yields that are expected from investment in such systems. As an integral part of these operations, cereal crops are fed in large quantities to animals in feeds that in turn required enormous amounts of fertilizer, water, land and industrial chemicals to produce. In the case of ruminants for example, the drastic dietary changes that have taken place over the last 60 years have resulted in grain-dependent alterations in ruminal pH and ecology that have created a variety of disorders that have in turn increased the need for more feed additives such as antibiotics (Russell and Rychlik, 2001). Although fossil energy is the main driver for feed production, it is also required in large quantities to drive many other aspects of the meat production process.

Meat production methods vary widely in the efficiencies by which they may convert feeds into animal protein and this conversion is influenced by many factors, however, it is widely accepted that an energy-dense human diet high in meat and animal products generally consumes more energy resources than a human diet based on plants. Even though grain feeding of animals to be killed and eaten by humans results in significant energy losses during conversion of grain calories to meat calories, it has been estimated that more than a third of the world's grain production is currently used as feed for animals (Leng, 2005), and FAO projects that over one half of world grain consumption will be used for feed by 2030 (FAO, 2003). In the U.S. and China, a major component of feed is maize (Steinfeld et al., 2006; Pollan, 2003) and this is the case even though maize production in the U.S. is reported to cause more total soil erosion and requires more total herbicides, insecticides and nitrogen fertilizer than any other U.S. crop (Pimentel, 2003). Currently, the price of maize is effectively determined by the price of oil (World Bank, 2009).

In the case of maize for example, it was calculated by Pimentel and Pimentel (2003) that in the production of U.S. broilers, turkeys, hogs, eggs, and beef cattle for example, 4 kcal, 10 kcal, 14 kcal, 39 kcal and 40 kcal of fossil fuel energy respectively were required to produce 1 kcal of animal protein while to produce an equivalent amount of grain protein required 2.2 kcal of fossil energy expenditure (Figure 2.0). Using an average fossil fuel energy input of 25 kcal of fossil fuel per kcal of meat protein produced, including that animal protein possesses approximately 1.4 times the biological value of grain protein based on its amino acid profile, the average energy requirement to produce animal protein is still more than 11 times greater than the requirement to produce its grain equivalent. When expressed in terms of live weight, cattle, hogs and chickens require approximately 7 to 9 kg, 4 to 6 kg and 2 kg of grain to produce 1 kg of live weight beef, pork or chicken respectively (McMichael and Bambrick, 2005; Horrigan et al., 2002).

Pollan (2003), reporting on calculations by Pimentel explained that the fossil fuel inputs required to grow a steer to slaughter weight in the U.S. were approximately equal to 1075 liters (284 gallons) of oil equivalents when using an assumption that a steer consumes 11.3 kg (25 lbs.) of maize per day after arrival on the feedlot and grown to a weight of 567 kg (1250 lbs.). This calculation did not include processing. To place some of this into perspective, the total U.S. livestock population consumed 250 million tons of grain in 2001 and this amount was more than seven times greater than the amount of grain consumed directly by the entire American population. Indeed, it is estimated that the amount of grain fed to U.S. livestock is sufficient to feed approximately 840 million plant-based vegetarians (Pimentel, 2004). The USDA (2001) estimated that approximately 45 million tons of plant protein is fed to U.S. livestock to produce only 7.5 million tons of animal protein for consumption and that for every kg of animal protein, 6 kg of plant protein are required.

Although calculation methods for approximating energy costs in agricultural systems have advantages and disadvantages, they serve to give an indication of inputs and outputs, and overall, it is agreed that intensive meat production processes require large cereal grain inputs that in turn require large fossil energy inputs. Indeed, it has been argued that the coming central challenge for world food markets in the medium-term future is not whether it will be physically possible to feed the growing population, but whether it will be physically possible to feed the animals (Keyzer et al., 2005).

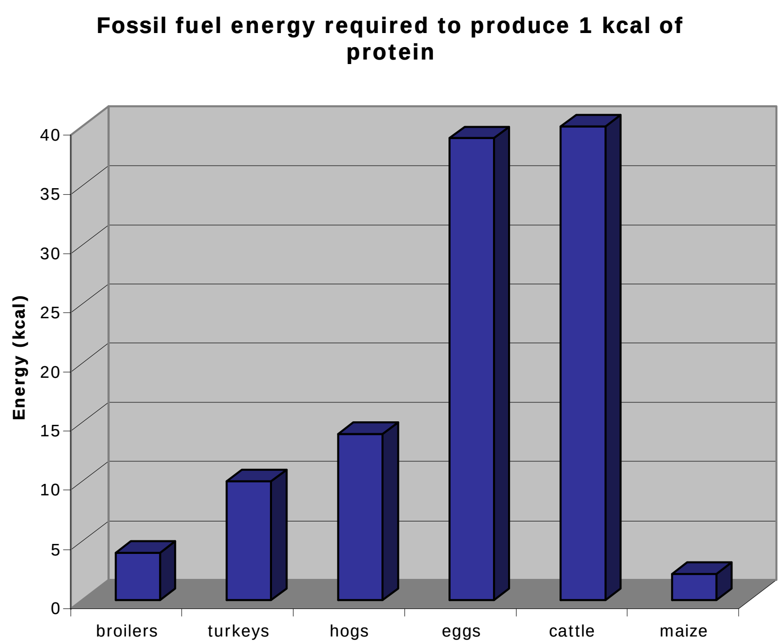

Figure 2. Fossil fuel energy required to produce 1 kcal of protein from various animals or chicken eggs compared to the amount required to produce an equivalent amount of grain protein. Adapted from Pimentel and Pimentel (2003).

2. Negative externalities of meat production

Due to the fact that shifts towards the intensification and industrialization of meat production in even the developed countries have not been accompanied by corresponding modernization of regulations to protect public health or adequately address issues related to environmental effects (Thorne, 2007), these operations have resulted in widespread and serious consequences through the convenient externalization of many of their operating costs. Externalization, any action that affects the welfare of or opportunities available to an individual or group without direct payment or compensation, may distort markets by allowing and encouraging activities that are costly to society even if private benefits are large (Pretty et al., 2000). When negative externalities are produced and when an industry is subsidized, as is the case for the fossil fuel and meat industries (Koplow and Dernbach, 2001), the price that the consumer pays is not reflected in the cost and ramifications include overproduction. In the agricultural and water sectors, externalities have four features: (1) their costs are often neglected, (2) they often occur with a time lag, (3) they often damage groups whose interests are not well represented, and (4) the identity of the source of the externality is not always known (Pretty et al., 2000; Pretty et al. 2003).

Cost assessments of externalities from agriculture are difficult to perform yet they serve to provide a framework for basing policy decisions. In the UK for example, it was determined that the annual total external costs to UK agriculture in 1996 were 2343 million pounds (or 89% of the average net farm income for the same year). Some of the most significant costs arose from drinking water contamination with pesticides, nitrate, and phosphate, soil erosion and organic carbon losses, food poisoning, parasites and bovine spongiform encephalopathy (BSE; Pretty et al., 2000). Evaluation of the external costs arising from the cultivation and raising of the twelve major arable, horticulture and livestock food commodities produced in the UK showed that livestock production contributed the greatest external costs per kilogram as indicated in Figure 3 (Pretty et al., 2005).

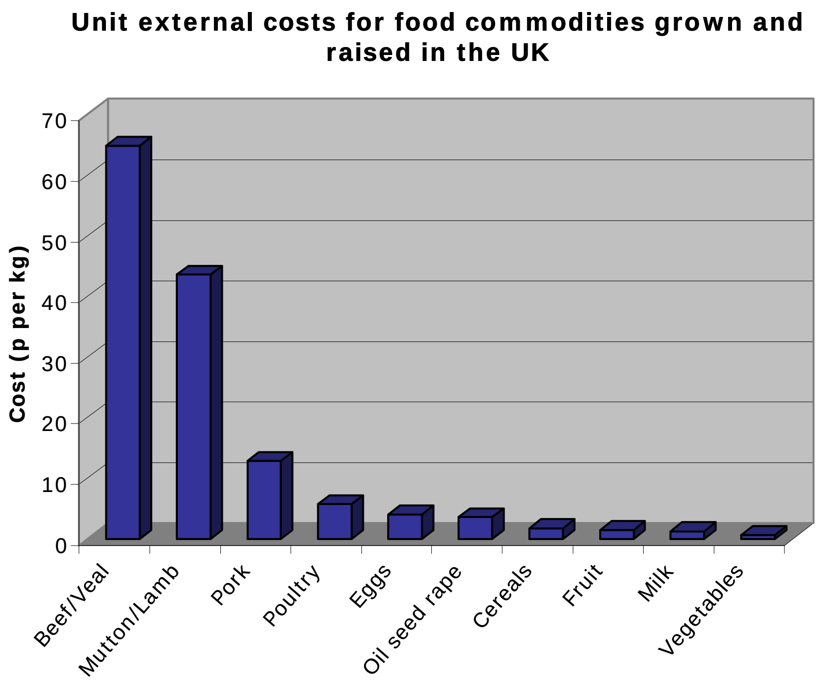

Figure 3. External costs arising from the cultivation and raising of commodities in the UK. Milk is expressed as per liter and eggs are expressed as per dozen (12 eggs). Monetary units are expressed as British pence. Adapted from Table 2 in Pretty et al. (2005).

Now, more thorough investigations into the negative externalities of intensive meat production are only just beginning to reveal that they are numerous and far-reaching, with many downstream effects and potentially large costs for society and the environment and include: (1) impacts on global climate change, (2) land degradation and deforestation, (3) water overconsumption and water pollution, (4) loss of biodiversity and loss of local livestock breeds, (5) production and distribution of antibiotic-resistant and pathogenic bacteria in the food supply and in communities, (6) release of naturally-occurring and synthetic hormones and hormone derivatives into the environment and their accompanying downstream effects, (7) release of ectoparasitides, (8) release and potential accumulation of metals and persistent organic pollutants in soil and sediments and in the food chain, (9) heavy socioeconomic costs that affect the poor and the wealthy, and (10) perhaps most dangerously, increases the risk of potentially devastating regional and global pandemics by spread of disease that come about as a result of the conditions and feed practices of intensive meat-production and animal transportation.

2.1 Global climate change

It is indisputable that climate change will cause significant and profound changes to the environment, and generally speaking, the more rapid the environmental changes, the more difficult it will be for humans and the biota to adapt to such changes as our abilities to deal with the changes will be overwhelmed by the rapidity of the change itself. This will vary by region, but will ultimately impact the entire planet. Meat production and climate change are tightly linked. It has recently been proposed that particular policy attention should be paid to the health risks posed by the rapid worldwide growth in meat consumption through the exacerbation of climate change and that both the average global consumption level of animal products and the emission intensity levels of production must be reduced to prevent increased greenhouse gas (GHG) emissions from this sector (Koneswaran and Nierenberg, 2008; McMichael et al., 2007). Overall, livestock production results in the release of large quantities of GHG emissions in the form of carbon dioxide, methane and nitrous oxide gases and the amounts of each gas released shall vary by the mode of production and intensity.

Comparisons of feedlot and pastoral beef production systems showed that 15 kg of carbon dioxide equivalents/kg of beef were released in feedlot systems and this value represented more than twice the emissions of pastoral systems even though methane gas was released in much greater amounts in pastoral systems due to lower productivity (Subak, 1999). Flessa et al. (2002) demonstrated the importance of nitrous oxide gas contributions to total GHG emissions and discussed that the extent or intensity of animal production was a key factor to controlling GHG emissions from food production due to direct releases from animals and animal wastes. In a study of German agricultural practices it was indicated that 80 to 95% of nitrogen intake in animal feed was excreted in dung or urine. They concluded that overall, reduction of crop production for use in animal feeds in favour of human nutrition represents one of the most efficient measures for mitigating greenhouse gas emissions from the agriculture sector. Livestock produce carbon dioxide during respiration and ruminant and monogastric animals also produce methane as part of digestion. Animal waste, which is produced on the order of 180 million tons (dry weight) per year in the U.S. (Roe and Pillai, 2003), release methane, nitrous oxides, ammonia and carbon dioxide depending upon their form and management.

At the same time, land use for livestock production contributes to the release of large quantities of carbon dioxide through the degradation and loss of forests and other forms of vegetative cover for the creation of grazing lands and for the production of feed crops such as maize (through the burning of forests for example). The direct impact of carbon dioxide on climate change is the greatest of the different greenhouse gases (GHG) because it is released in the largest quantity compared with other GHG and because it is also in highest concentration in the earth's atmosphere. However, methane gas which traps heat more than 20 times more effectively than carbon dioxide, and nitrous oxide, which traps heat almost 300 times more effectively than carbon dioxide and has an atmospheric lifetime of more than 100 years, are contributors to global climate change. Indeed, these activities have profound effects on the global cycling of carbon. It has been pointed out that the same land use and management practices that are accelerating GHG emissions are also undermining the ecosystem services upon which long-term food and fiber production will depend in the future (Scherr and Sthapit, 2009). Although the heavy reliance of meat production on fossil fuels has delivered benefits, their use is a major contributor to impending climate change and demands for urgent and widespread action have been called for (Wilkinson et al., 2007).

The FAO (Steinfeld et al., 2006) estimates that of the approximate 80 million tons of artificial nitrogenous fertilizers globally produced per year, that up to 25% may be used in the production of animal feed and that this situation results in the requirement for large amounts of fossil fuel just for the production of fertilizer. The result is that 41 million tons of carbon dioxide released per year is attributable to the fossil fuel expenditure required to produce the fertilizer that is required to produce the feed that is required to produce the meat. This value was calculated by estimating the amount of fertilizer that is used in the livestock production food chain for land animals by first analyzing the amounts of fertilizer used for certain crops (FAO, 2002) and then comparing these figures with the percentage of those crops that are used as feed for livestock. Through their analyses it was revealed that the amounts of chemical nitrogen-based fertilizer required for animal production were a very substantial share of total fertilizer use in developed and developing countries (Figure 4).

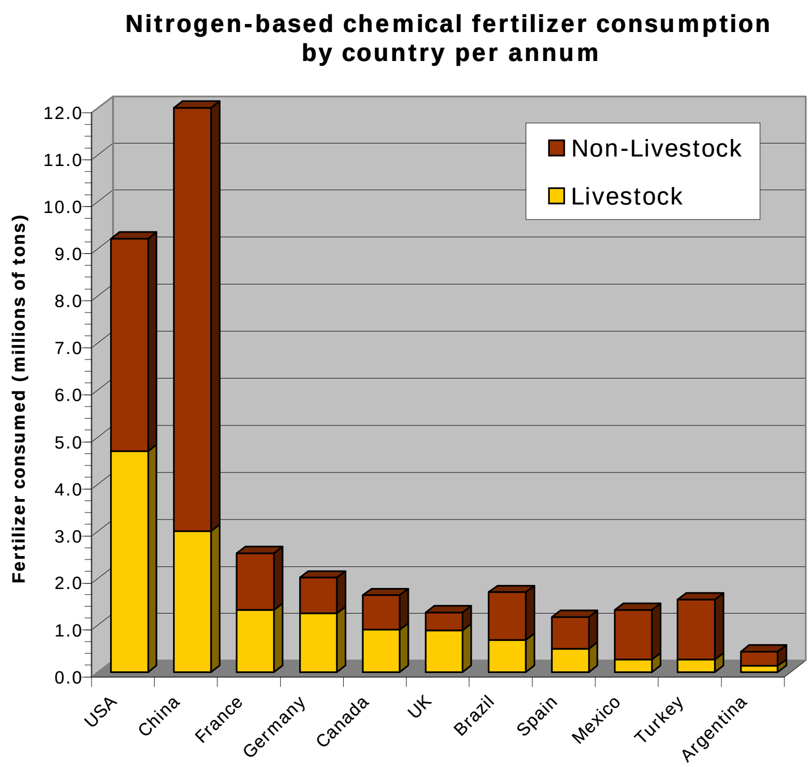

Figure 4. Total amounts of nitrogen-based chemical fertilizer consumed per year showing the percentage of that fertilizer that is consumed for the production of feed crops for livestock (in yellow). In China, total production of nitrogen-based fertilizers exceeded 19 million tons in 1997. Note that an uppermost limit of 12.0 million tons was used in this graph. Adapted from data presented in Steinfeld et al. (2006).

In the United States, France and Germany, 51%, 52% and 62% (4.7, 1.3 and 1.2 million tons per year respectively) of the total nitrogen fertilizers consumed in each country were used for livestock production. In China, 16% of total consumption was used for livestock production, even though the absolute amount of consumption was only second to the U.S.; 3.0 million tons of chemical nitrogenous fertilizer used per year. Taking into account other factors including that energy use in China for the production of fertilizer is higher than average due to their production processes, i.e., in coal-based production and small to medium-sized production facilities the annual emission of carbon dioxide for livestock production from fertilizer production was estimated to be 41 million tons with the largest contributions, 14.3 million and 11.7 million tons per year originating from China and the U.S. respectively.

Further analyses by FAO revealed that on-farm fossil fuel use may be responsible for the release of 90 million tons of carbon dioxide per year, that livestock-related land-use changes may result in 2.4 billion tons of carbon dioxide per year and that livestock-related releases from cultivated soils and from livestock-induced desertification may result in 28 million and 100 million tons of carbon dioxide released per year respectively. When calculations for methane and nitrous oxide were included, the FAO report concluded that overall, approximately 18 percent of global GHG emissions expressed in carbon dioxide equivalents were attributable to livestock production and it was noted that this amount was greater than the contribution from the transportation sector as indicated in Figure 5 (Steinfeld et al., 2006).

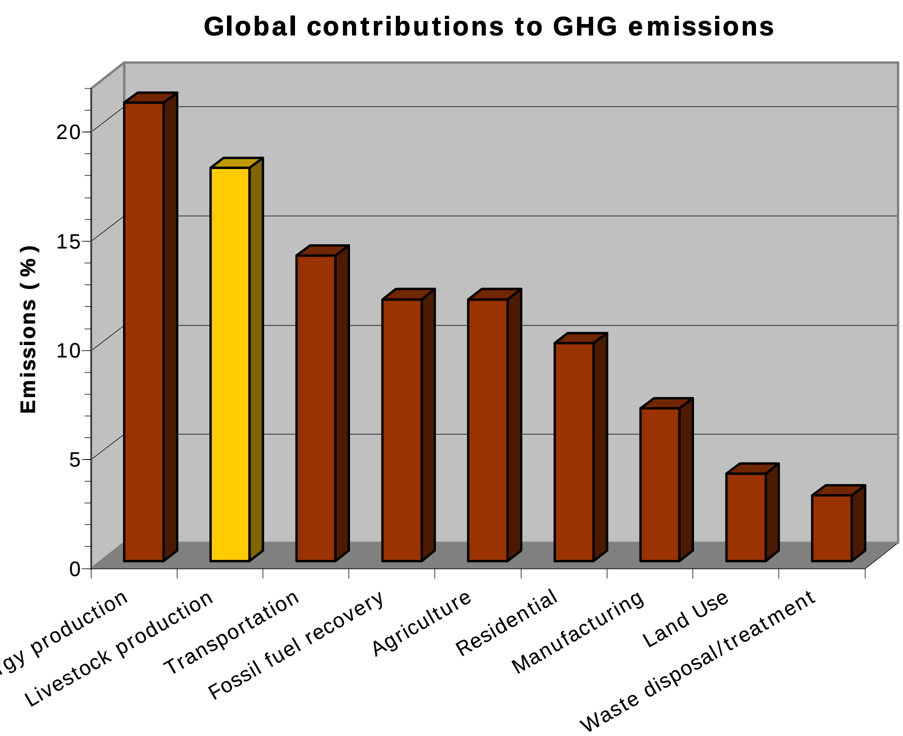

Figure 5. Global GHG emission contributions. Livestock production includes beef, chicken and pork. Adapted from a graph by Fiala (2009).

Total GHG emission contributions from mainly extensive and mainly intensive production were approximately 13% and 5% respectively and contributions from intensive production are projected to increase as more CAFO-type operations are built in response to increasing global demand (Steinfeld et al., 2006; Fiala, 2008).

Recently, Eshel and Martin (2006) compared the energy consumption of plant-based diets and meat-based diets and used an often-cited energy sink, personal transportation, to demonstrate that the GHG emissions of various diets were different by as much as owning an average sedan versus a sport utility vehicle in the U.S. After considering both direct and indirect emissions (carbon dioxide released from fossil fuel combustion, and methane and nitrous oxide released during animal-based food production), they concluded that consumption of a mixed diet that contained the mean caloric content and composition of an American diet resulted in the emission of 1,485 kg of carbon dioxide equivalents greater than the emissions associated with consumption of the same number of calories from a plant-based diet. They reported that this amounts to over 6% of total U.S. GHG emissions.

Through life-cycle assessments, Weber and Matthews (2008) demonstrated that dietary changes are an effective means for reducing GHG emissions. They explained that although food is transported long distances in general, the high GHG emissions associated with food consumption are dominated by the production processes and not transportation. In the U.S., 83% of the average household's GHG emissions from food consumption originated from the production process. Indeed, they concluded that modification of human diets by just 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 achieved more GHG reduction than buying all locally sourced food.

2.2 Land use, degradation and deforestation

Globally, intensified production on prime croplands in industrialized and industrializing economies is expected to continue and will require high inputs of water, inorganic and organic fertilizers, pesticides and improved seeds (Kates and Parris, 2003). Global trends indicate that the creation of pastureland and cropland is increasing and their combined projected total represents an average global agricultural land base that would be 18% larger than at present by 2050 (Tilman et al., 2001). Land for the livestock sector occupies the largest anthropogenic land use (Steinfeld, et al., 2006). Currently, 70% of all agricultural land and 30% of the land surface of earth is in use for pastoral, mixed-system and intensive livestock production and one of the most serious consequences of this intensive use is soil erosion which diminishes productivity (Horrigan et al., 2002; Pimentel, 2004; Steinfeld et al., 2006).

Arguably, soil fertility may be improved by large inputs of expensive fossil-fuel based fertilizers however further increases in nitrogen and phosphorous fertilizer application are unlikely to be as effective as before in increasing crop yields due to diminishing returns (Tilman et al., 2002). Intensive production will continue to result in serious environmental impacts due to the imbalances of nutrient inputs and outputs, i.e. the concentration of nutrients originating from large areas of primary production into much smaller areas of animal production invariably results in a large amount of waste due to the inefficiencies of nutrient assimilation by animals (Atkinson and Watson, 1996).

Now, ruminants consume 69% of animal feed overall, however non-ruminants consume 72% of all animal feed that is grown on arable land, and due to this scenario, conflict with food crop production is inevitable (Galloway et al., 2007). After calculating the energy requirements for the production of meat and milk, a 33% increase in global grassland productivity shall be required to allow for the projected increases in global grass consumption from ruminants (Bouwman et al., 2005) and if grassland areas do not expand in the near term, which is expected based upon a continuation of past trends, productivity shall have to somehow originate from increasing fertilizer inputs, grass-clover mixtures and improved management which as mentioned may not necessarily be feasible (Tilman et al., 2002). At the same time, vast increases in arable land will also be required to grow feed crops. According to Steinfeld et al. (2006) expansion of livestock production is a key factor in deforestation and it was estimated that about 20% of the world's pastures and rangelands have been degraded to some extent through overgrazing, compaction and erosion through livestock activity.

2.3 Water consumption and water pollution

Currently, over eight percent of global human water use is attributable to the livestock sector, mostly through irrigation of feed crops and the livestock sector is also most likely the largest source of many types of water pollution (Steinfeld et al., 2006). On average, an irrigated corn crop requires about three times more energy to produce than the same yield as rain-fed corn, the costs of irrigation are high, and irrigation may also result in salinized and waterlogged soils that can diminish crop productivity (Pimentel, 2004). Increased economic activities lead to increased domestic, agricultural, industrial and commercial water use (Lora et al., 2004). Water withdrawal is the removal of freshwater from reservoirs or water resources expressed in cubic km per year (Shiklomanov, 2000).[2] Water withdrawal is highest in the Philippines among Southeast Asian countries - 41.7 km^3 in 1990 and a projected withdrawal of 49.8 km^3 by 2025 (Seckler *et al.*, 1998 as cited in Rola et al., 2004).

Livestock excrete 60% to 95% of consumed nitrogen and phosphorous thereby releasing the majority of nutrients onsite and although manure is generally applied to land, over-application is resulting in significant groundwater and surface water contamination.[3] In the U.S., millions of tons of animal waste are produced per year of which the majority is applied to fields that are already saturated. Naturally, industrial-scale operations result in increased volumes of animal waste and other contaminants including nutrients, antibiotics, pesticides, fertilizers, hormones, and pathogenic parasites, viral and bacterial loadings which all contribute to the pollution burdens of groundwater and surface water (Knowlton and Cobb, 2006; Steinfeld et al., 2006) and are considered to be a leading source of contamination of water bodies in the U.S. (Centner and Feitshans, 2006). As of 2007, accepted livestock waste management practices in the U.S. did not adequately or effectively protect water resources from contamination from

[2] Shiklomanov, Gor A., SHI (State Hydrological Institute, St. Petersburg), and UNESCO, Paris, 1999. "World Resources 2000-2001: People and Ecosystems: the Fraying Web of Life", WRI, Washington DC, 2000; *Paul Harrison and Fred Pearce, AAAS Atlas of Population* 2001, AAAS, University of California Press, Berkeley. Link to web-site http://www.unep.org/dewa/assessments/ecosystems/water/vital, accessed 4 May 2009.

[3] The most common unit to calculate nutrient levels is the "animal unit" and it operates on the basis of excretions across species. Based on the averages use by the U.S. Extension Service, 1 animal unit is equal to 5 pigs or 250 broilers and is equated with the release of 298 pounds of nitrogen and 209 pounds of phosphate (Costales *et al.*, 2003).

multiple contaminants (Burkholder et al., 2007). In Asia, farming systems have developed whereby countries such as China, India, Thailand and Indonesia for example use raw sewage in their operations (Hooda et al., 2000). In China, where it is estimated that over 90% of animal farms nation-wide were built without pollution-prevention facilities, livestock production has become the leading source of pollution throughout vast rural areas of the country (Wang, 2005).

Steinfeld et al. (2006) estimate that in the U.S., the world's fourth largest land area, livestock are responsible for 55% of erosion and sediment, 37% of pesticide use, 50% of antibiotic use and 33% of the loads of nitrogen and phosphorous into sources of freshwater. Specific threats to groundwater and surface water from intensive farming operations indeed include the release of massive amounts of nitrate nitrogen, ammonia nitrogen and phosphorous nutrients which compromises drinking water quality in ground water and causes eutrophication in surface waters resulting in death to aquatic organisms and decreases in biodiversity (Neeteson, 2000). The loss of nitrate in agricultural runoff to surrounding areas has potentially serious implications for the quality of potable water considering for example that nitrate concentrations above only 50 mg per litre are associated with methemoglobinemia (blue baby syndrome; Hooda et al., 2000). Protozoal parasites such as *Cryptosporidium* and *Giardia* are also excreted from livestock and infections are prevalent among young farmed animals. *Cryptosporidium* oocysts can exist in water bodies for at least 140 days and *Giardia labbila* cysts have been shown to survive up to 33 days in animal waste and 47 days in water (Hooda et al., 2000). Pathogenic and antibiotic-resistant bacteria and antibiotic-resistance genes and hormone contamination of water are discussed in proceeding sections.

2.4 Loss of biodiversity and loss of local livestock breeds

Through livestock intensification and industrialization practices, biodiversity decreases and the consequences include the production of large livestock monocultures. Now such monocultures account for approximately 20 percent of the total terrestrial animal biomass worldwide and this is coupled with the fact that the 30 percent of the earth's land surface that they now occupy was once habitat for other plants and animals (Horrigan et al., 2002; Steinfeld et al., 2006). It must also be considered that intensive production of animals with little genetic diversity and high stocking densities will result in expansive host populations of animals that will be increasingly vulnerable to emergent pathogens newly resistant to pesticides, vaccines or other critical barriers (Doyle et al., 2005).

Loss of local livestock breeds as cultural properties are another serious concern of animal intensification practices. In developing countries, although livestock may be grown to produce meat and dairy, their roles in societies are many times much broader and include cultural issues related to religion, societal rituals, farmer social status, gender equality, the control of pests and the improvement of the structure and function of soils for example (Riethmuller, 2003). Local breeds may contribute to the preservation of ancient traditions and have value to cultures as historical witness and as custodians of local traditions (Gandini and Villa, 2003). It has been pointed out that the economic consequences of the livestock industries should not be considered in isolation from their social consequences (Riethmuller, 2003).

2.5 Production and dissemination of antibiotic-resistant and pathogenic bacteria in animals and food

During meat production, broad-spectrum antibiotics are administered to animals at sub-therapeutic/nontherapeutic and therapeutic doses to enhance growth and to try to control illness and these practices result in the creation of antibiotic-resistant and multidrug-resistant bacteria. In 2001, Mellon et al. devised a methodology for calculating antimicrobial use in agriculture from publicly available information including herd size, approved drug lists and dosing levels and they estimated that livestock producers in the U.S. were using 11.2 million kilograms of antimicrobials per year for nontherapeutic purposes. Their conclusions included that (1) tetracycline, penicillin, erythromycin, and other antibiotics that are important in human medicine are used extensively in the absence of disease, (2) that previous estimates were gross underestimations of actual usage, (3) that approximately half of the total amount of antibiotics used were already banned by the EU, and (4) that in the case of chickens for example, a greater than 300% increase in dosage per bird had occurred since the 1980s. Compared with an estimated 1.4 million kilograms of antibiotic usage in humans per year in the U.S., 800% more antimicrobials were used in the three major sectors of animal production. Indeed, nontherapeutic usages alone are estimated to total more than 70% of total antibiotic use in the U.S. and this figure does not include minor species such as turkeys or goats and does not include aquaculture at all (Mellon, 2001). In China in 2002, 3 million kilograms of antibiotics per year were estimated to be in use for growth promotion, i.e. subtherapeutic administration (Li, 2003).

Smith et al. (2001) showed that administration of antibiotics to farm animals hastens the appearance of antibiotic resistant bacteria in humans and explained that farms with high rates of antibiotic use are evolutionary "incubators" where high levels of antibiotic-resistant bacteria and multidrug-resistant bacteria thrive. It is also known that administration of antibiotics to animals result in contamination of meat by antibiotic-resistant bacteria and directly results in antibiotic-resistant bacterial infections in humans that are a risk to human health. Consequences from the administration of antibiotics to farm animals include:

(1) that antibiotic-resistant pathogenic bacteria are directly transferred to humans by increasing the frequency of antibiotic resistance in zoonotic pathogens such as *Salmonella* which are typically acquired through exposure to contaminated animal food products;

(2) that development of antibiotic resistance in human commensal bacteria which ordinarily colonize humans without causing infection may be caused by transfer of antibiotic-resistance genes present in bacteria in animals to bacteria in humans, and;

(3) when antibiotic-resistant bacteria that do not normally infect humans are ingested by people who are on antibiotic therapy, and thus who have altered human flora, the growth of antibiotic-resistant bacteria will occur in those persons (OTA, 1995).

It is accepted that in these cases, the risks to human health are increased.

Antibiotic-resistant bacteria have now been isolated from animals and food products under many circumstances including the isolation of antibiotic-resistant *Campylobacter* and *Salmonella* from chicken, pork, beef and turkey meat in different countries (Dechet et al. 2006; Hong et al., 2007; White et al. 2001; Smith et al. 1999). The high prevalence of vancomycin-resistant *Enterococcus faecium* in farm animals due to the use of the glycopeptide antibiotic avoparcin for growth promotion (banned in the EU in 1997) is most likely contributing to the increase in vancomycin-resistant *Enterococcus faecium* strains documented in farm animals, in pork and chicken meat (Gambarotto et al., 2001; Shea, 2003; Willems et al., 2000) and in humans for example. The strains found in pigs in one study were indistinguishable from strains found in humans and these data strongly suggested that community-based vancomycin-resistant infections in humans are originating from pigs (Willems et al. 2000). In 2005, vancomycin-resistant *Enterococcus faecium* isolates documented from broiler chicken and pig farms in England (Garcia-Migura et al., 2005). Sørensen et al. (2001) showed that antibiotic-resistant *Enterococcus faecium* that originated from chicken and pork led to detectable concentrations in human stool samples and these results showed that these organisms survived gastric passage and multiplied in humans.

Since many of the antibiotics administered to animals in intensive farming operations are also used to treat human diseases, cross-resistance is a major concern, i.e., using a fluoroquinolone such as sarafloxacin to prevent infections in chickens may result in the creation of antibiotic-resistant pathogens that cause dangerous infections in humans that are not treatable with fluoroquinolones. Indeed, the transmission of antibiotic-resistant bacteria from farm animals and meat to humans is well documented in many situations including the transmission of antibiotic-resistant bacteria from chickens fed tetracyclines to humans (Levy et al. 1976), the transmission of quinolone-resistant *Campylobacter jejuni* from retail chicken meat to humans (Smith et al. 1999), the transmission of multidrug-resistant, quinolone-resistant *Salmonella enterica* from pigs to humans (Chiu et al., 2002; Mølbak et al. 1999), the transmission of multidrug-resistant *Salmonella enterica* from ground beef to humans (Dechet et al. 2006), and the transmission of ceftriaxone-resistant *Salmonella enterica* from cattle to a 12-year old boy (Fey et al., 2000) for example. It is also widely known that *Salmonella*-infected hens have been reported to deposit *Salmonella* in either yolk or albumen of developing eggs as a possible consequence of colonization of the reproductive tract (Gast et al., 2005) and such contamination of the edible contents of the chicken egg serves as another potential mode of microbial antibiotic resistance transmission.

Since 1960, methicillin-resistant *Staphylococcus aureus* (MRSA) has become a major human pathogen that is responsible for considerable mortality, morbidity and healthcare costs worldwide and was generally considered a nosocomial pathogen until only recently whereby cases of community-acquired (CA-) MRSA infections are now increasing and the trends indicate that this is a rapidly emerging global phenomenon (Vandenesch et al., 2003; Klevens et al., 2007; Sergio et al 2007). By 2007, in Europe, Asia and North America, MRSA had been found in large numbers of farm animals, including chickens, pigs and cattle, and in retail meat. Of even more concern were the findings that farm animal MRSA transfer to humans may also be occurring and may be partly responsible for the increases in global CA-MRSA infections (Huijsdens et al., 2006; Soil Association, 2007).

In the Netherlands, it was documented that the prevalence rate of MRSA in a group of 26 regional pig farmers was 760 times greater than the rate that occurred in patients admitted to Dutch hospitals. In their study, transmission between pigs and pig farmers, between pig farmers and family members and between an infected family member and a hospital nurse were demonstrated. In all, 3 different MRSA strains, including a new *spa*-type were documented (Voss et al, 2005). In France, Armand-Leferve et al. (2005) reported results that suggested a high rate of MRSA exchange of a variety of strains between pigs and farmers and discussed the fact that since nasal carriage is a recognized source of *Staphylococcus aureus* bacteremia with severe consequences, that their findings suggest that pig farming may be a staphylococcal hazard. These data were corroborated in 2008 by van Belkum et al. where it was reported that ST398 MRSA from pigs was capable of causing serious infection in humans even though its primary host has appeared to be pigs. The first documented case of MRSA transmission between cows and humans (ST1/*spa*-type t127) was reported in Hungary in 2007 (Juhasz-Kaszanyitzky et al., 2007) and the possibility of a human to animal MRSA strain transmission (ST22-MRSA-IV also known as UK-EMRSA-15) was reported in a pig in Singapore; this was in addition to another MRSA strain (ST398) that originated from pigs imported from Indonesia (Sergio et al., 2007). In the Republic of Korea, where the rate of methicillin resistance in humans to *Staphylococcus aureus* is reported to be over 50%, MRSA and oxacillin-resistant strains of *Staphylococcus aureus* were shown to occur in samples from cows and chickens and the author concluded that contaminated meat consumption is a probable source of human infections (Lee, 2003). In retail chicken meat in Japan, MRSA and enterotoxigenic *Staphylococcus aureus* strains were also documented (Kitai et al., 2005a; Kitai et al. 2005b). Most recently, on five farms in Ontario, Canada multiple indistinguishable MRSA strains were documented in pigs and in pig farm personnel (Khanna et al. 2008) and on different types of pig farms in the Netherlands (van Duijkeren et al., 2008). In 2009, for the first time, MRSA strains were documented in pigs and pig farmers in the United States and it was concluded that agricultural animals could become important reservoirs for these bacteria (Smith et al., 2009).

The presence of large numbers of insects, especially flies, at intensive farming operations is a health risk that contributes to the spread of bacterial infections, antibiotic-resistant bacteria and antibiotic-resistance genes. Recent studies of the digestive tracts of house flies (*Musca domestica* L.) collected from urban fast food restaurants in Kansas, U.S. showed that the flies carried large populations of multi-drug resistant enterococci. The authors reasoned that the high prevalence of *Enterococcus faecalis* and *Enterococcus faecium* in the houseflies indicated that they must have developed in or were in contact with manure and feces of domestic animals. It was concluded that although contamination from the feces of dogs and cats was possible, the main reservoir for the resistant bacteria was from farm animals (Macovei and Zurek, 2006).

Flies that thrive in great numbers at intensive animal farming operations have also been shown to disperse pathogens that are a threat to human health in their own right. Alam and Zurek (2004) investigated U.S. cattle feedlots and demonstrated that house flies were carrying virulent enterohemorrhagic *E. coli* O157:H7 which is a well-known causative agent of hemorrhagic colitis and hemolytic uremic syndrome in humans, the main reservoir of which is cattle. The strain is disseminated by flies after their larvae develop in cattle feces. Outbreaks from *E. coli* O157:H7 have been reported in North America, Europe and Asia and it is reported to cause more than 20,000 human infections and more than 250 deaths per year in the U.S. (Nataro and Kaper, 1998). Laboratory studies in 1999 demonstrated that *E. coli* O157:H7 ingested by house flies remained viable in the fly excreta and was disseminated for several days (Kobayashi et al., 1999). This was especially interesting after considering that the dispersal range of house flies is 0.5 to 2 miles, but possibly up to 20 miles. In Japan, house flies were implicated in the transmission of *E. coli* O157:H7 from reservoir animals to other animals and also to humans (Moriya et al., 1999).

2.6 Production and dissemination of antibiotic-resistant and pathogenic bacteria in the environment

The waste from millions of animals such as pigs, grown in intensive meat production systems is often spread as fertilizer onto nearby agricultural lands, stored in deep pits or stored in outdoor lagoons and results in large-scale soil, water and air contamination. As a result of percolation, runoff and lagoon-breaching during episodic weather events, pathogenic contaminants enter surface waters and groundwater posing threats to human health and the environment. Waterways contaminated with the animal wastes may then serve to disseminate antibiotic-resistant organisms and genes and such widespread contamination has been documented throughout many areas of the U.S. (McEwen and Fedorka-Cray, 2002; Roe and Pillai, 2003).

Multidrug-resistant *E. coli* were isolated from water retention ponds and manure from pig, chicken, beef and dairy farms in Florida, U.S. and among the four livestock sources, 84% of the isolates were resistant to one or more antibiotics (Parveen et al., 2005). Pig manure which is known to carry high loads of antibiotic resistance genes and antibiotics are applied to soil and has been shown to result in horizontal antibiotic-resistance gene transfer from spread manure to soil bacteria (Heuer et al., 2009). Sapkota et al. (2007) examined surface water and groundwater samples from areas up-gradient and down-gradient of industrialized pig growing operations (CAFOs) and also examined indoor air samples from the same facilities (Chapin et al., 2005). Generally, down-gradient water samples were contaminated with significantly higher levels of *Enterococcus* spp., *E. coli* and fecal coliform bacteria when compared to up gradient-water samples of surface and groundwater and it was explained that these results were in agreement with previous studies of industrialized pig-growing operations. High levels of antibiotic-resistant *Enterococcus*, staphylococci and streptococci were also documented in air that was sampled inside the same industrialized pig-growing facilities and indicated that inhalation of air from these operations may also serve as an exposure pathway (Chapin et al., 2005). Similarly, multi-drug-resistant organisms were detected in bioaerosols inside and downwind concentrated pig growing operations (Gibbs et al., 2006). Antibiotic-resistant bacteria were detected in groundwater on or near pig farms where 68% of *E. coli* isolates were resistant (Anderson and Sobsey, 2006). Fecal and fecal bacteria impacts on groundwater were shown to occur from swine manure pits, and there was suggestion that bacterial filtration by soils may not be as effective as commonly assumed (Krapac et al., 2002).

Other examples include recent documentation of sulfonamide antimicrobials in private groundwater wells nearby CAFOs (Batt et al., 2006), documentation of higher numbers of tylosin-resistant bacteria in agricultural soils (Onan and LaPara, 2003), documentation of high levels of antibiotics (Qiang et al., 2006) and antibiotic-resistance genes in feedlot and CAFO lagoons, nearby surface waters and downstream locations (Chee-Sanford et al., 2001; Smith et al., 2004; Peak et al., 2007), and recent documentation of the potential for antibiotic resistance gene transmission to native wildlife (Blanco et al., 2007). Multidrug-resistant bacteria were documented in rendered animal products from poultry, cattle and fish and this has wide implications for the buyers who plan to use such feed in their operations, especially for farmers that do not use antibiotics in their operations (Hofacre et al., 2001). In a recent excellent review on industrial animal production, antimicrobial resistance and human health by Silbergeld et al. (2008) it was discussed that the role of antimicrobials in agriculture will be recognized as one of the most of important drivers of increasing multi-drug resistant pathogens in the future.

As has been carried out in the EU, discontinuation of nontherapeutic administration of antibiotics to farm animals has been recommended in the U.S. (Gilchrist et al., 2007) and should be considered carefully by developing countries. Other policy recommendations include coordinated country-wide surveillance programs, bacteria strain identification programs, and the incorporation of solids tanks for manure storage combined with municipal-type waste treatment to limit microbial contamination of surface water and groundwater (Gilchrist et al., 2007). As carefully pointed out by Witte et al. (2000), the transfer of antibiotic-resistant bacteria is not restricted to a particular country or league of countries such as the EU because meat trade occurs world-wide. For example, chicken imported to Japan from France and Thailand was contaminated with vancomycin-resistant *Enterococcus faecium* (Ike et al., 1999; Ozawa et al., 2002).

Athough beyond the scope of this report at this time, it should be emphasized that antibiotic use in commercial fish farming is now rapidly increasing and sea- and lagoon-based (Schmidt et al., 2000; Miranda and Zemeiman, 2002; Chelossi et al., 2003; Furushita et al., 2003) and integrated lagoon-based farming (Peterson et al., 2002) have been shown to result in the production of antibiotic multidrug-resistant bacteria including documentation that antibiotics move through the aquatic environment and affect the flora of wild fish (Ervik et al., 1994).

2.7 Release of naturally-occurring and synthetic hormones and hormone derivatives

Liquid and solid wastes generated from intensive animal agriculture are significant sources of natural and synthetic hormones and their derivatives released into the environment. When compared to per capita estrogen releases in the U.S., livestock emissions may be ten times greater (Raman et al., 2004). Lange et al. (2002) estimated that almost 50 tons of estrogens were being released per year in the U.S. in 2000 and that pregnant cattle accounted for most of these releases. Estrogen releases into the environment are of concern because even at low concentrations of 10 to 100 ng per liter, adverse effects on normal endocrine function in aquatic vertebrate species such as fish, amphibians and reptiles may occur (Hanselman et al., 2006). Estrogenic compounds such as estrone, 16α-hydroxy-17β-estradiol (estriol), 17α-ethynylestradiol and 17α- and 17β-estradiol are present in pig, poultry, dairy and beef waste and are present in waste lagoons (Hanselman et al., 2006; Hutchins et al., 2007; Raman et al., 2004; Zhao et al., 2009) and the hormonal effects from industrial farm runoff have already been reported in aquatic species (Orlando et al., 2004). Fine et al. (2003) showed that pig lagoon samples from three different types of operations in the U.S. contained levels of estrone, estriol, and estradiol up to 25,000, 10,000 and 3,000 ng per liter respectively. Relatively potent fish and mammal androgens such as the trenbolone acetate metabolites 17α- and 17β-trenbolone have also been detected in beef cattle feedlot discharge and the androgenic activity of feedlot discharge was shown *in vitro* (Schiffer et al., 2001; Durhan et al., 2005). Still, the effects of estrogen, androgen and progestin hormones in the environment and in the food chain are largely unknown.

2.8 Release of ectoparasitides and derivatives

Not much discussed, externally applied ectoparasitides are chemical formulations in common use on livestock to control external parasites. Most are neurotoxins. Their release into the environment may result in soil and water contamination through fecal release and other means. Ectoparasitides include chlorinated hydrocarbon, organophosphate, carbamate, synthetic pyrethroid, amidine, macrocyclic lactone and benzylphenyl urea chemical formulations that are used to control ticks, flies and lice (Khan et al., 2007; Hooda et al., 2000) and their use in farming operations should be considered depending upon the operation type and region of the world.

2.9 Release and potential accumulation of heavy metals and persistent organic pollutants

Release and potential accumulation of heavy metals in soil, sediments and in the food chain are concerns that are related to animal intensification in that chemicals such as arsenicals, for example, are added to poultry and cattle feed for growth promotion and prevention of parasitic infections. Soil, ash and fertilizer contamination result (Nachman et al., 2005; Sapkota et al., 2007) including contamination of for-consumption chicken meat (Lasky et al., 2004). Potential biomagnification of chemicals that negatively impact human health and the potential propagation of prion-based diseases such as bovine spongioform encephalopathy (BSE) may occur due to the practice of re-feeding of animal parts and animal waste from different sectors of intensive meat production back to animals. For example, waste and animal parts from chicken and hog sectors are fed to cows and, in turn, waste and animal parts from cows are fed to the chicken and hog sectors (Sapkota et al., 2007). The effects of these practices are unknown but clearly require further investigation.

It must also be considered that persistent organic halogenated pollutants such as polychlorinated biphenyls (PCBs), dioxins, furans and DDTs enter the food chain through animal diets in forage and feed which contain large amounts of recycled fat. This system of re-feeding of animal-based substances may result in bioaccumulation of halogenated pollutants and cause potential downstream effects (Walker et al., 2005). Although not addressed in this report, it should also be noted that due to growth in the aquaculture sectors, waste and animal parts from terrestrial intensive meat production are now fed to aquatic species on a larger scale in developed and developing countries, especially in China, and the ramifications of these practices are also unknown (Ai et al., 2006; Wang et al., 2006).

2.10 Socioeconomic costs

The socioeconomic costs of intensification of livestock production are numerous and varied and depend upon many conditions including the industry type and country of operation. In the U.S., the negative influence of large-scale specialized farming on communities has been reported to result in population decline, lower incomes, decreases in property values, fewer community services, less participation in democratic processes, less retail trade, increases in unemployment and an emerging rigid class structure (Broadway and Stull, 2006; Donham et al. 2007; as cited in Honeyman, 1996; Mirabelli et al., 2006; Worosz et al., 2008). Negative effects on mental, physical and occupational health, issues of environmental injustice and failure of the political process to meet its obligations to regulate intensive animal farming operations are documented in the literature and calls for the creation of adequate regulations and enforcement are being voiced (Cole et al., 2000; Donham et al., 2007; Heederik et al., 2007; Osterberg et al., 2004; Schiffman et al., 2005; Westerman and Bicudo, 2005; Wilson et al., 2002; Wing et al., 2002; Wing et al., 2008). Residents in rural communities are generally excluded from decisions to build intensive animal production operations but they suffer the environmental, public health and economic consequences of living in close proximity (Walker et al., 2005). Residents often organize to defend their rights after defining their platform, e.g. - intensive broiler operations are an illegitimate form of economic development that was detrimental to health, soil, water and air, community cohesiveness and property values (Constance, 2002). Intensive animal production involves growing economies of scale and vertical and horizontal corporate integration that combined with market distortions favours the powerful producers.

In the hog sector, Donham et al. (2007) reported that there have been over 70 published reports that discuss the adverse health effects of intensive pig operations on pig producers for example. The severity of the problems has resulted in recent changes to U.S. federal regulations (Centner, 2006) and the calling for a moratorium on CAFOs by the American Public Health Association (APHA, 2003).

Recommendations for removing distortions and promoting institutional change in regard to property rights, fair contracting and the support of smallholder farmers have been made (Delagdo, 2003). Other little discussed socioeconomic costs include the nutrition transition which involves populations shifting from traditional grain-based diets to diets that include more energy dense foods and a decrease in physical activity levels, resulting in increased rates of obesity and epidemics of overweight populations as is now the case in the U.S. and Australia for example (Kennedy, 2005).

2.11 Transmissible disease risk

As discussed previously, human population growth and urbanization in Asia are expected to continue to increase rapidly, and as these occur, risks that infectious diseases will evolve, emerge or spread will also increase. At the same time, depending upon the mode of intensive animal production, risk exacerbation for infectious disease outbreaks will also increase because closer contact between animals and humans under unhygienic and overcrowded production conditions may result in greater chances of zoonotic disease transmission from animals to humans and vice versa. Additionally, animal production facilities are being built closer to urban centers and may allow for even greater human-animal contact and the potential for disease spread through large urban populations quickly (Steinfeld et al., 2006).

In intensive animal production operations, high stocking densities, physical and mental stress, unclean conditions, lack of sunlight and feeding, breeding and transport practices may enhance the risk of emergence and spread of diseases such as avian influenza, H5N1, and increase the risk of causing regional or even global pandemics as a result of such conditions and practices; the impacts of which will have serious and lasting economic consequences for the affected countries (Saenz et al., 2006; Greger, 2006; Greger, 2007a; Greger, 2007b; HSUS, 2007). In May 2009 a new influenza virus, H1N1, was found to be infecting humans (CDC, 2009). The index case for the virus appears to have occurred in the same area as an industrial pig farm CAFO in Veracruz, Mexico that is the largest such operation in the country (Cohen, 2009) and which had already been the subject of protests by local communities due to health and environmental concerns (Fainaru, 2009). However, there is debate over the origin of the virus. Nevertheless, there are concerns about the development of influenza viruses in communities where pigs, birds and humans live in close proximity. Gilchrist et al. (2007) recently acknowledged that although there are numerous known potential risks for human infection from animals that are raised in high concentration, antibiotic resistance and influenza are probably the most dangerous at this time.

As mentioned previously, the potential for propagation of prion-based diseases such as the progressive and fatal bovine neurological disorder, BSE (so-called mad cow disease), occur due to the practice of re-feeding of animal parts from different sectors of intensive meat production back to animals and may raise the risk of transmission to humans. As is well known, human exposure to the BSE agent via contaminated beef products was linked to the cause of a variant form of Creutzfeldt-Jakob disease (vCJD) in humans and subsequently the feeding of ruminants back to ruminants was banned. However, as discussed in a previous section, the cycle of re-feeding of animal parts in the bovine, porcine and poultry sectors has by no means been closed.

3. Industrial hog and chicken production in the Philippines

This section provides an overview of industrialized hog and chicken production systems in the Philippines and describes operational procedures used for existing livestock production with focus on Central Luzon and Southern Luzon. Four meat companies that have their main plants located in Central and Southern Luzon were contacted to participate in a survey that involved environmental values and were part of a larger study of fifteen food companies that are located in Metro Manila or areas within the vicinity of Laguna Lake.

As a developing country, meat production patterns in the Philippines show that hogs and chickens are the leading livestock produced (Costales *et al.*, 2003). The Philippines' Bureau of Agricultural Statistics (BAS) reported that by the third quarter of 2004, livestock production reached 519.8 thousand metric tons liveweight, distributed into hog (77.6%), cattle (11.7%), carabao (6.5%) goat (3.7%) and dairy (caracow's and cow's milk, 0.5%) sectors. For the same time period, poultry production reached 379.6

thousand metric tons liveweight comprised of chicken (73.3%), duck (3.2%), chicken eggs (19.9%) and duck eggs (3.6%). In 2007, hog and chicken still dominated with 1,886 and 1,212 metric tons, respectively and goat meat was reported as the least produced (Table 1) Numbers of poultry dressed reached 263,233,296 followed by 9,789,062 heads for hogs. Following a similar pattern, only 146,041 heads of goat were reported slaughtered in abattoir as indicated in (Table 2).

According to Costales *et al.* (2003), production was concentrated in Central Luzon and Southern Luzon. These two regions are densely populated areas adjacent to Metro Manila and also serve as the largest demand center.

Table 1. Volume of Production of Livestock and Poultry by Animal Type in 2007

Animal Type	Quantity (in metric ton live weight)
Hog	1,886
Chicken	1,212
Chicken egg	335
Cattle	237
Carabao	137
Goat	77

Source: Bureau of Agricultural Statistics Database 1994-2007

Table 2. Livestock and Poultry Slaughtered/Dressed in Abattoir in 2007

Animal Type	Quantity (in heads)
Chicken	263,233,296
Swine	9,789,062
Cattle	566,053
Carabao	245,177
Goat	146,041

The average Filipino family spends 43% on food with expenditures for dining growing at an average rate of 15% to 20% per annum over the last 10 years (Catelo, 2006). The Family Income and Expenditure Survey (FIES) of the National Statistics Office (NSO) estimated household spending on food increased by 26% from 1997 to 2000. Personal consumption expenditure (PCE) on food and beverages in 2002 reached about PhP 448 B from PhP 401.7 B in 1998, or an average annual growth rate of about 3% (Omaña, 2005 as cited in Catelo, 2006). Consumer Price Index for meat increased from 100 in 2000 to 135 in 2007 (BAS, 2007).

The retail prices in the Philippines from 1978-2002 showed that beef is the most expensive meat, followed by pork and chicken according to the Market Development Division of Bureau of Animal Industry (2004) as cited in Chang (2004). As listed in Table 4, however, farm gate prices changed in 2007 with cattle for slaughter becoming cheaper (Php 66.1 per kg) than hogs (Php 71.28 per kg) and chicken broiler (Php80.63) (BAS, 2007).

Table 3. Daily Per Capita Consumption and Supply of Selected Agricultural Commodities in 2007

Commodity	Quantity (in grams)
Pork	51.02
Chicken	21.53
Chicken egg	9.53
Beef	6.24
Carabeef	5.02

Source: Bureau of Agricultural Statistics Database 1994-2007

Table 4. Annual Farmgate Prices of Agricultural commodities in 2007

Commodity	Amount (in Peso per kilogram)
Carabao for Breeding	65.35
Carabao for Fattening	56.66
Carabao for Slaughter	52.80
Carabao for Work	58.48
Cattle for Breeding	75.16
Cattle for Fattening	73.86
Cattle for Slaughter	66.16
Cattle for Work	88.95
Goat for Breeding	63.04
Goat for Slaughter	69.93
Hogs Upgraded for Breeding	148.70
Hogs Upgraded for Slaughter	71.28
Chicken Broiler, other breed (backyard)	80.63
Chicken Fighting Cock (backyard)a/	971.77
Chicken Layer (culls)	32.73
Chicken Native/Improved	97.32
Duck for meat (backyard)	67.10
Chicken egg, other breed (backyard)*	4.03

Source: Bureau of Agricultural Statistics Database 1994-2007
Note for chicken eggs: 21 pieces per kg

3.1 Forces that drive increases in demand for meat and animal products

In general, new patterns of production and consumption resulted from increases in meat demand, cheap feed costs, improved transport, and changes in the technology and organization of animal production (Delgado *et al.*, 1999 as cited in Galloway *et al.*, 2007). In this section, seven precursors of increased demand for meat in the Philippines are identified, namely: (1) increasing human population; (2) policies in agriculture and investment; (3) changes in Filipino lifestyle; (4) changing patterns in consumption; (5) changing attitudes towards meat; (6) growing international trade; and (7) changing patterns in production

1) Increasing human population

The increase in population in the Philippines has resulted in a proportional increase in demand for meat which, in turn, resulted in poultry and livestock intensification (Briones, n.d). According to the National Statistics Office (2008), Philippine population in 2000 was 76,504,077 and jumped to 88,574,614 by 2007, a considerable 13.6% increase after seven years. Using a high assumption, projected population for 2010 will reach 94,349,600 (NSO, 2006).

2) Policies in agriculture and investment

Several Philippine policies in agriculture and investment have resulted in an increase in meat production. The policy of "balanced agro-industrialization" as promoted by the Medium Term Philippine Development Plans of the Philippine government in the 1980-1990s contributed to increase in meat production (Costales *et al.*, 2003). Part of such policy provided incentives such as tax and duty exemptions for breeding stock and capital equipment for firms which locate or relocate outside Metro Manila and, thus, spread growth beyond Metro Manila (Costales *et al.*, 2003).

The Omnibus Investment Code of 1987 pushed for private Filipino and foreign investments in industry, agriculture and other sectors of the economy.[4] A component of the policy about livestock production promoted exemption from all taxes and duties to companies which imported breeding stocks and genetic materials within ten years from the date of registration or commercial operation. In addition, this policy gave tax credit equivalents to one hundred percent of the value of national internal revenue taxes and customs duties if the purchases of breeding stock and genetic materials were from domestic producers.

Still another policy, the Foreign Investment Act of 1991, allowed foreign investments which can amplify value of farm products. Large-scale feed mills, broiler integrators, large-scale commercial hog and poultry firms benefited by having access to lower tariffs on minimum access volume (MAV) imports of corn (Costales *et al*., 2003). Since feed cost make up 70% of the total of intensive poultry production system (Chang, 2005), the availability of feed that can be bought at cheaper rate due to MAV gave commercial poultries an edge over backyard smallholders.

3) Changes in Filipino Lifestyle

Meat consumption in the Philippines was influenced by a fast changing lifestyle and accrual of more income (Catelo, 2006). Meat consumption is associated with elevated societal class (Lewis, 19994). According to Rifkin (1992), the proportion of meat in diets serves as indicator of entry to the middle class. The created need for convenience food supported the rise of supermarkets and convenience stores which, in turn, also benefited the large food manufacturers who entered into strategic partnerships with them (Catelo, 2006). He further added that the growing food retail industry has become a lucrative market for agriculture. According to Palma (2005), total market in the quick service or fast food segment in 2000 was over PhP 30 B.

[4] Philippine Laws, "Omnibus Investment Code," http://www.gov.ph/index.php?option=com_content&task=view&id=2000444&Itemid=2, accessed 26 November 2008.

4) Changing patterns in consumption

The entry of fast food into the Filipino market has resulted in more branches and had tremendous effects on the food industry with dominant players such as McDonald’s, Wendy’s, Kentucky Fried Chicken, Kenny Rogers and Pizza Hut (Catelo, 2006) taking a large part of the total foreign market share. The Filipino-owned Jollibee Food Corporation accounted for about 52 percent of the total fast food market (Omaña, 2005 as cited in Catelo, 2006). However, many agricultural raw materials and ingredients needed to supply these fast food chains have to be imported such as beef, potatoes, cheese and other dairy products (Palma, 2005 as cited in Catelo (2006). Given that the Philippines does not have a comparative advantage in the production of beef (Chang, 2004), the increasing demand for beef-based fast food products in the Philippine market creates an unfavourable balance of trade.

5) Changing attitudes towards meat

Sapp (1991 as cited in Lea and Worlsly, 2001) mentioned that beliefs influence attitude and attitudes influences behaviour. Consumers’ interest in health considerations, convenience and later on palatability and safety had created marketing programs that led to product differentiation and changes in production practices (Lau *et al.*, 2007). Consumers’ demand for convenience, consistency and high quality-value- added products were the drivers that led to institutional changes supporting product differentiation by further processing and branding, i.e. deboned, cut-up parts or pre-cooked chicken meat (Martinez, 1999 as cited in Chang, 2005). Retailers are now mindful of providing these factors to consumers as well as efficiency of service in a clean environment (Palma 2005 as cited in Catelo, 2006).

6) Growing international trade

The Philippines' share in export of meat and meat preparations has been limited with only 6,728 tons in 2007 having a freight on-board value (F.O.B.) of about $20 million. Please see Table 5 and 6 for details. Notably, majority of exports are feeds for animals. However, import on same commodity totaled 215,554 tons which showed how dependent the Philippines is on other countries for its continuous supply of meat and meat preparations (Windhorst, 2006). Table 7 lists types of agricultural commodities and their corresponding quantities imported in 2007.

Table 5. Quantity and Value of Agricultural Exports in 2007

Commodity	Quantity (in kilograms)
Meat and Meat Preparations	6,727,941
Dairy Products and Bird's Eggs	36,614,978
Feeding Stuff for Animals (excluding Unmilled Cereals)	499,430,386
Fish and Fish Preparations	136,814,310

Source: Bureau of Agricultural Statistics Database 1994-2007

Table 6. Quantity and Value of Agricultural Exports (F.O.B. Values in USD) in 2007

Commodity	Quantity (in kilograms)
Meat and Meat Preparations	19,720,827
Dairy Products and Bird Eggs	140,709,577
Feeding Stuff for Animals (excluding Unmilled Cereals)	49,631,745
Fish and Fish Preparations	468,786,593

Source: Bureau of Agricultural Statistics Database 1994-2007

Table 7. Quantity of Agricultural Imports in 2007

Commodity	Quantity (in kilograms)
Meat and Meat Preparations	215,553,711
Dairy Products and Bird'S Eggs	286,894,293
Feeding Stuff for Animals (excluding Unmilled Cereals)	1,716,793,766
Fish and Fish Preparations	156,270,280

Source: Bureau of Agricultural Statistics Database 1994-2007

7) Changing patterns in production

The pattern of growth in the broiler industry can be ascribed to the efficiency in feed conversion ratio (FCR) and lower production costs associated with intensive poultry production (Chang, 2005). Broiler chickens have FCR of 1.80 to 1.90 (Lacy and Vest, 1997).[5] It is worth noting that feed costs comprise 70% of the total costs of intensive poultry production (Chang, 2005). The fast growth rate leads to a shorter growing period and when combined with the broilers' efficient FCR translates to significantly lower production costs. Tilman (2002) notes that increasing production of feed concentrates takes its own environmental toll through the use and loss of fertilizer and pesticides, use of scarce water resources, or conversion of ecologically valuable land. In the case of the Philippines, this has eventually led to native chicken breeds being replaced by modern broiler types to produce day-old chicks used for broiler raising (Chang, 2005). Another reason native chickens are replaced is that imported hybrid chickens produce around 300 eggs per hen per year, while native chickens produce only 40 (Chang, 2004).

There are seven vertically integrated companies dominating the Philippine broiler industry which are engaged in breeding and contract growing, processing and distribution of branded output (Costales *et al.*, 2003). These integrators include Swift Foods, San Miguel Foods, Pure Foods, Vitarich Corporation, Tysons Agro-Ventures, General Milling Corporation and Universal Robina Corporation (DA-AMAS, 2001) which are involved in both production and marketing of broiler chickens, importation of grandparent and parent stocks, and manufacture and sales of commercially mixed feeds. The integrators have organized into the Philippine Association of Broiler Integration, which accounts for about

---

[5] FCR refers to the amount of feed required to produce a unit of meat (Dyck and Nelson, 2003 as cited in Chang, 2005).

80% of the broiler supply in the country (DA and NDFC, 2002). These integrators are the main sources of day-old chicks and operate under a commercial contract for more than 10,000 birds and smaller-size contracts of 6,000-10,000 birds (Costales *et al.*, 2003). Chang (2005) mentioned that in 2002, nearly all broiler production was supplied by integrators under contracts with growers. The average volume of imports for grandparent and parent stock broiler increased in 1980-1985 from 0.7 million birds to 1.8 million in 1996-2001 (Costales *et al.*, 2003).

In addition to increased vertical integrations, contract farming has also increased. As a pioneer in the broiler industry, the U.S. developed contract farming and vertical integrated production systems that still prevail in the Philippines today (Ollinger *et al.*, 2000; Martinez, 1999 as cited in Chang, 2005). Today, the dominant production management in broilers is through contract production with a minimum contract size of 10,000 birds. It is considered large–scale production if there are more than 10,000 birds. Martinez (2002, as cited by Chang, 2005) described contract farming wherein the processors provide the chicks, feed, management and veterinary services to growers while growers provide labour and chicken houses and are then paid per kilogram based on the live broilers produced.

3.2 Economics and negative externalities of hog production in the Philippines

From 1994-2007, the most popular meat in the Philippines was pork, which is consumed at 51.02g daily per capita (BAS, 2007). Pork production showed the highest livestock production growth in the Philippines from 1986-2000 (Costales *et al.*, 2003). Moreover, the BAS reported that by the third quarter of 2004, hogs accounted for 77.6% of the 519.8 thousand metric tons liveweight of livestock production. Central Luzon leads hog production with an annual average of 216.4 thousand metric tons from 1990-2001 (Costales *et al.*, 2003) which accounts for 15% of the national total (BAS, 2002).

The economic importance of hog farming in the Philippines is shown by the Philippine National Statistics Office (NSO, 2007) report that indicates that hog farming accounted for the highest number (769 or 23.3%) of the 3,295 establishments in the agriculture and forestry sector. Additionally, hog farming ranked second in terms of employee generation, providing 12,469 workers with employment, representing ten (10%) percent of the total number of agricultural workers nationwide (NSO, 2007). Total revenue earned during the year 2005 by all Philippine agriculture and forestry establishments, under which hog farming is classified, was estimated at P51.2 billion (NSO, 2007). Not surprisingly, from 1986-2000, livestock was one of the strongest sources of growth and rural income for the Philippine economy (Costales *et al.*, 2003).

Traditional hog farming in the Philippines predominated over commercial hog production (Costales *et al.*, 2003). Independent hog producers still occur in substantial numbers but few feed mills engage in contract production with smallholders under the farrow-to-weaning or piglet production operation (Costales *et al.*, 2003). Backyard scale is not more than 20 heads, 100-1,000 heads for medium-scale and more than 1,000 heads for large-scale (Costales *et al.*, 2003). For countries importing finished meat products, the environmental effects are mostly hidden by the existing production and trade system. (Galloway et al., 2007). A study done by EMB-DENR (2005 as cited in Orejas and Reyes, 2008) described the fates of two large Philippine rivers, the Marilao River and

Meycauyan River, both in Bulacan, a province in Central Luzon, Philippines. The Marilao River became polluted due to domestic sources and industries including piggeries, livestock and poultry. Similarly, in Meycauyan River, also in Bulacan the main industries responsible included livestock and poultry. Domestic sewage in the Philippines has contributed about 52 percent of the pollution load while industries account for the remaining 48 percent (NSCB n.d.). Briones (n.d.) states that increasing pollution resulted from intensification of livestock and poultry production driven by the proportionate increase in the demand for meat from the increasing Philippine population.

Costales *et al.* (2003) note that the scaling up and concentration of production in hogs and broiler chickens in Central Luzon (where Bulacan is located) and Southern Luzon caused problems of animal waste disposal. Disposal of hog wastes has raised concern because there is no available market for hog manure. To dispose of this manure, Costales *et al.* (2003) reported that 56% of the hog farms invested in impounding structures such as lagoons, septic tanks or digesters. Alarmingly, however, in the same report, Costales *et al.* (2003) note that more than half of those who raise hogs by contract simply throw the manure into canals, rivers, open pits or just pile it on ground to decompose. This is a clear example of Tilman's (2002) warning that nutrient output from intensive animal production often exceeds the absorptive capacity of the surrounding area. Moreover, Tilman (2002) adds that increasing transport costs and distances mean that these nutrients are often not returned to the land in a productive manner.

1) Land conversion for livestock use

As opposed to big portions of forestlands being cleared for grazing in other parts of the world such as Brazil (Lewis, 1994), the Philippines grazing area is getting smaller. Over a 30 year period, the grazing area was reduced from 1,285 thousand ha in 1971 to 120 thousand ha in 2000 (FMB-DENR, 2000). Grassland area covers 1.5 M ha, part of which is leased by the government to qualified individuals or corporations for grazing purposes. Extensive grazing areas are found in the provinces of South Cotabato, North Cotabato and Bukidnon in Mindanao; in Cagayan and Isabela in Luzon and the island provinces of Mindoro Occidental and Masbate (Moog and Marbella, n.d.).

2) Replacement of native landraces

Prior to the intensification of meat production in the Philippines, native pig landraces were mostly raised in backyard farms and fed with crop residues. After the introduction of industrialized production operations, the native pigs were replaced with exotic breeds fed with commercial mix (Costales et al., 2003).

3) Pollutant loading

The concentration of particulate matter especially the fine particulate species of sulfates, whether acidic (e.g., sulfuric acid) or basic (e.g., ammonia sulfate) is the main concern on air quality affecting health (Kuprick *et al.*, 2003). Almost ten years ago, ENRAP as cited in UNIDO (1999) pointed out that the major sources of pollution are food and beverage companies, in terms of particulate matter, sulphur dioxide, nitrous oxide, volatile organics, SS and BOD. Just recently, Santos (2008) reported that the Department of Environment and Natural Resources (DENR) shut down five companies for violating laws on clean air and water. Three of these (60%) were food companies.

The total industrial emissions in terms of PM10 (particulate matter) are 37,000 metric tons, 85% of which (31,000 metric tons) is from 750 industrial sources while thermal power stations, cement and oil refineries contribute only 5,600 metric tons (Rolfe, 2002). He added that these industrial sources, except thermal, cement and oil firms produce 34,000 metric tons of NOx and 89,000 SOx. Detrimental health effects of PM include visibility impairment, cardiovascular and respiratory ailments (Dixson-DeCleve, S. and Thi Tihn, H. 2005). World Health Organization Monitor Reports (2002 as cited in Dixson-DeCleve and Thi Tihn, 2005) for the Philippines showed that health-related air-pollution cost is equal to $392 million.

4) Disease transmission

In terms of diseases that may spread from livestock to humans, the Department of Health (DOH) (2007), has reported no cases of bird flu in the Philippines. The greatest risk of spread of the avian influenza virus in the country rests on the entry of live poultry carrying the virus from countries with avian influenza. At the same time, the Department of Health and the Department of Agriculture are establishing a monitoring and surveillance system to prevent the spread of BSE in the Philippines. This is in line with the DOH's National Objectives for 2005 – 2010 wherein the public health, economic and social impact of emerging infections with the potential for outbreaks and high mortality should be reduced. Until now, BSE has not been documented in the Philippines.

Recently, however there was a global animal and health authorities' emergency mission to the Philippines to investigate a strain of deadly Ebola-Reston virus, discovered in dead pigs. Six of 28 swine samples which came from two commercial and two backyard farms in three provinces north of Manila tested positive for Ebola-Reston by the U.S. Department of Agriculture.[6] In December 2008, according to the Straits Times, there were 6,000 pigs from Pandi, Bulacan and Talavera farms which tested positive for the Ebola-Reston virus and were also infected with a highly virulent strain of Porcine reproductive and respiratory syndrome (PRRS) virus (Businessworld, 2009).[7] Ebola-Reston outbreaks in macaque monkeys occurred in the Philippines in 1989-1990, 1992, and 1996 however these are the first cases of Ebola Reston appearing in pigs (Businessworld, 2009) and evidence that the virus had jumped to another species (Promed, 2009).[8] Although considered a level 4 organism and non-pathogenic to humans, the virus is mildly fatal to monkeys. Six out of 141 people tested from the Philippines have tested positive for Ebola-Reston antibodies since the testing started in December

---

[6] Business World Online, "International Experts to study Ebola" Vol. XXII, No. 112, January 8, 2009. http://www.bworldonline.com/BW031409/content.php?id=073, accessed 4 May 2009.

[7] Business World Online, "State to test Fruit bats for ebola," Vol. XXII, No. 158-A, March 14, 2009, http://www.bworldonline.com/BW031409/content.php?id=073, accessed 4 May 2009.

[8] Pro-med Online, "Detection of Ebola-Reston virus in pigs; FAO/OIE/WHO offer assistance to the Philippines," Archive Number 20081226.4075, December 26, 2008, http://www.gov.ph/index.php?option=com_content&task=view&id=2000444&item1d=2, accessed 3 May 2009.

2008 and the latest reported was in 16 February 2009. According to the Department of Health, all six adult males who tested positive had occupational exposure to pigs and appear to be in good health but the threat is still unknown for other population groups (Wikinews, 2009).[9]

3.3 Economics and negative externalities of chicken production in the Philippines

Chicken production has continually been an important economic activity for the Philippines. The BAS reported that by the third quarter of 2004, chicken accounted for 73.3% of the 379.6 thousand metric tons liveweight of poultry production while chicken eggs accounted for 19.9% (Chang, 2004). Chicken broiler producers numbered 651 (19.8%) out of the 3,295 establishments in agriculture and forestry sector (NSO, 2007). Chicken broiler production including the operation of chicken hatcheries and agricultural and animal husbandry service activities employed 6.9 percent and 5.6 percent of total employment of agricultural workers, respectively (NSO, 2007). From 1986-2000, poultry provided the Philippines with a strong source of economic growth and income (Costales *et al.*, 2003).

Central Luzon was the top producer of broilers with an annual average output of 259.1 thousand metric tons in 1996-2000 accounting to 28% of Philippines' broiler production (BAS, 2002). In contrast, native chickens take about 18-20 weeks to reach about 1.2-1.5 kg (Chang, 2004). Native chicken production was prevalent only in regions outside Central Luzon, Southern Luzon and Metro Manila while feed-milling operations are within Metro Manila. Compared with broilers, native chickens were usually raised in backyard farms using free range practices (Chang, 2004) wherein the feed used consists mainly of crop residues and grain spillage along with rice and corn and brokens which are rice that have been broken during milling and considered lower in quality (Costales *et al.*, 2003). Independent broiler producers still abound but few feed mills engage in contract production with smallholders for grow-to-finish production operation (Costales *et al.*, 2003). The BAS classifies poultry production in the Philippines into commercial and backyard, with commercial having more than 100 birds (Chang, 2004).

From 1994-2007, the second most popular meat in the Philippines was chicken meat and is currently consumed at 21.53 g daily per capita or 7.86 kg per year (BAS, 2007). This is a decrease from the 8.04 kg of chicken per capita per year consumed in previous years (BAS, 2003b). This rate of chicken meat consumption is relatively low compared to Thailand and Malaysia where the annual per capita were 11.5 kg and 27 kg, respectively (DA and NAFC, 2002 as cited in Chang, 2004).

Within the Philippines, the integrators' operation takes place at the expense of the small independent broiler producers who are being driven out of the market (Costales *et al.*, 2003). On the global and regional setting, the broiler industry in the Philippines faces threats from cheaper imports as a result of higher production costs and less efficient marketing system (Chang, 2005). The "dumping" of chicken leg quarters in the world market created problems for fledgling broiler industries like the Philippines (DA and

[9] Wikinews Online, "International experts probe deadly Ebola Reston virus outbreak in Philippine pigs," January 8, 2009, http:// en.wikinews.org/wiki/International_experts_probe_deadly_Ebola_Reston_virus_outbreak_in_Philippine_pigs, accessed 3 May 2009.

NAFC, 2002 as cited in Chang, 2005). "Dumping" is made possible because U.S., consumers prefer breasts and other white meat so dark meat is exported (Ollinger *et al.*, 2000 as cited in Chang, 2005). In the 1980s, the thrust to develop the Philippine monogastric livestock industry created tensions with the Philippine domestic corn sector because at that time Philippine trade policies in meat and feed grains were still evolving (Costales *et al.*, 2003).

Costales *et al.* (2003) noted that the disposal of chicken manure was either by selling to trader for Php10-Php22 per 50-kg bag, spreading manure in their own farm or in combination. Much more environmentally damaging, as reported by Costales *et al.* (2003), were other means of disposing poultry manure which include placing manure in closed pits, conveniently throwing wastes into the rivers or canals or simply leaving the waste in the ground to decompose.

Some meat companies have become known as heavy polluters of the Philippine environment. For example, Company A has one of its branches included in LLDA's top 26 worst polluters of Laguna de Bay in 2007 with four of its other branches on the "horror list" of polluting companies. Please see Table 8 for details. In another more graphic example, Company B has also one of its branches listed among the top 26 worst polluters in the Philippines and has previously been found to release effluents that exceeded wastewater standards in terms of BOD, COD, pH, oil and grease content. One of its branches has also been ordered by LLDA to close down for violating five times the effluent standards during only one year of operation.

4. Ethics of animal production

4.1 Introduction

Non-human animals are used in many ways by people. Do non-human animals have a right to live without pain caused by people? Do they have a right to live free? If non-human animals have rights, then humans have corresponding duties towards them. While we would all agree that we have some duties towards non-human animals, there is disagreement about just how many and what kinds of duties we have. We are confronted with these issues every day when we eat meat, play with our pets, or use products that were made from, or tested on, animals.

The agricultural policies of all states includes animal production and consumption. Hence this report begins with the presupposition that it is inevitable that animals play an important role in giving energy and nutrition to humans. Though there may be some argument that animals need not be killed for human sake, the theme of this report is not to argue for vegetarianism, which is a lifestyle choice some make. The main issues that are connected with meat production can be discussed philosophically under the following headings.

4.2 Animals as food

Almost everywhere, animals are killed for human consumption. Humans in many environments have to depend on other living beings for survival and killing animals has become part of human life. Some people choose not to eat animals. A vegetarian is a person who does not eat animals. A vegan is one who does not eat any animals or animal products (milk, eggs, etc.) or use animal products (e.g. leather). There are proven health advantages to eat less meat to lower the level of saturated fat, especially in middle-aged persons living in countries where people over-consume food. Some choose not to eat animals for moral or religious reasons. Eating more plants also has environmental advantages as food and energy is wasted in the transfer from plants to animals.

However, except for South Asia, most people today say it is natural for us to eat some meat or fish. Even if we do eat animals we should minimize the harm we cause. Many people will continue to eat animals, and practical ethics must improve the ethical treatment of all animals.

4.3 Equality of life

All human animals are members of *Homo sapiens,* one of the millions of species currently living on Earth. There is a long history of coexistence of different species together on the earth, in a variety of ecological systems. When it comes to moral issues, fundamentally we should ask whether humans are a special form of life. Are humans different from other living creatures? By comparing humans with other species, we may be able to understand both the differences and similarities between living organisms.

The common human-centered ethics has been questioned by many philosophers like Hans Jonas, Leopold, Gandhi, Peter Singer and a host of others. It has been pointed out by these thinkers that humans should "respect" others' life, whether it is animal or plant. In this approach, they are trying to derive a "holistic approach'. This means to include non-human life otherwise the "non-person" should also be treated on par with human beings. We cannot neglect the life of other beings.

The first key issue here is whether we are treating other beings as equal. The word "equality" can be interpreted and understood in different ways. One way of understanding it is to treat others as equal to oneself. But here the question arises as to how people should treat non-human animals compared to with humans. Other living beings do live on this earth like human beings, however few insist that policies should treat them equally.

One of the important reasons for this distinction between human and non-human animals is that certain groups of human animals think that the entire world exists for their purpose. Though this "anthropocentric" approach[10] is subscribed to by many thinkers from the ancient past to the present, it is equally maintained by many scholars that humans have the responsibility towards nature and to other living beings on earth. Hence there is a shift in ethics, i.e., from theoretical to the practical or applied. The word applied has become the focus of attention of our contemporary thinkers.

It is accepted that humans possess unique moral wills, and most want to exercise choice and their autonomy. People have been conducting psychological experiments and observing animal behaviour in attempts to answer whether animals also have some capacity for free moral judgment. Based on animal research, it has been discovered that some animals are clearly self-aware such as higher apes, and some whales and dolphins. Chimpanzees have been taught to communicate in human languages, for example sign language or computer symbols. Some mothers also taught their babies how to "talk" to humans. This has given us a new way of looking at other species. Behaviour is determined by genes, environment, and moral choices.

In 1993, a book called "The Great Ape Project" (http://www.greatapeproject.org/) was published calling for equal rights for chimpanzees, gorillas, and orangutans with human beings (who are also a higher primate species). It is claimed that these four species of higher primates form a more natural group to confer ethical duties on, rather than humans as the only species having rights.

4.4 Is there any ethical justification for killing?

Are we justified in killing other living beings? How far do moral arguments justify the above claims? One significant difference between some animals and plants is the capacity to feel pain as we know it. Beyond the motivations behind what we are doing, another important criteria we use in judging the use of animals is avoiding the infliction of pain. Beings which feel pain are called sentient beings. In practice one important criteria we may use in judging the use of animals is how much pain is caused.

Pain is more than simple sensation of the environment. While plants do send ionic potential signals in response to harm, similar in some ways to action potentials in animal nerves, the difference is in the processing of those signals to become the perception of pain. Some distinguish pain from "suffering", but they are both departures from the ideal of avoiding harm. Suffering can be defined as prolonged pain of a certain intensity, and it is claimed that no individual can suffer who is incapable of experiencing

[10] Please refer to EETAP WG2 report on "Ethical Worldviews of Nature".

pain. The capacity for suffering and/or enjoyment has been described as a prerequisite for having any moral interests.

Judging pain is subjective, and there are parallels in the way non-human animals and humans respond. Many of the neurotransmitters are similar between higher non-human animals and humans. It is possible that animals do have a different quality of "pain", as the frontal region of the cerebral cortex of humans is thought to be involved in feelings of anxiety, apprehension, suffering and other components of pain. This region is much smaller in animals, and if surgically treated in humans it can make them indifferent to pain. There are differences seen in the types of pain receptors; some respond to mechanical stimuli, some to noxious or irritant chemicals, and some to severe cold or heat.

Let us consider some of the other factors that people use when discussing the ethical treatment of animals. We can think of ethical factors within an organism itself (intrinsic factors), and others that are external to it (external factors). A summary of some factors for judging animal use is in the table below. We can see there is value in something being alive when we observe the way most people protect life. Various qualities in animals increase their ethical status, including the capacity to feel pain, self-awareness, being conscious of others, and an ability to plan for the future. Extrinsic factors that are important include human sensitivity to suffering, or the effects of upsetting other animals. Being cruel to animals may also lead to brutality towards people. There is debate over what is the natural way to treat animals, as it changes between cultures.

Intrinsic Ethical Factors	**Extrinsic Ethical Factors**
- Pain - Self-awareness - Conscious of others - Ability to plan for the future - Value of being alive	- Human Necessity / Desire - Human sensitivity to animal suffering - Brutality in Humans - Effect on other animals - Religious status of animals - What is natural

4.5 Luxury or necessity?

Many extrinsic factors are important in deciding whether it is ethical to use animals or not. Destruction of nature and life by humans is caused by two human motives - necessity (needs) and desire (wants). It is more ethically acceptable to cause harm if there is some necessity for survival than if there is simply desire for more pleasure.

If we are going to harm life, a departure from the ideal of doing no harm, or love of life, it should be for a very good reason. Such a reason might be survival, and we can see this as natural - all organisms consume and compete with others. Plants compete with each other for space to grow, animals eat plants or other animals, bacteria and fungi also compete for resources and space - sometimes killing other organisms, at other times competing without killing, and also cooperating in mutual symbiosis. This distinction is required ever more as human desire continues to destroy the environment of the planet, including many endangered animal species, and even whole ecosystems.

Certain religions give special status to some animals, for example, the Hindu religion gives cows a high status so that few Hindu persons will kill cows for food. This also means that, in India, animals are not used in school experiments. There is a trend in all countries for less use of animals in schools for teaching, and experimentation.

It is said that, for the Eskimos, the killing of animals for the sake of food is necessary. This means for the survival of one's own existence, it is accepted. But is it so for other human beings too? Is this the case where intensive agricultural production is the main source of local food production? There is no proof that consumption of animal flesh is necessary for good health or longevity of human beings provided that proper plant nutrition is gained. Actually lower metabolic intake is associated with longer life in animal studies.

4.6 Ethical issues arising from intensive meat production

Intensive meat production raises further ethical issues, including those related to animal living conditions. Most animals in these systems are made to lead miserable lives so that their muscle and fat can be made available to humans at the lowest possible cost. Modern forms of intensive farming apply science and technology with the attitude that animals are objects for us to use. In systems which choose low cost over life, society tolerates methods of meat production that confine sentient non-human animals in cramped, and arguably often very unsuitable conditions for the entire duration of their lives.

The discussion of recent scientific analyses in the previous chapters of this report demonstrates that from an energy conversion perspective, meat eating is not an efficient way of producing food. Animal production in industrialized societies is based on consumption of animals that have been fattened on grains and other foods that we could have eaten directly. Animals are treated like machines that convert fodder into flesh, but when we feed these grains to animals, only about 10% of the nutritional value remains as meat for human consumption. So, with the exception of animals raised entirely on grazing land unsuitable for crops, animals are eaten neither for health, nor to increase our food supply. Although any innovation that results in a higher "conversion ratio" is liable to be adopted, it is ironic that the actual energy conversion ratio chosen by use of animals is inefficient compared to vegetable production.

Alternatives to intensive methods can be developed. Some consumers demand to know that the meat they are eating was not produced by industrialized or intensive farming methods. The following problems are to be viewed from ethical perspective. In Switzerland, hens are not kept in cages. For the sake of cheaper prices, there are other things done to animals. One such thing is castration. Another is the early separation of mother and young, the breaking up of herds, inhumane transportation methods and finally the moments of slaughter - all of these involve suffering.

The ethical issue here is whether the animal biomass could be produced without suffering and because the killing does not take place painlessly – most of the killing does not take place under conditions that even approximate an ideal.

Though the above ethical issues are important, one can also raise some counter questions such as the fact that in ecosystems animals eat each other. Should human beings behave as carnivores, omnivores, or herbivores?

It is argued by Peter Singer, that throughout the world, nonhuman animals have been seen as beings of no ethical significance or at best, of very minor significance. Aristotle thought animals exist for the sake of more rational humans, to provide them with food and clothing. Thinkers like Descartes argued that animals do not suffer. Kant thought only rational beings can be an end in themselves and that animals are mere means. But history shows some exceptions too. For example, Montaigne challenged human arrogance and Hume said that we owed "gentle usage". The strongest dissent to the dominant view came from the British utilitarian thinkers like Bentham, Mill, and Sidgwick, each of whom insisted that the suffering of animals matters in itself. Bentham argued about the rights of animals. Over the past thirty years there has been much rethinking about these philosophical concepts and philosophers from a variety of ethical traditions have rejected the traditional view of the status of non-human animals.

Philosophers have tried to bridge the ethical gap between animal life and human life. Some have rejected the assumption of the priority of human interests as "speciesism". By using the term, they make an analogy between our attitude toward other species and the earlier, now discredited, attitude of racism toward members of other races. As a result of this, we have to alter radically our practices regarding animals, including our practice of routinely raising them for food.

4.7 The replaceabiliy argument

The replaceability argument is related to utilitarian theory. The basic principle of utilitarianism is called the "principle of utility". This principle has several formulations in Bentham and Mill as well as in utilitarianism after them. The principle can be stated as follows: "The morally best alternative is that which produces the greatest or greater net utility, where utility is defined in terms of happiness or pleasure." We ought to do that which produces the greatest amount of happiness for the greatest number of people.

One version of utilitarianism is the "total" view which justifies meat-eating. The 19^{th} century British philosopher Leslie Stephen said "Of all the arguments for vegetarianism none is so weak as the argument from humanity. The pig has a stronger interest than anyone in the demand for bacon. If all the world were Jewish, there would be no pigs at all".

Stephen views animals as if they were replaceable, and with this those who accept the total view must agree. The total version of utilitarianism regards sentient beings as valuable only in so far as they make possible the existence of intrinsically valuable experiences like pleasure. The argument here is that although meat-eaters are responsible for the death of the animal they are also responsible for the creation of more animals, since if no one ate meat there would be no more animals bred for fattening. The loss meat eaters inflict on one animal is thus balanced, on the total view by the benefit they confer on the next. This is "replaceability argument".

Two points emerge from the replaceability argument:

1. Even if it is valid when the animals in question have a pleasant life it would not justify eating the flesh of animals reared in modern factory farms, where the animals are so crowded together and restricted in their movements that their lives seem to be more of a burden than a benefit to them.
2. If it is good to create happy life, then presumably it is good for there to be as many happy beings on our planet as it can possibly hold. Supporters of meat-eating had better hope that they can find a reason why it is better for there to be happy people rather than just the maximum possible number of happy beings, because otherwise the argument might imply that we should eliminate almost all human beings in other to make way for much larger numbers of smaller happy animals.

The above two points actually weaken the replaceability argument. For example, Henry Salt in his book, *Animals' Rights* shows how the argument rests on a simple philosophical error. He says that the argument attempts to compare existence with non-existence. A person who is already in existence may feel that he would rather have lived than not, but he must first have the terra firma of existence to argue from. Peter Singer who accepted the position of Salt now rejects it.

Derek Parfit describes another situation which amounts to an even stronger case of the replaceability view. He asks us to imagine that two women are each planning to have a child. The first woman is already three months pregnant when her doctor gives her both and bad news. The bad news is that the fetus she is carrying has a defect that will significantly diminish the future child's quality of life. The good news is that the defect can be rectified by taking some tablets. The second woman who sees the doctor before her pregnancy, when she is about to stop using contraception also receives bad and good news. The bad news is that she has a medical condition that if she conceives a child within the next three months, that child will have a significant defect which is not treatable. The good news is that the woman's condition is a temporary one, and if she waits three months before becoming pregnant, her child will not have the defect. The above two arguments points out the ethical dilemma and the replaceability argument is not right always.

The above arguments clearly show that there is an exploitation of animals by humans. We assign low moral value to animals. What Singer says in the following passage is very significant here: "… a vast social practice in which the most powerful group exploits the less powerful and builds ideological justifications for what it does. From this perspective there were familiar analogues situations, foremost among them in the enslavement of Africans by Europeans. ". Thus non-human animals are on this view another aggrieved group being subjected to unjustifiable discrimination by a privileged group, i.e., humans with the power to indulge their urge to discriminate.

According to some philosophers, *sentience* is the key to the ethical status of animals. Some philosophers look to the utilitarian Bentham, who wrote that to know the ethical status of animals, we need not ask if they can speak, but only whether or not they can suffer. Besides feeling pleasure and pain, many animals also experience types of emotions such as fear and anger. Unlike the philosopher Descartes, we do not think that all animals are machines devoid of an inner sense or consciousness. Because of their sentience, we have laws that protect animals from cruelty. What counts as cruelty, however will be disputed. Whether caging certain animals, for example is cruel is a matter upon which many philosophers will disagree.

Many people disagree about the reasons why we ought not to be cruel to animals. Some believe a major reason is the effects on those who are cruel. If one is cruel to a sentient animal, then will he or she become more likely to be cruel to people as well? It is one thing to say that the suffering of a non-human animal, just as the suffering of us humans, is a bad thing in itself. It is another to say that we or the non-human animals have a right not to be caused to suffer or feel pain. To know what to say about the question of animal rights, we need to think a little about what a right is or what it means to have a right. A right is generally defined as a strong and legitimate claim that can be made by a claimant against someone.

In his important paper, “All Animals are Equal”, Singer argues in favour of moral expansionism. He examines the reductionist attitude of human beings towards nature and other beings. By criticizing human speciesism, he says: “The suffering we inflict on the animals while they are alive is perhaps an ever clearer indication of our speciesism than the fact that we are prepared to kill them.” Thus criticizing anthropocentric ethics, he shows the moral right of the other living beings on earth. By developing “ethical sentientism”, Singer supports an inclusive expansive ethical theory, which takes into account animals also.

At the other end of the spectrum is the position that non-human animals have no rights or moral standing and thus can be used. In the middle is the belief that animals have some moral status and thus limits and restrictions should be placed on conducting research with these creatures. But here it should be noted that those who support animal rights sometimes agree that the uses of animals in experimentation can be ethically supported if they “serve important and worthwhile purposes”. They may be justified if they do so, help us develop significant medical advances, if the information cannot be obtained in any other way, and if the experiments are conducted with as little harm for the animals as possible. The use of non-human animals for food, entertainment, clothing and the other purposes will probably need to be considered each on its own terms. In this context it must also be noted that it is the duty of the human society to take care of endangered species. According to the World Wildlife Fund (WWF), “without firing a shot, we may kill one-fifth of all species of life on this planet in the next twenty years.” We do this primarily by destroying their habitats. The Global 2000 Report asserts that within a few decades we will lose up to 20 percent of the species that now exist if nothing is done to change the current trend.

4.8 Ethical issues arising from the interactions of selected meat companies in the Philippines that use industrialized production

This section examines in detail the Philippine case study described in section 3 above. Meat as food is inexorably linked with culture, health and environment. Agriculture falls in between different value areas of “environment” connected with plants, animals, ecosystems and landscapes; “production” which is connected with farms, food chains, and distribution and; “consumption” values which are attached to lifestyles, health, food security and food safety (Korthals, 2001). The four companies described previously in section 3 have interweaving functions and roles in relation to the existing production, distribution and consumption of meat in the Philippine socio-economic, political, environmental and ethical context. The following section identifies some ethical issues which arise from such interactions. Of course, there is no "one size fits all" approach to dealing with the ethical issues involved in intensive hog and poultry production in even just the case studies described in this report, but as mentioned by Bhardwaj et al. (2003) "specific opportunities" can be identified to tackle some of the ethical issues.

1) Non-transparency

During their study on meat production in the Philippines, Costales *et al.* (2003) encountered problems such as unwillingness of producers to be interviewed and secrecy. The integrators of the producers from Central Luzon did not allow producers to share information as well. Throughout the Philippines, the situation is the same: in Southern Luzon, contract production farms were unwilling to participate in interviews upon the order of the management.

The four meat companies presented in this paper are a subset of fifteen food companies within the vicinity of Laguna Lake invited to participate in determining the integration of Environmental Education and levels of Responsible Environmental Behaviour of their employees (Manzanero, 2008). Formal letters of invitation to participate in this study were sent and endorsed by the thesis adviser from the University of the Philippines College of Education. Distributed together with the invitation was a sample survey questionnaire and interview questions, part of which included items on the company's existing values, norms, environmental programs and policies. Data gathering took place from August 2007 to August 2008. Follow up was done through e-mail, telephone calls and meetings with employees working in these food companies when given the chance. Copies of the invitation and sample survey questionnaires were furnished by this author to other e-mail addresses as additional evidence that the invitations had been sent to the main recipients.

Common to all fifteen food companies was the unwillingness to participate in the study on determining integration of EE and identifying their employees' Responsible Environmental Behaviour. Additionally, all fifteen companies, except one, did not share their existing policies and programs related to the environment. The exception was a multi-national company that had published its strong Corporate Social Responsibility through the internet (Manzanero, 2008).

Their unwillingness to disclose information is a clear indication of non-transparency. Transparency according to Oliver (2004) demands *"active disclosure"* including communicating essential information in a timely and convenient fashion and providing fast, inexpensive means of getting feedback to the stakeholders such as employees, customers, constituents, shareholders, community leaders which tell the organization what it is doing well and what it needs to work on. In the case of these four meat companies, the author found it difficult to find out if there is specific environmental Education training being conducted or other environment-related topics that can enhance responsible environmental behaviour as well as develop environmental ethics. With this current situation, environmental transparency plays a critical role in accessing pertinent information that can fill in this existing in the business environment, particularly in highly polluting food companies.

Strauss and Bradshaw (2003) described that in the word *"trust"*, transparency, ethics, and the support of social values are incorporated. This non-disclosure of information by these food companies is an issue of trust. Just like the experience of Costales *et al.* (2003), the case of these four meat companies reiterated the existing behaviour of not engaging in proactive communication, of being non-transparent and thus, cannot be trusted in the way they operate as regards the environment.

It is ideal that companies would be transparent to the shareholders and that all the shareholders would receive simultaneously the same information (Cory, 2004). In this experience with the four meat companies, we need transparency to access pertinent information, otherwise, it will be difficult to safeguard the interests of the environment. These food companies can be made accountable in the way they operate through environmental stewardship and social responsibility. Through corporate governance there can be alignment of the interests of individuals, corporations and society and focusing on the importance of the relationships that companies have with stakeholders (Andriof, Waddock, Husted and Rahman, 2002).

2) Lack of integration of environment in company values and lack of concern for the environment

Three of the four companies shared their company values, except for Company B. Please see Table 8 for details. Of those which shared, it was clear that valuing or protecting the environment was not included. All of them did not explicitly state that their goals include an intention to value and protect the environment as they conduct their "business as usual" activities. How then can the employees of these companies imbibe a culture of high level of responsible environmental behaviour as described by Sia, Hungerford and Tomera (1985/86) if the companies they work with do not promote such environmental values? This becomes an ethical issue since Curry (2006) mentioned that people will not treat properly whoever or whatever they do not care about.

Moreover, how then can environmental concerns be effectively communicated and integrated in the decision-making on the food companies' operations if these are not upheld in their company values? Lastly, how then can the transition of highly polluting meat companies be facilitated to make them stewards of the environment given the lack of transparency existing among them?

3) Sustainable development

The components of sustainable development include environmental stewardship, economic prosperity and social responsibility (Andriof, Waddock, Husted and Rahman, 2002). Using these indicators, Company A is focused on achieving economic prosperity as indicated by aiming to be globally recognized through having more branches in other countries. However, it has been lagging on environmental stewardship and social responsibility by intentionally dumping untreated wastewater in Laguna Lake of one of its branches which belong to LLDA's top worst polluter in 2007 while four of its branches belong to LLDA's horror list.[11]

[11] Yap, D.J. "Top fast food chains among worst Laguna de Bay polluters," August 17, 2007. http://www.inquirer http://www.inquirer.net, accessed 12 August 2008.

Company B is the only one with existing Corporate Social Responsibility even though it does not have Market-Based Instruments implemented in the Philippines. As the world's largest chicken restaurant chain, it practiced integrated poultry management. Although it has no processing plant in the Philippines, its three multi-national suppliers have been accused of multiple complaints regarding the welfare of chicken being raised and processed. In one of its processing plants in Asia, it processed some 32.6 million birds, 41.547 metric tons (MT) of processing products and 13.453 MT of further processed products and 5,395 MT of de-boned meat in 2006. With this quantity, it is surely geared towards economic prosperity. One of its fast food branches in the Philippines was found to exceed wastewater standards and in an entire year of operation, LLDA found out that it exceeded the effluent standards five times.[12] Violating environmental laws five times is a clear indication of disregard for the existing environmental laws in the country and clearly reflects lack of environmental ethics.

Company C had been awarded as Outstanding Meat Processor for five consecutive years from 1999 to 2003. It was awarded as the best meat processing plant for three consecutive years (1999, 2000 & 2001) by the Agriculture Department through the National Meat Inspection Commission and recognized as most improved supplier 2005. This company implements Good Manufacturing Practices (GMP) and Standard Sanitation Operating Procedures (SSOP) and had three of its products Hazard Analysis and Critical Control Point (HACCP) certified. Although it has no known violation, majority of its supply of raw pork came from Bulacan (a province of the Philippines) wherein its Marilao and Meycauyan Rivers were reported by EMB-DENR as highly polluted (EMB, 2005 as cited in Orejas and Reyes, 2008).

Among the four companies, Company D is the only one which operates and processes both pork and chicken. Aside from that, it produces feeds from protein-rich by-products of brewing beer and has operations related to dairy, feeds and livestock. Integrated poultry operations began in the 1970s and eventually started commercial feed business. It managed feed and livestock in 1991 and through vertical integration, it provided value-added business by the direct selling of fresh meat to franchise meat shops and supplying its branded products in supermarkets, groceries and other retailers. In its long history of existence in the Philippines, it has established itself in terms of economic prosperity and has strong social responsibility. However, more information is needed regarding its environmental stewardship since it is does not disclose information of its various livestock and poultry operations and integration activities being run in the entire country. The difficulty in accessing pertinent information encountered by Costales *et al.*(2003) is still happening (Manzanero, 2008). For these four meat companies, while economic and legal responsibilities are required, moral responsibility is expected.

4) Stewardship

Worrell and Appleby (2000) define stewardship as "the responsible use of natural

[12] GMA News," Food establishments ordered closed for wastewater violations," May 5, 2006. http://www.gmanews.tv/story/7304/Food-establishments-ordered-closed-for-wastewater-violations, accessed 26 November 2008.

resources in a way that takes full and balanced account of the interest of society, future generations and other species, as well as private needs, and accepts significant answerability to society." Using this definition, how accountable are the four meat companies in the communities in which they operate and to the consumers they cater to? Take for example Company A and Company B which operate many branches in quick service and serve thousands of chicken everyday. Both had records of violations by directly contributed to increasing pollutant loading of Laguna Lake. In terms of animal welfare issues, Company B still continues to get its supply of chicken from three multi-national suppliers which have not been responsive to the issues they are facing. There is no study yet that has been conducted on how much solid wastes are being generated by both of these companies from all of the operating branches in the Philippines and on mitigation measures. There is also lack of data available on the health implications of their products to their loyal consumers and so far, no adequate information has been disseminated on nutritional information and labeling. The burden of being informed had been passed on to the unwary consumers.

Unlike the previous two companies, Company C and Company D have complied with the required nutritional labeling for their branded products distributed to the consumers thru retailers such as groceries, supermarkets, wet and dry markets, franchise dealers and others. However, little is known on how these distributed meat products have been farmed since both companies are very secretive about their suppliers, contractors and integrators. For all four meat companies, the implications of the filing of GMO labeling law in the Philippines are yet to be determined.

Table 8. Meat Company Values, Environmental Transparency and their Operations

Company	Food Company Characteristics				Production Operations	
	Description	**Values / Norms, Policies / Programs related to the environment**	**Transparency**	**Compliance with Regulations and Application of Market-Based Instruments**	**Description**	**Effects on the Environment**
A	• Belongs to Philippines top 500 corporations • Commissaries located in Pasig, Cebu, and Laguna • produces 150,000 chicken; 480,000 both for hamburger patties and bread per day • 1,655 stores worldwide and 1,466 stores in the Philippines	• Customer Focus • Excellence • Respect for the Individual • Teamwork • Spirit of Family and Fun • Humility to Listen and Learn • Honesty and Integrity • Frugality	Not willing to disclose company information on policies / programs	• 1 branch belongs to top 26 worst polluters of Laguna de Bay in 2006 • 4 of its branches belong to LLDA's horror list of polluting companies • Pasig commissary awarded an ISO 9002 in 1998	• Supply chain made up of commissaries and distribution centers all over the country • Has 16 commissaries as of Feb 2008 and has Corporate Supply Chain Unit in Laguna •	• Contributed to increasing pollutant loadings in Laguna Lake
B	• World's largest chicken restaurant chain and the third	No available information	Not willing to share information on Values / Norms	• 1 branch listed in LLDA horror list in 2006	• It practiced integrated poultry operations with three	• 1 branch in Libis found to exceed wastewater standards in terms

	largest fast-food chain in 2000 which operates more than 10, 800 restaurants in 85 countries • With 150 outlets of chickens and donuts		and Policies / Programs	• 1 plant ordered to close down • No known Market-Based Instrument implemented but has CSR (Corporate Social Responsibility	multinational suppliers but operates no processing plant in the Philippines • The Malaysian plant processed some 32.6 million birds, 41.547 metric ton (MT) of processing products and 13.453 MT of further processed products and 5,395 MT of de-boned meat in 2006	of the BOD, COD, pH level and oil and grease content of its effluents • In entire 1 year of operation, LLDA found out that it exceeded the effluent standards five times
C	• Manufacturing processed meat products such as corned beef, hotdog, meat loaf, hamburger patties, ham • A leader in meat toppings production and canned meat processing • Has its line of branded	• Pursuit of quality • Customer focus • Pursuit of ideals of Total Quality Management Principles of Food Safety • Employee development, • Teamwork, Cooperation and mutual Trust and Respect	Not willing to disclose company information on policies / programs	• No known violation • Outstanding Meat Processor for five consecutive years from 1999 to 2003 • Awarded Best Meat Processing Plant for three consecutive	• Supplier of popular food chains which are considered global leaders in chicken, hamburger, quick-service seafood, pizza and Mexican-style food categories	

	products sold in groceries and supermarkets			years (1999, 2000 & 2001) by the Agriculture Department through the National Meat Inspection Commission • Recognized as most improved supplier in the 3rd Asia Franchise Awards held in Singapore last 2005 • Three of its products are HACCP certified in 2009		
D	• An integration of two institutions in the food and beverage industry • Markets chicken, pork and beef to the manufacture of	• Integrity • Customer and market focus • Teamwork and respect for the individual • Strong competitive spirit	Not willing to disclose information on policies / programs	• No known violation • ISO 9000 certified • Cavite facility awarded the Best Meat Processing Plant (triple A category),	• Produce feeds from protein-rich by-products of brewing beer and has operations related to dairy, feeds and livestock. • Integrated poultry	

	refrigerated, canned and ready-to-cook meat products, butter, cheese, margarine, oils and fats, as well as animal and aquatic feeds • Entered into food service business in 1996	• Passion for excellence.		Marikina's Abattoir the National Winner in the Triple A Slaughterhouse Category • Marketed Halal in 1995	operations began in the 1970s and the first chicken processing plant was set up in Muntinlupa. It managed feeds and livestock in 1991. • Thru vertical integration, it provided value-added business by direct selling of fresh meat to franchise meat shops • The other institution is on processing that ventured into poultry business via fully integrated operations in 1983 and later on started commercial feed business	

5. Discussion and policy options

5.1 Progressive policy options need to be considered

Rising per capita income and urbanization will result in rapid increases in the demand for meat and animal-based products in Asia. Intensification of meat production requires large inputs of fossil energy and results in numerous negative externalities that have far-reaching effects on air, soil, and water quality and global climate change. In some countries the total energy input far exceeds food energy yield. Intensive meat production poses significant risks to public health, and increases the risk of infectious disease pandemics.

Although it may be considered to have succeeded economically, largely because the full costs of production and consumption have never been accounted for (McMichael and Bambrick, 2005), more open and clear discussion is required in regard to the manner by which these systems have been operating until now. Analysis and discussion should include better accounting of the energy requirements and the negative externalities incurred, as well as where opportunities may exist for attempts at cost internalization, even though this may be challenging (Buttel, 2003). Learning from the experiences of the U.S. and elsewhere, developing Asian economies may want to carefully examine the ramifications of using the environment as a sink for pollution for increasing the scale of their meat production operations and it may be prudent for these countries to consider their policies in regard to future investment in and promotion of such systems.

Importantly, the rapid increase in meat consumption in developing countries will occur mostly in the economically advantaged populations and not in the nutritionally deprived populations even though it is the latter population that would benefit from a modest increase in meat intake. At the same time, it is the former population that will become the new over-consumers of cheaply-produced meat, putting them at risk for the chronic diseases now endemic in the developed countries (McMichael and Bambrick, 2005).

Many groups are calling for urgency in addressing meat production and consumption globally and there is widespread agreement that meat production is a major concealed cause of far-reaching and serious environmental, public health and socioeconomic problems (Akhtar et al., 2009; Cole et al., 2000; Gossard and York, 2003; Horrigan et al., 2002; McMichael and Bambrick, 2005; Koneswaran and Nierenberg, 2008; Walker et al. 2005). Steinfeld et al. (2006) refers to the livestock production sector as “one of the top two or three most significant contributors to the most serious environmental problems, at every scale from local to global” and goes further to say that “[the livestock sector] should be a major policy focus when dealing with problems of land degradation, climate change and air pollution, water shortage, water pollution and loss of biodiversity.”

Effective public policies are essential to ensure that livestock contribute to broad development goals and minimise damage to social equity, the environment and public health. Policy decision-making whether at the national, regional or international level should be cognizant of existing customary laws, territories, traditions, customs and institutions of local communities and indigenous peoples.

Both existing international policies and new ones that influence intensive livestock production should be considered.

5.2. ISO certification, EMS, and GMP to promote international competitiveness

The public’s demand that corporations deal with environmental quality, health and safety and social justice in a systematic, integrated and strategic way is usually met by implementation of Corporate Social Responsibility (CSR) (Kuhre, 1998). Environmental Management Series (EMS) is a business management practice that companies can implement in pursuit of CSR. It is a planning and implementation system which focuses on the company’s production processes and general management system and can be adapted by a company to manage the way it interacts with the natural environment (Cheremisinof and Bendavid-Val, 2001). Examples of global EMS are the British Standards Institutions BS 7750 which served as the point of departure for developing ISO 14001 and the European Union’s EMAS (Eco-Management and Auditing Scheme) which permits ISO 14001 to serve as its core EMS component (Cheremisinof and Bendavid-Val, 2001).

The International Organization for Standardization (ISO) is a federation of national standards bodies representing about 130 countries (ISO, 2009). It promotes international standardization which facilitates international exchange of goods and services and promotes international cooperation in the sphere of intellectual, scientific, technological, and economic activities. ISO standards are technical agreements which provide the framework for compatible technology worldwide.[13] For example, the ISO 9000 series is for developing and encouraging international standards for quality management systems while ISO 14001 is for EMS that entails commitment to comply with all applicable environmental regulations, to improve

---

[13] International Organization for Standardization (2009), “International Standards for Business, Government and Society,” http://www.iso.org./iso/iso_catalogue/catalogue_ics/catalogue_detail_ics.htm?ics1=67&ics2=120, accessed 3 May 2009.

environmental performance even beyond what is required by law, and find creative ways of reducing pollution at source and commitment to continual improvement on standards in the EMS (Marcus and Willig, 1998).

For the livestock sector, widespread adoption of ISO means that suppliers can develop and offer products and services meeting specifications that have wide international acceptance. For the consumers, the worldwide compatibility of technology guarantees safety, quality and reliability. For the government standards from ISO provide the technological and scientific bases underpinning health, safety and environmental legislation. "Conformity assessment" means checking that products, materials, services, systems, processes or people measure up to the specifications of a relevant standard or specification. Their use contributes to the consistency of conformity assessment worldwide and so facilitates trade.

Good Manufacturing Processes (GMP) established by U.S. F.D.A. includes the fundamental principles, procedures and means needed to design a suitable environment for the production of acceptable quality which minimize or eliminate instances of contamination, mix-ups, and errors (GMP Institute, 2008). Manufacturers, processors, and packagers of drugs, medical devices, some food, and blood are to take proactive steps to ensure that their products are safe, pure, and effective. The U.S. F.D.A., under the Federal Food, Drugs and Cosmetic Act, had identified definitions and standards for food, adulterated food, misbranded food, dietary supplement, labeling exemptions, disclosure emergency permit control, regulations making exemptions tolerances for poisonous ingredients in food, oleomargarine or margarine tolerances and exemptions for pesticide chemical residues, food additives, bottled drinking water standards, vitamins and minerals requirements for infant formulas, new dietary ingredients, maintenance and inspection of records, registration of food facilities, and sanitary transportation practices. Strict requirements of U.S. and other countries require that products entering them implement GMP.

5.3. Codex Alimentarius and HACCP on food safety

FAO and WHO established the Codex Alimentarius Commission[14] in 1963 and it has produced 250 commodity standards and more than 40 hygienic and technological codes of practice as reference points in determining food standards. There is a special status given to Codex standards, guidelines and recommendations by the Sanitary and Phytosanitary measures (SPS) agreement and the agreement on

[14] http://www.codexalimentarius.net/

Technical Barriers to Trade (TBT) in response to strict requirements on sanitation and hygiene and stiff competition in the foreign market. Through harmonization, the Codex Alimentarius aims to protect the health of consumers and ensuring fair practices in the food trade and had produced the Code of Ethics for International Trade in Food (FAO, 2006.).[15] The code of ethics is available for implementation into policy.

5.4. World Organization for Animal Health (OIE) Guidelines

OIE is made up of 167 member countries and is an intergovernmental organization created to guarantee the transparency of animal disease status worldwide. It has become the international reference for animal welfare in the trade of animals and products and the control of eradication of animal diseases.[16] OIE guidelines are used as bases for bilateral agreements between OIE member countries as well as for the development of national and regional assurance programs (OIE, 2006). The codes of welfare or standards which aim to ensure that the needs of terrestrial (especially intensive pig and poultry) and aquatic animals are met by setting minimum requirements for treatment of animals throughout the production process. This was agreed on during the 76th General Session in May 2008 of the OIE.[17] These codes of welfare and standards are available for implementation into policy.

5.5. Investment instruments in agricultural development that include livestock production operations

The financial emphasis of global production influences food production systems (Bello, 1998).[18] In the Philippines, the Omnibus Investment Code of 1987 granted exemption from all taxes and duties in addition to the fact that tax credit

---

[15] Codex Alimentarius Commission, "Current Official Standards," http://www.codexalimentarius.net/web/standard_list.jsp, accessed 3 May 2009.

[16] World Organization for Animal Health (OIE, 2006), Terrestrial Animal Health Code-2006, part 3, section 3.7. www.oie.int/eng/normes/mcode/en_titre_3.7.htm, accessed 3 May 2009.

[17] World Organization for Animal Health (OIE), :Terrestrial Animal Health Code 2008, Volume 1,http://www.oie.int/eng/normes/MCode/a_summry.htm, accessed 3 May 2009.

[18] Bello, W. (1998), "The GATT Agricultural Accord and Food Security: The Philippines Case", http://focusweb.org/publicatons/1998 / /publications/1998/The%20GATT%20Agricultural%20Accord%20and%20Food%20Security.htm, accessed 3 May 2007.

equivalents were given to Filipino and foreign-owned companies that imported breeding stocks. The Foreign Investment Act's promotion of lower tariffs on minimum access volume (MAV) imports of corn was favoured by large-scale feed mills, broiler integrators, large-scale commercial hog and poultry firms (Costales et al., 2003). These subsidies and regulations implemented by the government contributed to the intensification of livestock production and favored companies and not the farmers or consumers.

The development of smallholder agriculture is often paralyzed by their dependency on one product, on buyer monopoly, on a single source of input and credit, and on a market that is dominated by a few countries and corporations (Gura, 2008). In a study carried out by the NGO Focus on the Global South pertaining to livestock smallholders in Thailand, those who were urged to leave behind their traditional methods and engage in industrial farming ended up earning less than their minimum wage (Gura, 2008).

Entry of corporate livestock farming into the developing countries caused displacement of traditional smallholders, irreparable socio-economic, genetic and environmental damage and threat to food security (Gura, 2008). However, the contents and impact of contract farming in regard to sharing of market risks were difficult to assess because contract farmers are obliged to keep the contents secret (Costales et al. 2003; Gura, 2008). Each country could assess the situation through research and evaluation.

5.6. Sustainable livestock production

Challenges faced by intensive livestock production include waste production, gas emission, higher demand for feed as well as increasing the need for cultivation, and the pressure for genetically uniform stock which results in a reduction in biodiversity. Its social, cultural and economic impacts still need to be examined. Environmental costs related to livestock production may be mitigated by aligning farming systems with the land's ability to absorb nutrient surpluses, practicing sustainable rotational farming, and by using improvements in technology to enhance the digestibility of key nutrients (CIWF, 2002).[19]

Developing policies related to livestock production should provide opportunity for meaningful participation of various stakeholders. Human and institutional

[19] Compassion in World Farming, 2002. "Impact of Livestock Farming," http://www.ciwf.org.uk/includes/documents/cm_docs/2008/i/impact_of_livestock_farming.pdf, accessed 4 May 2009.

arrangements that could facilitate the process as well as the dynamics of engagements such as a systems of care model as put forth by Lejano (2008) wherein a web of relationships are nurtured and are more effective than bureaucratic-organizational models may be considered. There are 640 million smallholders and 190 million pastoralists raising livestock (Steinfeld et al., 2006). The role of these smallholder systems as basic units of social organization with unique cultural identity has to be considered when national and international policies are implemented. The small-scale family farms hold the key to more productivity, environmental sustainability, and more employment (Gura, 2008). Access to quality breeding services of farmers should be guaranteed as well as appropriate breeding policies. Any changes to husbandry practices need to consider local communities' knowledge, experience and beliefs, as well as the demands of the international food supply chain (Ryan, 2006).

A shift in perspective supporting reduction in meat production and consumption in high consuming countries coupled with more environmentally sustainable and humane livestock systems worldwide has also been discussed (CIWF, 2002). This can be considered in each country.

5.7. The role of livestock in poverty alleviation and promoting nutritional adequacy

Livestock production is not for income generation, but rather should serve as means to reduce poverty, hunger and malnutrition as well as social and economic inequalities. Livestock production can benefit poor rural communities by enhancing food security, providing employment, and reducing the risk of social instability. Current policies such as those implemented by financial institutions are biased to large-scale companies operating in livestock production. A re-orientation of policies recognizing customary laws, traditional knowledge, customs and practices of local communities and indigenous peoples who participate in livestock production should be considered.

5.8. Role of institutions in promoting food safety and environmental protection

Many policies and programs have already been in place in relation to food safety. However, concrete policies that promote environmental protection, mechanisms to evaluate impacts of intensive livestock production and existing mitigations need further discussion. The environmental damage caused by intensive livestock production has hardly been assessed in economic terms. Importing countries should compensate producer countries for the ecological footprint of the products.

Involvement of multiple stakeholders to augment the research process and outputs has to be considered while taking into consideration the unique characteristics of the communities directly or indirectly affected by livestock intensification. The need for transparency among private and public partnerships is also necessary.

5.9. Research in livestock farming, meat production and processing technologies that are considerate of animal welfare

Animal welfare is linked to human health and prosperity. An animal in a poor state of welfare may suffer from discomfort, distress, or pain, which may compromise its ability to grow, survive, and produce or reproduce. The health and well-being of animals can have a direct impact on growth, reproduction, or meat quality, and is therefore important to producers, food retailers, customers, and others in the supply chain. When not properly handled, down-grading of carcasses and lower quality cuts result. Bruised meat (and the carcass) has a higher pH value and may be considered unfit for human consumption. Bruised chicken meat is more prone to microbial contamination. Animals stressed prior to slaughter tend to have depleted glycogen stores in their muscles—leading to muscle that has a higher pH value and is likely to be dark-cutting, objectionably dark in color, and prone to microbial spoilage.

Better management of and care for livestock can improve productivity and food quality, thereby helping to address nutritional deficiencies and food shortages as well as ensuring food safety. Breeding objectives should be assessed not only by production characteristics, but also by rates of injury, disease, and mortality in both breeding stock and offspring. In broiler chickens, genetic selection and manipulation for fast growth has led to unacceptably high rates of leg disorders, acute and chronic pain, abnormal gait, respiratory infections, acute death syndrome, and other welfare issues. The “Five Freedoms” of the World Organization for Animal Health (OIE) serves as ideal guides in intensive livestock farming.[20]

5.10. Managing immediate risks and impacts related to animal health, such as the spread of avian influenza and swine influenza

Human health risks associated with livestock production and consumption may lead to disease transmitted from livestock to humans, environmental pollution, food-borne disease, risks and diet-related chronic disease (Catelo, 2006). Fear of the spread of avian influenza led to the slaughter of millions of poultry in Hong Kong

[20] Freedom from hunger and thirst ; discomfort; pain, injury or disease; fear and distress; and freedom to express natural behavior.

while the recent swine flu affecting 40 countries[21] caused stockpiling of flu medications. The state government in Idaho recommends that each state have enough of a stockpile of medications to treat about 25 percent of the population.[22] Asian nations agreed to increase their stockpiles of medicines against swine flu and urged WHO to ensure equitable access in case of a pandemic.[23]

The intensification of livestock production is exacerbating the risks of new emerging diseases, food borne diseases and zoonoses partly because the main industrial breeds of cattle, pig and poultry have been reduced to a narrow window of genetic diversity (Gura, 2008). The Global Early Warning System for Major Animal Diseases, including Zoonoses (GLEWS) is a collaborative effort of WHO, FAO and OIE.[24] Its activities include disease tracking, information sharing, data verification, disease analysis and response. Although its activities play a role in preventing global pandemics, these activities are not pro-active. Engagements involving representatives from various stakeholders may need to be carried out with focus on alternative solutions in addressing the health risks posed to humans by intensive livestock production and which addresses issues at their source, e.g. research that focuses on native breeds with higher immunity, exploration of sustainable livestock practices by small livestock holders, and the use of organic farming coupled with OIE's standards on animal welfare.

5.11. Case Study of Policies in the Philippines

This analysis of the policies in the Philippines does not make a statement about the relative situation of the issue in relation to other countries, but illustrates the issues presented in the case study contributed in this report. There are lessons on the way that different policies may actually be implemented, and on how they could be developed in this and other countries. Under the Clean Air Act of 1999, the concept "polluters must pay" became part of environmental policy. Stationary sources are required to pay fees determined based on the type of pollutant, the mass emission rate

---

[21]Allen, Paddy, 2009, "Swine flu: the affected Nations," May 12, 2009, http://www.guardian.co.uk/world/interactive/2009/apr/28/swine-flu-outbreak-mexico-pandemic, accessed 12 Ma7 2009.

[22] KTVB-TV, 2009, "Idaho stockpiling medicine to combat swine flu outbreak," May 1, 2009, http://www.msnbc.msn.com/id/30526805, accessed 4 May 2009.

[23] Agance-Frence Presse, 2009, "Asian nations to boost flu drug stockpiles," MSN News, May 8, 2009, http://news.sg.msn.com/regional/article.aspx?cp-documentid=3290856, accessed 9 May 2009.

[24]GLEWS, "Zoonoses and veterinary public Health," July 18, 2007, http://www.who.int/zoonoses/outbreaks/glews/en/, accessed 4 May 2009.

at the source, and the type of airshed (attainment or non-attainment) into which the emissions occur (Krupnick *et al.*, 2003). Some of the Philippine laws related to water use are PD 1067 ("The Philippine Water Code of 1976) and Republic Act No. 9275 ("The Philippine Clean Water Act of 2004"). These laws streamlines processes and procedures in the prevention, control and abatement of pollution of the country's water resources and promotes environmental strategies, use of appropriate economic instruments and of control mechanisms for the protection of water resources. It also has provisions for wastewater charge system, discharge permits, financial liability for environmental rehabilitation, clean-up operations, programmatic environmental impact assessment, environmental impact assessment system programmatic compliance with water quality standards.

Government agencies regulating pollution – Laguna Lake Development Authority (LLDA)

The Environmental Management Bureau of the Department of Environment and Natural Resources of the Philippines is the authorized agent on stationary emissions sources that regulate permits, review environmental impact statements (EIS), monitor and inspect compliance with intensity of industrial production. The Laguna Lake Development Authority (LLDA) has been mandated to regulate the activities that pollute the largest freshwater lake in the Philippines. It ensures regulation of pollution emissions of industries within the vicinity of the lake as well as crop and livestock agriculture including hog and poultry production. Other mandates of LLDA include issuance, renewal, denial, revocation, modification or suspension of permits for companies for the purpose of preventing or abating pollution. LLDA representatives can enter any property of the public dominion and private property devoted to industrial, manufacturing, processing or commercial use to inspect and investigate conditions relating to pollution or possible or imminent pollution.

LLDA's Enforcement of its mandate using regulatory and market-based instruments

Since 1997, LLDA has applied Market-Based Instruments to regulate and impose sanctions on commercial scale livestock production in the country such as the environmental users' fee systems (EUFS) (Costales *et al.*, 2003) to reduce the biological oxygen demand (BOD) discharges into the lake by charging industrial and commercial enterprises a pollution fee. Firms pay 5 pesos (about 0.10 USD when 1 USD = Php 50) per kg of BOD loading if they are within the compliance level, and 30 pesos (0.60 USD) per kg beyond that level.

Rolfe (2002) said that the program started with major BOD-contributing industries such as food, pulp and paper, pig farms and slaughterhouses, textiles, and beverage manufacturers and was credited for reducing annual BOD inflows to the lake by almost 75% from 1993 to 2000. However, according to Costales *et al.* (2003) the incidence of paying license fees, taxes, pollution fees/permit is only 26% for medium-scale, 41% for large independent growers and 33% for large contract growers. Additionally, LLDA is implementing a “shame campaign” for companies violating environmental laws. Resources have to be spent by companies in order to comply with environmental regulations. For the meat companies, environmental mitigation includes all costs of disposing manure such as water treatment cost, transport of manure for disposal, taxes, licenses, permits and compliance certificates (Costales *et al.*, 2003). Usually, the higher the compliance cost, the less likely it is for the company to comply.

These companies spent considerable resources in order to comply with environmental regulations. Presumably, their costs included all environmental mitigation costs including disposing manure, transport cost of manure for disposal, water treatment cost, taxes, licenses, permits and compliance certificates.

Rock (1997) described that environmental agencies are weak in the Philippines and there is difficulty developing and implementing emission standards on industrial polluters due to historic emphasis on green environmental issues, high staff turn-over, insufficient budget and less pro-activity in anticipating or responding to environmental market pressures. Integrating the environment into economic and industrial policy and promotion of programs to reduce the pollution intensity and resource-use had been wanted. The lack of funds and enforcing mechanisms on the side of the government may not detect violations easily and when companies violate environmental laws, they do not face penalties immediately. Hence, food companies which violate laws may only face a chance of being penalized. This explains the typical behaviour of simply washing the waste in the nearby canals.

In an indicative study done by Rock (1997), his team found out that there were public and private sector actions that shape the behaviour of manufacturing firms. In the 10 countries in Asia they studied, including the Philippines, governments are building traditional command and control environmental agencies as well as operating with a range of market-based programs such as green labeling, voluntary environmental management standards like ISO 14000 and multinational corporation environmental practices like greening of the supply chain and incentive programs. Food companies directly impact the environment because pollution is the by-product of production which yields profit to companies (Manzanero, 2008). In the absence of any constraint or regulation on the manufacturer’s activities, the act of polluting becomes free (Bowers, 1997).

7. Conclusions

This report provides a foundation to open discussion in regard to the complex relationships of energy, environment, ethics and meat production. Intensive meat production is expanding in Asia, especially in low-income and middle-income economies while at the same time, the risks of intensification as a mode of production are becoming evident to the global community. High energy consumption and low efficiency of energy conversion during the production of meat will need to be addressed more clearly in future discussions about sustainable energy use. Ten key groups of serious negative externalities that are brought about as a result of intensive meat production were presented in this report. The effects of intensive meat production on global climate change and heightened risks for zoonotic disease transmission were identified as two of the most serious.

Each society shall have to decide how much more they are prepared to pay for their meat so as to include the true costs of the production processes in the retail price. These production costs shall include appropriate environmental controls during production, workers treated to appropriate working conditions, decreases in subsidization in supply chains and appropriate treatment of animals for example.

As previously discussed, advocacy of a contraction and convergence strategy to reduce consumption of livestock products whereby contraction of consumption in high-income countries per head would define the lower ceiling to which low- and middle-income countries could converge has been proposed (McMichael et al., 2007). Removal of subsidies for animal feeds such as corn and soy would work towards incorporating the true cost of meat production in the retail price and would serve to control consumption through a more free market mechanism. For countries with limited capital for balancing food production and investment in strategies to procure and use energy, intensive meat production may be a relatively energy-inefficient approach that will result in costly externalities and a reliance on volatile and non-transparent fossil fuel markets. Careful case-by-case consideration shall be required.

Examination of the negative externalities of intensive animal production reveals that there are many ethical issues of environment, energy use, and animal treatment that necessitate discussion including a detailed discussion on how to move forward. Such discussions will be further incorporated into this report, and subsequent deliberations of EETAP WG13.

8. Acknowledgements

This report was supported by UNESCO Bangkok, in the EETAP project. Some members of the Working Group 13 (WG13) of EETAP project provided comments, and we acknowledge the contributions and comments of Mr. Amarbayasgalan Dorjderem, Ms. Lindsey McGraw and Dr. Daniel Nesy. The WG chair, Dr. Robert Kanaly, and the EETAP coordinator, Dr. Darryl Macer, request more comments, and contributions to enhance this draft report. Contributions will be acknowledged, and substantive contributions of approved text is a criteria of co-authorship.

9. References

1. Agfeed Industries Inc. 2007. *AgFeed Industries announces acquisition of the largest breeder hog farm in China's Jiangxi province, AgFeed executes strategic plan and enters into hog farm business.* www.agfeedinc.com/html/news20071107.asp (Accessed 21 November 2007)
2. Ai, Q., K. Mai, B. Tan, W. Xu, Q. Duan, H. Ma, and L. Zhang. 2006. Replacement of fish meal by meat and bone meal in diets for large yellow croaker, *Pseudosciaena crocea*. *Aquaculture*, Vol. 260, pp. 255-263.
3. Akhtar, A. Z., M. Greger, H. Ferdowsian, and E. Frank. 2009. Health professionals' roles in animal agriculture, climate change, and human health. *American Journal of Preventative Medicine*, Vol. 36, pp. 182-187.
4. Alam, M. J., and L. Zurek. 2004. Association of *Escherichia coli* O157:H7 with houseflies on a cattle farm. *Applied and Environmental Microbiology,* Vol. 70, pp. 7578-7580.
5. Anderson, M. E., and M. D. Sobsey. 2006. Detection and occurrence of antimicrobially resistant *E. coli* in groundwater on or near swine farms in eastern North Carolina. *Water Science and Technology,* Vol. 54, pp. 211-218.
6. Andriof, J., S. Waddock, B. Husted and Rahman, S. 2002. Unfolding stakeholder thinking: theory, responsibility and engagement. Greenleaf Publishing-Sheffield, U.S.A.
7. APHA. 2003. *Precautionary moratorium on new concentrated animal feed operations*. Policy date: 2003.11.18, Policy number: 20037.
8. Armand-Leferve, L., R. Ruimy, and A. Andremont. 2005. Clonal comparison of *Staphylococcus aureus* isolates from healthy pig farmers, human controls, and pigs. *Emerging Infectious Diseases*, Vol. 11, pp. 711-714.
9. Atkinson, D., and C. A. Watson. 1996. The environmental impact of intensive systems of animal production in the lowlands. *Animal Science*, Vol. 63, pp. 353-361.
10. Bhardwaj, M., Maekawa, F., Niimura, Y., & Macer, D. 2003. Ethics in food and agriculture: views from FAO. *International Journal of Food Science & Technology*, Vol. 38, pp. 565-577.
11. Batt, A. L., D. D. Snow, and D. S. Aga. 2006. Occurrence of sulfonamide antimicrobials in private water wells in Washington County, Idaho, USA. *Chemosphere*, Vol. 64, pp. 1963-1971.
12. Blanco, G., J. A. Lemus, J. Grande, L. Gangoso, J. M. Grande, J. A. Donazar, B. Arroyo, O. Frias and F. Hiraldo. 2007. Geographical variation in cloacal microflora and bacterial antibiotic resistance in a threatened avian scavenger in

relation to diet and livestock farming practices. *Environmental Microbiology*, Vol. 9, pp. 1738-1749.

13. Bouwman, A. F., K. W. Van der Hoek, B. Eickhout, and I. Soenario. 2005. Exploring changes in world ruminant production systems. *Agricultural Systems*, Vol. 84, pp. 121-153.
14. Briones, N. Environmental sustainability issues in Philippine agriculture. *Asian Journal of Agriculture and Development*. Vol. 2, pp. 67-78.
15. Broadway, M. J., and D. D. Stull. 2006. Meat processing and Garden City, KS: Boom and bust. *Journal of Rural Studies*, Vol. 22, pp. 55-66.
16. Burkholder, J., B. Libra, P. Weyer, S. Heathcote, D. Kolpin, P. S. Thorne, and M. Wichman. 2007. Impacts of waste from concentrated animal feeding operations on water quality. *Environmental Health Perspectives*, Vol. 115, pp. 308-312.
17. Buttel, F. H. 2003. Internalizing the societal costs of agricultural production. *Plant Physiology*, Vol. 133, pp. 1656-1665.
18. Catelo, M.A. 2006. Understanding the links between agriculture and health for food, agriculture and the environment. http://www.ifpri.org/2020/focus/focus13/focus13_09.pdf (accessed 3 May 2009).
19. Catelo, S. 2006. The region's changing retail food sector: the case of the Philippines. *PECC*. http://www.pecc.org/food/papers/2005-2006/Philippines/ppecc-catelo-paper.pdf (accessed 21 October 2008).
20. Centers for Disease Control and Prevention (CDC). 2009. http://www.cdc.gov/h1n1flu/ (accessed 12 May 2009).
21. Centner, T. 2006. Governmental oversight of discharges from concentrated animal feeding operations. *Environmental Management*, Vol. 37, pp. 745-752.
22. Centner, T. J., and T. A. Feitshans. 2006. Regulating manure application discharges from concentrated animal feeding operations. *Environmental Pollution*, Vol. 141, pp. 571-573.
23. Chang, H. 2004. Cross-sector comparisons of poultry production in the Philippines. Working Paper Series in Agricultural and Resource Economics. University of New England. http://www.une.edu.au/febl/EconStud/wps.htm (accessed 26 November 2008).
24. Chang, H. 2005. Overview of the world broiler industry: implications for the Philippines. Working Paper Series in Agricultural and Resource Economics. University of New England. http://www.une.edu.au/febl/EconStud/wps.htm (accessed 26 November 2008).
25. Chapin, A., A. Rule, K. Gibson, T. Buckley, and K. Schwab. 2005. Airborne multidrug-resistant bacteria slated from a concentrated swine feeding operation.

Environmental and Health Perspectives, Vol. 113, pp. 137-142.

26. Chiu, C.-H., T.-L. Wu, L.-H. Su, C. Chu, J.-H. Chia, A.-J. Kuo, M.-S. Chien, and T.-Y. Lin. 2002. The emergence in Taiwan of fluoroquinolone resistance in *Salmonella enterica* serotype choleraesuis. *New England Journal of Medicine*, Vol. 346, pp. 413-419.
27. Chee-Sanford, J. C., R. I. Aminov, I. J. Krapac, N. Garrigues-Jeanjean, and R. I. Mackie. 2001. Occurrence and diversity of tetracycline resistance genes in lagoons and groundwater underlying two swine production facilities. *Applied and Environmental Microbiology*, Vol. 67, pp. 1494-1502.
28. Chelossi, E., L. Vezzulli, A. Milano, M. Branzoni, M. Fabiano, G. Riccardi and I. M. Banat. 2003. Antibiotic resistance of benthic bacteria in fish-farm and control sediments of the Western Mediterranean. *Aquaculture*, Vol. 219, pp. 83-97.
29. Cheremisinoff, N.P. and A. Bemdavid-Val. 2001. Green profits: the manager’s handbook for ISO 14001 and pollution prevention. Butterworth-Heinemann, Boston
30. Cohen, J. 2009. Interview with CDC chief of molecular virology and vaccines, Ruben Donis, April 29, 2009. http://blogs.sciencemag.org/scienceinsider-/2009/04/exclusive-cdc-h.html (acessed 11 May 2009).
31. Cole, D., L. Todd, and S. Wing. 2000. Concentrated swine feeding operations and public health: a review of occupational and community health effects. *Environmental Health Perspectives*, Vol. 108, pp. 685-699.
32. Constance, D. H. 2002. Globalization, broiler production, and community controversy in east Texas. *Southern Rural Sociology*, Vol. 18, pp. 31-55.
33. Cory, J. 2004. *Business ethics: the ethical revolution of minority shareholders.* Springer, U.S.A.
34. Cororaton, C., Corong, E. and J. Cockburn. 2008. *Global trade reforms, poverty and inequality in the Philippines.* Paper presented during the 11GTAP Annual Conference: “Future of Global Economy” Helsinki, Finland. 12 to 14 June 2008.
35. Costales, A., Delgado, C., Catelo, M., Tiongco, M., Chattterjee, A. and A. delos Reyes. 2003*. Livestock industrialization project: phase I-policy, technical and environmental determinants and implications of the scaling-up of broiler and swine production in the Philippines.* Part of phase II of IFPRI-FAO project.
36. DA & NAFC (Department of Agriculture and National Agricultural and Fishery Council). 2002a. Broiler industry master plan. Quezon City, Philippines, June 2002.
37. DA & NAFC (Department of Agriculture and National Agricultural and Fishery Council). 2002b. Layer industry master plan. Quezon City, Philippines, June

2002.

38. DA-AMAS (Department of Agriculture-Agribusiness and Marketing Assistance Service) 2001. Broiler industry situation report (available at http://www.da.gov.ph/agribiz/broiler.html (accessed 26 November 2008).

39. Delgado, C. L. 2003. Rising consumption of meat and milk in developing countries has created a new food revolution. *The Journal of Nutrition*, Supplement, pp. 3907S-3910S.

40. Dechet, A. M., E. Scallan, K. Gensheimer, R. Hoekstra, J. Gunderman-King, J. Lockett, D. Wrigley, W. Chege, J. Sobel, and the Multistate Working Group. 2006. Outbreak of multidrug-resistant *Salmonella enterica* serotype Typhimurium Definitive Type 104 infection linked to commercial ground beef, northeastern United States, 2003-2004. *Clinical Infectious Diseases*, Vol. 42, pp. 747–52.

41. Donham, K. J., S. Wing, D. Osterberg, J. L. Flora, C. Hodne, K. M. Thu, and P. S. Thorne. 2007. Community health, and socioeconomic issues surrounding concentrated animal feeding operations. *Environmental and Health Perspectives*, Vol. 115, pp. 317-320.

42. Doyle, M., L.-A. Jaykus, and M. Metz. 2005. Research opportunities in food and agriculture microbiology: a report from the American Academy of Microbiology. American Society for Microbiology.

43. Durhan, E. J., C. S. Lambright, E. A. Makynen, J. Lazorchak, P. C. Hartig, V. S. Wilson, L. E. Gray, and G. T. Ankley. 2006. Identification of metabolites of trenbolone acetate in androgenic runoof from a beef feedlot. *Environmental and Health Perspectives*, Vol. 114, pp. 65-68.

44. Energy Information Administration. 2007. International Energy Outlook 2007. DOE/EIA-0484(2007).

45. Ervik, A., B. Thorsen, V. Eriksen, et al. 1994. Impact of administering antibacterial agents on wild fish and blue mussels *Mytilus edulis i*n the vicinity of fish farms. *Diseases of Aquatic Organisms*, Vol. 18, pp. 45–51.

46. Eshel, G., and P. Martin. 2006. Diet, energy, and global warming. *Earth Interactions*, Vol. 10, pp. 1-17.

47. Fainaru, S. 2009. *Mexicans blame industrial hog farms but health officials have found no link to recent flu outbreak.* Washington Post, May 10, 2009. http://www.washingtonpost.com/wpdyn/content/article/2009/05/09/AR2009050902531.html (accessed 12 May 2009).

48. FAO. 2001. *Ethical issues in food and agriculture. FAO Ethics Series 1,* edited by J. Bruinsma. Earthscan Publications, Ltd., London.

49. FAO. 2003. *World agriculture: towards 2015/2030, an FAO perspective,* edited

by J. Bruinsma. Earthscan Publications, Ltd., London.

50. Fey, P. D., T. J. Safranek, M. E. Rupp, E. F. Dunne, E. Ribot., P. C. Iwen, P. A. Bradford, and F. J. Angulo. 2000. Ceftriaxone-resistant Salmonella infection acquired by a child from cattle. *New England Journal of Medicine,* Vol. 42, pp. 1242–1249.
51. Fiala, N. 2009. How meat contributes to global warming. *Scientific American*, Vol. 300, pp. 72-75.
52. Fiala, N. 2008. Meeting the demand: an estimation of potential future greenhouse gas emissions from meat production. *Ecological Economics,* Vol. 67, pp. 412-419.
53. Fine, D. D., G. P. Breidenbach, T. L. Price, and S. R. Hutchins. 2003. Quantification of estrogens in ground water and swine lagoon samples using solid-phase extraction, pentafluorobenzyl/trimethylsilyl derivatizaFtions gas chromatography-negative ion chemical ionization tandem mass spectrometry. *Journal of Chromatography A*, Vol. 1017, pp. 167-185.
54. Flessa, H., R. Ruser, P. Dorsch, T. Kamp, M. A. Jimenez, J. C. Munch, and F. Beese. 2002. Integrated evaluation of greenhouse gas emissions (CO_2, CH_4, N_2O) from two farming systems in southern Germany. *Agriculture Ecosystems and Environment*, Vol. 91, pp. 175-189.
55. Furushita, M., T. Shiba, T. Maeda, M. Yahata, A. Kaneoka, Y. Takahashi, K. Torii, T. Hasegawa, and M. Ohta. 2003. Similarity of tetracycline resistance genes isolated from fish farm bacteria to those from clinical isolates. *Applied and Environmental Microbiology*, Vol. 69, pp. 5336-5342.
56. Galloway, J. N., M. Burke, G. E. Bradford, R. Naylor, W. Falcon, A. K. Chapagain, J. C. Gaskell, E. McCullough, H. A. Mooney, K. L. L. Oleson, H. Steinfeld, T. Wassenaar, and V. Smith. 2007. International trade in meat: the tip of the pork chop. *Ambio.*, Vol. 36, pp. 622-629.
57. Garcia-Migura, L., E. Pleydell, S. Barnes, R. H. Davies, and E. Liebana. 2005. Characterization of vancomycin-resistant *Enterococcus faecium* from broiler poultry and pig farms in England and Wales. *Clinical Microbiology,* Vol. 43, pp. 3283-3289.
58. Gambarotto, K., M.-C. Ploy, F. Dupron, M. Giangiobbe, and F. Denis. 2001. Occurrence of vancomycin-resistant Enterococci in pork and poultry products from a cattle-rearing area in France. *Journal of Clinical Microbiology,* Vol. 39, pp. 2354-2355.
59. Gandini, G. C., and E. Villa. 2003. Analysis of the cultural value of local livestock breeds: a methodology. *Journal of Animal Breeding and Genetics*, Vol. 120, pp. 1-11.

60. Gast, R. K., P. S. Holt, and T. Murase. 2005. Penetration of *Salmonella enteritidis* and *Salmonella heidelberg* into egg yolks in an in vitro contamination model. *Poultry Science,* Vol. 84, pp. 621-625.
61. Gibbs, S. G., C. F. Green, P. M. Tarwater, L. C. Mota, K. D. Mena, and P. V. Scarpino. 2006. Antibiotic-resistant bacteria from the air plume downwind of a swine confined or concentrated animal feeding operation. *Environmental Health Perspectives,* Vol. 114, pp. 1032-1037.
62. Gilchrist, M. J., C. Greko, D. B. Wallings, G. W. Beran, D. G. Riley, and P. S. Thorne. 2007. The potential role of concentrated animal feeding operations in infectious disease epidemics and antibiotic resistance. *Environmental and Health Perspectives,* Vol. 115, pp. 313-316.
63. Gillespie, J. M., and J. R. Fulton. 2001. A marko chain analysis of the size of hog production firms in the United States, *Agribusiness,* Vol. 17, pp. 557-570.
64. Gossard, M. H., and R. York. 2003. Social structural influences on meat consumption. *Research in Human Ecology*, Vol. 10, pp. 1-9.
65. Greger, M. 2006. *Bird flu, a virus of our own hatching*. Lantern Books, NY.
66. Greger, M. 2007a. The human/animal interface: emergence and resurgence of zoonotic infectious diseases. *Critical Reviews in Microbiology,* Vol. 33, pp. 243-299.
67. Greger, M. 2007b. The long haul: risks associated with livestock transport. *Biosecurity and Bioterrorism: Biodefense Strategy, Practice, and Science*, Vol. 5, pp. 301-311.
68. Gura, S. 2008. Industrial livestock production and its impact on smallholders in developing countries. Report to the League for Pastoral Peoples and Endogenous Livestock Development. www.pastoralpeoples.org. accessed 4 May 2009.
69. Gura, S. 2008. Concentration in the livestock genetics industry. Presentation at NCCR Trade Regulation IP-9 Workshop “Animal Breeding, Innovation, Trade and Proprietary Rights.” World Trade Institute, Berne, 27-28 November 2008.
70. Graetz, A. C. Wilkie, N. J. Szabo, and C. S. Diaz. 2006. Determination of steroidal estrogens in flushed dairy manure wastewater by gas chromatography-mass spectrometry. *Journal of Environmental Quality*, Vol. 35, pp. 695-700.
71. Heederik, D., T. Sigsgaard, P. S. Thorne, J. N. Kline, R. Avery, J. H. Bønløkke, E. A. Chrischilles, J. A. Dosman, C. Duchaine, S. R. Kirkhorn, K. Kulhankova, and J. A. Merchant. 2007. Health effects of airborne exposures from concentrated animal feeding operations. *Environmental Health Perspectives*, Vol. 115, pp. 298-302.
72. Heffernan, W. 1999. *Report to the National Farmers Union, consolidation in the*

food and agriculture system. National Farmers Union.

73. Hendrickson, M., and W. Heffernan. 2007. *Concentration of the agricultural markets, April 2007*. National Farmers Union.
74. Heuer, H., C. Kopmann, C. T. T. Binh, E. M. Top, and K. Smalla. 2009. Spreading antibiotic resistance through spread manure: characteristics of a novel plasmid type with low %G+C content. *Environmental Microbiology*, Vol. 11, pp. 937-949.
75. Hofacre, C. L., D. G. White, J. J. Maurer, C. Morales, C. Lobsinger, and C. Hudson. 2001. Characterization of antibiotic-resistant bacteria in rendered animal products. *Avian Diseases*, Vol. 45, pp. 953–961.
76. Honeyman, M. S. 1996. Sustainability issues of U.S. swine production. *Journal of Animal Science*, Vol. 74, pp. 1410-1417.
77. Hong, J., J. M. Kim, W. K. Jung, S. H. Kim, W. Bae, H. C. Koo, J. Gil, M. Kim, J. Ser, and Y. H. Park. 2007. Prevalence and antibiotic resistance of *Campylobacter* spp. isolated from chicken meat, pork, and beef in Korea, from 2001 to 2006. *Journal of Food Protection*, Vol. 70, pp. 860-866.
78. Hooda, P. S., A. C. Edwards, H. A. Anderson, and A. Miller. A review of water quality concerns in livestock farming areas. *The Science of the Total Environment*, Vol. 250, pp. 143-167.
79. Horrigan, L., R. S. Lawrence, and P. Walker. 2002. How sustainable agriculture can address the environmental and human health harms of industrial agriculture. *Environmental Health Perspectives*, Vol. 110, pp. 445-456.
80. Huijsdens, X. W., B. J. van Dijke, E. Spalburg, M. G. van Santen-Verheuvel, M. E. O. C. Heck, G. N.. Pluister, A. Voss, W. J. B. Wannet, and A. J. de Neeling. 2006. Community-acquired MRSA and pig farming. *Annals of Clinical Microbiology and Antimicrobials*, Vol. 5, pp. 26-29.
81. Hutchins, S. R., M. V. White, F. M. Hudson, and D. D. Fine. 2007. Analysis of lagoon samples from different concentrated animal feeding operations for estrogens and estrogen conjugates. *Environmental Science and Technology*, Vol. 41, pp. 738-744.
82. HSU.S. 2007. *An HSU.S. report: Human health implications of intensive poultry production and avian influenza*. The Humane Society of the United States.
83. Ike, Y., K. Tanimoto, Y. Ozawa, T. Nomura, S. Fujimoto, and H. Tomita. 1999. Vancomycin-resistant enterococci in imported chickens in Japan. *Lancet*, Vol. 353, p. 1854.
84. International Finance Corporation. 2006. IFC World Bank Group.---
85. Jorgensen, S. and J, Kay. 2000. *Thermodynamics and ecological modelling*. Lewis Publishing, U.S.A.

86. Juhász-Kaszanyitzky, É., S. Jánosi, P. Somogyi, Á. Dán, L. van der Graaf-van Bloois, E. van Duijkeren, and J. A. Wagenaar. 2007. MRSA transmission between cows and humans. *Emerging Infectious Diseases*, Vol. 13, pp. 630-632.

87. Kates, R. W., and T. M. Parris. 2003. Long-term trends and a sustainability transition. *Proceedings of the National Academy of Sciences*. Vol. 100, pp. 8062-8067.

88. Kennedy, E. T. 2005. The global face of nutrition: what can governments and industry do? *Journal of Nutrition*, Vol. 135, pp. 913-915.

89. Keyzer, M. A., M. D. Merbis, I. F. P. W. Pavel, and C. F. A. van Wesenbeeck. 2005. Diet shifts towards meat and the effects on cereal use: can we feed the animals in 2030? *Ecological Economics*, Vol. 55, pp. 187-202.

90. Khan, S. J., D. J. Roser, C. M. Davies, G. M. Peters, R. M. Stuetz, R. Tucker, and N. J. Ashbolt. 2007. Chemical contaminants in feedlot wastes: concentrations, effects and attenuation. *Environment International*, Vol. 34, pp. 839-859.

91. Khanna, T., R. Friendship, C. Dewey, and J. S. Weese. 2008. Methicillin resistant *Staphylococcus aureus* colonization in pigs and pig farmers. *Veterinary Microbiology*, Vol. 128, pp. 298-303.

92. Kitai, S., A. Shimizu, J. Kawano, E. Sato, C. Nakano, H. Kitagawa, K. Fujio, H. Matsumura, R. Yasuda, and T. Inamoto. 2005a. Prevalence and characterization of *Staphylococcus aureus* enterotoxigenic *Staphylococcus aureus* in retail raw chicken meat throughout Japan. *Journal of Veterinary Medical Science*, Vol. 67, pp. 107-110.

93. Kitai, S., A. Shimizu, J. Kawano, E. Sato, C. Nakano, T. Uji, and H. Kitagawa. 2005b. Characterization of methicillin-resistant *Staphylococcus aureus* isolated from raw chicken meat in Japan. *Journal of Veterinary Medical Science*, Vol. 67, pp. 269-274.

94. Klevens, R. M., M. A. Morrison, J. Nadle, S. Petit, K. Gershman, S. Ray, L. H. Harrison, R. Lynfield, G. Dumyati, J. M. Townes, A. S. Craig, E. R. Zell, G. E. Fosheim, L. K. McDougal, R. B. Carey, and S. K. Fridkin. 2007. Invasive methicilin-resistant Staphylococcus aureus infections in the United States. *Journal of the American Medical Association*, Vol. 298, pp. 1763-1771.

95. Kobayashi, M., T. Sasaki, N. Saito, K. Tamura, K. Suzuki, H. Watanabe, and N. Agui. 1999. Houseflies: not simple mechanical vectors of enterohemorrhagic *Escherichia coli* O157:H7. *American Journal of Tropical Medicine and Hygiene*, Vol. 61, pp. 625–629.

96. Korthals.2001. Ethical dilemmas in sustainable agriculture. *International Journal of Food Science and Technology*, Vol. 36, pp. 813-820.

97. Krapac, I. G., W. S. Dey, W. R. Roy, C. A. Smyth, E. Storment, S. L. Sargent, and J. D. Steele. 2002. Impacts of swine manure pits on groundwater quality. *Environmental Pollution*, Vol. 120, pp. 475-492.

98. Krupnick, A., Morgenstern, R., Fischer, C., Rolfe, K., Logarta, J. and Rufo, B. 2003. *Air pollution control policy options for Metro Manila*. Resources for the Future, Washington.

99. Knowlton, K. F., and T. D. Cobb. 2006. Implementing waste solutions for dairy and livestock farms. *Journal of Dairy Science*, Vol. 89, 1372-1383.

100. Koneswaran, G., and D. Nierenberg. 2008. Global farm animal production and global warming: impacting and mitigating climate change. *Environmental Health Perspectives*, Vol. 116, pp. 578-582.

101. Koplow, D., and J. Dernbach. 2001. Federal fossil fuel subsidies and greenhouse gas emissions: a case study of increasing transparency for fiscal policy. *Annual Review of Energy and the Environment*, Vol. 26, pp. 361-389.

102. Kuhre, W.L. 1995. ISO 14001 certification, environmental management systems: a practical guide for preparing effective environmental management systems. Prentice Hall, U.S.A

103. Kuhre, W.L. 1998. ISO 14031- environmental performance evaluation (EPE) : practical tools and techniques for conducting an environmental performance evaluation, Prentice Hall, U.S.A.

104. Lange, I. G., A. Daxenberger, B. Schiffer, H. Witters, D. Ibarreta, and H. H. D. Meyer. 2002. Sex hormones originating from different livestock production systems: fate and potential disrupting activity in the environment. *Analytica Chimica Acta*, Vol. 473, pp. 27-37.

105. Lasky, T., W. Sun, A. Kadry, and M. K. Hoffman. 2004. Mean total arsenic concentrations in chicken 1989-2000 and estimated exposures for consumers of chicken. *Environmental Health Perspectives*, Vol. 112, pp. 18-21.

106. Lau, M., Beverly, M., Kelley, S. and R. Hanagriff. 2007. The economic and social values consumers place on all natural/healthy beef products and how his value added commodity effects demand: a literature review. *The Business Review*, Vol. 9, pp. 159-164.

107. Lee, J. H. 2003. Methicillin (oxacillin)-resistant *Staphylococcus aureus* strains isolated from major food animals and their potential transmission to humans. *Applied and Environmental Microbiology*, Vol. 69, pp. 6489-6494.

108. Leng, R. A. 2005. Implications of the decline in world oil reserves for future world livestock production, *Recent Advances in Animal Nutrition in Australia*, Vol. 15, pp. 95-105.

109. Levy, S. B., G. B. FitzGerald, and A. B. Macone. 1976. Changes in intestinal

flora of farm personnel after introduction of a tetracycline-supplemented feed on a farm. *New England Journal of Medicine*, Vol. 295, pp. 583-588.

110. Lewis, S. 1994. An opinion on the global impact of meat consumption. *The American Journal of Clinical Nutrition*, Vol. 59, p. 1009.
111. Li, D. 2003. Use of alternatives to AGP in animal food production in China. *Beyond antimicrobial growth promoters in food animal production, World Health Organization, Collaborating Centre for Antimicrobial Resistance in Foodborne Pathogens,* p. 141-145.
112. MacDonald, J. M., M. E. Ollinger, K. E. Nelson, and C. R. Handy. 2000. *Consolidation in U.S. Meatpacking*, Food and Rural Economics Division, Economic Research Service, U.S. Department of Agriculture. Agricultural Economic Report No. 785.
113. Macovei, L., and L. Zurek. 2006. Ecology of antibiotic resistance genes: characterization of enterococci from houseflies collected in food settings. *Applied and Environmental Microbiology,* Vol. 72, pp. 4028-4035.
114. Manzanero, Lea Ivy O. 2008. *Environmental education and environmental ethics of some Philippine food companies as stakeholders of the environment.* Paper presented in the Ninth Asian Bioethics Conference (ABC-9) with the theme: “Bioethics in Asia: Healthy and Productive Life in Harmony with Nature”, Yogyakarta, Indonesia, 3-7 November 2008.
115. Marcus, P.A. and J.T. Willig (eds.). 1997. Moving ahead with ISO 14000: improving environmental management and advancing sustainable development. John Wiley & Sons, Inc. New York.
116. McEwen, S. A., and P. J. Fedorka-Cray. 2002. Antimicrobial use and resistance in animals. *Clinical Infectious Diseases*, Vol. 34 (suppl 3), S93-106.
117. McLaughlin, N. B., A. Hiba, G. J. Wall, and D. J. King. 2000. Comparison of energy inputs for inorganic fertilizer and manure based corn production. *Canadian Agricultural Engineering*, Vol. 42, pp. 2.1-2.14.
118. McMichael, A. J., and H. J. Bambrick. 2005. Meat consumption trends and health: casting a wider risk assessment net. *Public Health Nutrition,* Vol. 8, pp. 341-343.
119. McMichael, A. J., J. W. Powles, C. D. Butler, and R. Uauy. 2007. Food, livestock production, energy, climate change, and health. *Lancet*, Vol. 370, pp. 1253-1263.
120. Mellon M., C. Benbrook, and K. L. Benbrook. 2001. Hogging it: estimates of antimicrobial abuse in livestock. Union of Concerned Scientists, Cambridge, MA.
121. Mirabelli, M. C., S. Wing, S. W. Marshall, and T. Wilcosky. 2006. Race, poverty,

and potential exposure of middle-school students to air emissions from confined swine feeding operations. *Environmental and Health Perspectives,* Vol. 114, pp. 591-596.

122. Miranda, C. D., and R. Zemeiman. 2002. Bacterial resistance to oxytetracycline in Chilean salmon farming. *Aquaculture,* Vol. 212, pp. 31-47.
123. Mølbak, K., D .L . Baggesen, F. M. Aarestrup, J. M. Ebbesen, J. Engberg, K. Frydendahl, P. Gerner-Smidt, A. M. Petersen, and H. C. Wegener. 1999. An outbreak of multidrug-resistant, quinolone-resistant S*almonella enterica* serotype typhinurium DT104. *New England Journal of Medicine,* Vol. 341, pp. 1420–1425.
124. Moog, F. and Marbell, J._____. *Land use transformation of Philippine grassland.* Research Division, Bureau of Animal Industry, Department of Agriculture, Philippines.
125. Moriya, K., T. Fujibayashi, T. Yoshihara, A. Matsuda, N. Sumi, N. Umezaki, H. Kurahashi, N. Agui, A. Wada, and H. Watanabe. 1999. Verotoxin-producing *Escherichia coli* O157:H7 carried by the housefly in Japan. *Medical and Veterinary Entomology,* Vol. 13, pp. 214-216.
126. Myers, N., and J. Kent. 2003. New consumers: the influence of affluence on the environment. *Proceedings of the National Academy of Sciences,* Vol. 100, pp. 4963-4968.
127. Nachman, K. E., J. P. Graham, L. B. Price, and E. K. Silbergeld. 2005. Arsenic: a roadblock to potential animal waste management solutions. *Environmental Health Perspectives*, Vol. 113, pp. 1123-1124.
128. Nataro, J. P., and J. B. Kaper. 1998. Diarrheagenic *Escherichia coli*. Clinical Microbiology Reviews, Vol. 11, pp. 142–201.
129. Neeteson, J. J. 2000. Nitrogen and phosphorous management on Dutch diary farms: legislation and strategies employed to meet the regulations. *Biology and Fertility of Soils*, Vol. 30, pp. 566-572.
130. Office of Technology Assessment of the U.S. (OTA). 1995. *Impacts of Antibiotic Resistant Bacteria*. Congress of the United States. OTA-H-629.
131. Oliver, R. 2004. What is transparency*?* McGraw-Hill-Education, Europe.
132. Orejas, T. and C. Reyes. 2008. Central Luzon Desk. http://www.bulacan.govph/nfe/components2.shtml (accessed 1 December 2008).
133. Orlando, E. F., A. S. Kolok, G. A. Binzcik, J. L. Gates, M. K. Horton, C. S. Lambright, L. E. Gray Jr., A. M. Soto, and L. J. Guillette Jr. 2004. Endocrine-disrupting effects of cattle feedlot effluent on an aquatic sentinel species, the fathead minnow. *Environmental Health Perspectives*, Vol. 112, pp. 353-358.
134. Onan, L. J., and LaPara, T. M. 2003. Tylosin-resistant bacteria cultivated from

agricultural soil. *FEMS Microbiology Letters*, Vol. 220, pp. 12-20.

135. Osterberg, D., and D. Walinga. 2004. Addressing externalities from swine production to reduce public health and environmental impacts. American Journal of Public Health, Vol. 94, pp. 1703-1708.
136. Ozawa, Y., K. Tanimoto, T. Nomura, M. Yoshinaga, Y. Arakawa, and Y. Ike. 2002. Vancomycin-resistant enterococci in humans and imported chicken in Japan. *Applied and Environmental Microbiology*, Vol. 68, pp. 6457-6461.
137. Palma, A. C. S. 2005. An update on the Philippine fast food industry. *Agriculture and Agri-Food Canada*. http://atn-riae.agr.ca/asean/e3395.htm (accessed 26 November 2008).
138. Parveen, S., J. Lukasik, T. M. Scott, M. L. Tamplin, K. M. Portier, S. Sheperd, K. Braun, and S. R. Farrah. 2005. Geographical variation in antibiotic resistance profiles of Escherichia coli isolated from swine, poultry, beef and dairy cattle farm water retention ponds in Florida. *Journal of Applied Microbiology*, Vol. 100, pp. 50-57.
139. Peak, N., C. W. Knapp, R. K. Yang, M. M. Hanfelt, M. S. Smth, D. S. Aga, and D. W. Graham. 2007. Abundance of six tetracycline resistance genes in wastewater lagoons at cattle feedlots with different antibiotic use strategies. *Environmental Microbiology*, Vol. 9, pp. 143-151.
140. Petersen, A., J. S. Anderson, T. Kaewmak, T. Somsiri, and A. Dalsgaard. 2002. Impact of integrated fish farming on antimicrobial resistance in a pond environment. *Applied and Environmental Microbiology*, Vol. 68, pp. 6036-6042.
141. Pimentel, D. 2003. Ethanol fuels: energy balance, economics, and environmental impacts are negative. *Natural Resources Research*, Vol. 12, pp. 127-134.
142. Pimentel, D. 2004. Ethical issues of global corporatization: agriculture and beyond. *Poultry Science*, Vol. 83, pp. 321-329.
143. Pimentel, D. and M. Pimentel. 2003. Sustainability of meat-based and plant-based diets and the environment. *American Journal of Clinical Nutrition*, Vol. 78, pp. 660S-663S.
144. Pimentel, D. and M. Pimentel. 2007. *Food, energy and society.* CRC Press, U.S.A.
145. Pollan, M. 2002. *Power Steer.* New York Times Magazine, March 31, 2002.
146. Pretty, J. N., A. S. Ball, T. Lang, and J. I. L. Morison. 2005. Farm costs and food miles: an assessment of the full cost of the UK weekly food basket. *Food Policy*, Vol. 30, pp. 1-19.
147. Pretty, J. N., C. Brett, D. Gee, R. E. Hine, C. F. Mason, J. I. L. Morison, H. Raven, M. D. Rayment, and G. van der Bijl. An assessment of the total external

costs of UK agriculture. *Agricultural Systems*, Vol. 65, pp. 113-136.

148. Pretty, J. N., C. F. Mason, D. B. Nedwell, R. E. Hine, S. Leaf, and R. Dils. 2003. Environmental costs of freshwater eutrophication in England and Wales. *Environmental Science and Technology*, Vol. 37, pp. 201-208.
149. Pretty, J. N., A. D. Noble, D. Bossio, J. Dixon, R. E. Hine, F. W. T. Penning de Vries, and J. I. L. Morison. 2005. Resource-conserving agriculture increases yields in developing countries. *Environmental Science and Technology*, Vol. 40, pp. 1114-1119.
150. Qiang, Z., J. J. Macauley, M. R. Mormile, R. Surampalli, and C. D. Adams. 2005. Treatment of antibiotics and antibiotic resistant bacteria in swine wastewater with free chlorine. *Journal of Agricultural Food Chemistry*, Vol. 54, pp. 8144-8154.
151. Raman, D. R., E. L. Williams, A. C. Layton, R. T. Burns, J. P. Easter, A. S. Daugherty, M. D. Mullen, and G. S. Sayler. 2004. Estrogen content of dairy and swine wastes. *Environmental Science and Technology*, Vol. 38, pp. 3567-3573.
152. Riethmuller, P. 2003. The social impact of livestock: a developing country perspective. *Animal Science Journal*, Vol. 74, pp. 245-253.
153. Rifkin, J. ____. Beyond beef: the rise and fall of cattle culture. *Tikkun*, Vol. 7, pp. 28-29.
154. Rock, M. 1997. *Industry and the environment in ten Asian countries: synthesis report of US-AEP country assessments*. USAID/ANE/US-AEP.
155. Roe, M. T., and S. D. Pillai. 2003. Monitoring and identifying antibiotic resistance mechanisms in bacteria. *Poultry Science*, Vol. 82, pp. 622-626.
156. Rola, A., Francisco, H. and J. Liguton. ____. Winning the water war: watersheds, water policies and water institutions. PIDS and PCARRD.
157. Rosegrant, M. W., N. Leach, and R. V. Gerpacio. 1999. Alternative futures for world cereal and meat consumption. *Proceedings of the Nutrition Society*, Vol. 58, pp. 219-234.
158. Russell, J. B., and J. L. Rychlick. 2001. Factors that alter rumen microbial ecology. *Science*, Vol. 292, pp. 1119-1122.
159. Saenz, R. A., H. W. Hethcote, and G. C. Gray. 2006. Confined animal feeding operations as amplifiers of influenza. *Vector-Borne and Zoonotic Diseases*, Vol. 6, pp. 338-346.
160. Sapkota, A. R., F. C. Curriero, K. E. Gibson, and K. J. Schwab. 2007. Antibiotic-resistant enterococci and ecal indicators in surface water and groundwater impacted by a concentrated swine feeding operation. *Environmental Health Perspectives*, Vol. 115, pp. 1040-1045.
161. Sapkota, A. R., L. Y. Lefferts, S. MacKenzie, and P. Walker. 2007. What do we

feed to food-production animals? A review of animal feed ingredients and their potential impacts on human health. *Environmental Health Perspectives*, Vol. 115, pp. 663-670.

162. Scherr, S. J., and S. Sthapit. 2009. Farming and land use to cool the planet. In State of the world 2009: Into a warming world. The Worldwatch Institute, pp. 30-49.
163. Schmidt, A. S., M. S. Bruun, I. Dalsgaard, K. Pedersen and J. L. Larsen. 2000. Occurrence of antimicrobial resistance in fish-pathogenic and environmental bacteria associated with four Danish rainbow trout farms. *Applied and Environmental Microbiology*, Vol. 66, pp. 4908-4915.
164. Schiffer, B., A. Daxenberger, K. Meyer, and H. H. D. Meyer. 2001. The fate of trenbenolone acetate and melengestrol acetate after application as growth promoters in cattle: environmental studies. *Environmental and Health Perspectives*, Vol. 109, pp. 1145-1151.
165. Schiffman, S. S., C. E. Studwell, L. R. Landerman, K. Berman, and J. S. Sundy. 2005. Symptomatic effects of exposure to diluted air sampled from a swine confinement atmosphere on healthy human subjects. *Environmental Health Perspectives*, Vol. 113, pp. 567-576.
166. Sergio, D. M. B., T. H. Koh, L.-Y. Hsu, B. E. Ogden, A. L. H. Goh, and P. K. H. Chow. 2007. Investigation of methicillin-resistant *Staphylococcus aureus* in pigs used for research. *Journal of Medical Microbiology*, Vol. 56, pp. 1107-1109.
167. Shea, K. M. 2003. Antibiotic resistance: what is the impact of agricultural uses of antibiotics on children's health? *Pediatrics*, Vol. 112, pp. 253-258.
168. Shi, T. and Phee, B. Y. 2008. China's hog market to benefit from greater foreign investment. Available: http://www.efeedlink.com/ShowDetail/b0403930-1e2f-4a02-a6dd-335294dd4e25.html (accessed 23 December 2008).
169. Sia, A.P., Hungerford, H.R. and Tomera, A.N. 1985/86. Selected predictors of responsible environmental behavior. *The Journal of Environmental Education*, Vol. 17, pp. 31-40.
170. Silbergeld, E. K., J. Graham, and L. B. Price. 2008. Industrial food animal production, antimicrobial resistance, and human health. *Annual Review of Public Health*, Vol. 29, pp. 151-169.
171. Smith, D. L., A. D. Harris, J. A. Johnson, E. K. Silbergeld, and J. G. Morris Jr. 2001. Animal antibiotic use has an early but important impact on the emergence of antibiotic resistance in human commensal bacteria. *Proceedings of the National Academy of Sciences,* Vol. 99, 6434-6439.
172. Smith, K. E., J. M. Besser, C. W. Hedberg, F. T. Leano, J. B. Bender, J. H. Wicklund, B. P. Johnson, K. A. Moore, and M. T. Osterholm. 1999 Quinolone-

resistant *Campylobacter jejuni* infections in Minnesota, 1992–1998. *New England Journal of Medicine*, Vol. 340, pp. 1525–1532.

173. Smith, T. C., M. J. Male, A. L. Harper, J. S. Kroeger, G. P. Tinkler, E. D. Moritz, A. W. Capuano, L. A. Herwaldt, and D. J. Diekema. 2009. Methicillin-resistant *Staphylococcus aureus* (MRSA) strain ST398 is present in midwestern U.S. swine and swine workers. *PloS ONE*, Vol. 4, pp. 1-6.
174. Smith, M. S., R. K. Yang, C. W. Knapp, Y. Niu, N. M. Peak, M. M. Hanfelt, J. C. Galland, and D. W. Graham. 2004. Quantification of tetracycline resistance genes in feedlot lagoons by real-time PCR. *Applied and Environmental Microbiology*, Vol. 70, pp. 7372-7377.
175. Soil Association. 2007. *MRSA in farm animals and meat, a new threat to human health.* Soil Association, UK.
176. Sørensen, T. L., M. Blom, D. L. Monnet, N. Frimodt-Møller, R. L. Poulsen, and F. Espersen. 2001. Transient intestinal carriage after ingestion of antibiotic-resistant Enterococcus faecium from chicken and pork. *New England Journal of Medicine,* Vol. 345, pp. 1161–1166.
177. Subak, S. 1999. Global environmental costs of beef production. *Ecological Economics*, Vol. 30, pp. 79-91.
178. Steinfeld, H. 2003. Economic constraints on production and consumption of animal source foods for nutrition in developing countries. *The Journal of Nutrition*, Supplement, pp. 4054S-4061S.
179. Steinfeld, H., P. Gerber, T. Wassenaar, V. Castel, M. Rosales, and C. de Hann. 2006. *Livestock's long shadow, environmental issues and options.* Food and Agriculture Organization of the United Nations.
180. Stern, P. C., T. Dietz, V. W. Ruttan, R. H. Socolow, and J. L. Sweeney. 1997. *Environmentally Significant Consumption: Research Directions*. National Academies Press, Washington D.C.
181. Strauss, S. and H. Bradshaw (eds.) 2003. *The bioengineered forest: challenges for science and society*. U.S.A.
182. Thorne, P. S. 2007. Environmental health impacts of concentrated animal feeding operations: anticipating hazards – searching for solutions. *Environmental Health Perspectives*, Vol. 115, pp. 296-297.
183. Tilman, D., K. G. Cassman, P. A. Matson, R. Naylor, and S. Polasky. 2002. Agricultural sustainability and intensive production practices. *Nature,* Vol. 418, pp. 671-677.
184. Tilman, D., J. Fargione, B. Wolff, C. D'Antonio, A. Dobson, R. Howarth, D. Schindler, W. H. Schlesinger, D. Simberloff, and D. Swackhammer. 2001. Forecasting agriculturally driven global environmental change. *Science*, Vol.

292, pp. 281-284.

185. Tradingmarkets.com. 2008. Goldman Sachs invests in China's pig farms. Available: http://www.tradingmarkets.com/.site/news/Stock News/1803736/ (accessed 23 December 2008).
186. Tudge, C. 2004. It's a meat market. *New Scientist*, Vol. 18, pp. 2438.
187. van Duijkeren, E., R. Ikawaty, M. J. Broekhuizen-Stins, M. D. Jansen, E. C. Spalburg, A. J. de Neeling, J. G. Allaart, A. van Nes, J. A. Wagenaar, and A. C. Fluit. 2008. Transmission of methicillin-resistant *Staphylococcus aureus* strains between different kinds of pig farms. *Veterinary Microbiology*, Vol. 126, pp. 383-389.
188. van Belkum, A., D. C. Melles, J. K. Peeters, W. B. van Leeuwen, E. van Duijkeren, X. W. Huijsdens, E. Spalburg, A. J. de Neeling, and H. A. Verbrugh. 2008. Methicillin-resistant and –susceptible *Staphylococcus aureus* sequence type 398 in pigs and humans. *Emerging Infectious Diseases*, Vol. 14, pp. 479-483.
189. Vandenesch, F., T. Naimi, M. C. Enright, G. Lina, G. R. Nimmo, H. Heffernan, N. Liassine, M. Bes, T. Greeland, M.-E. Reverdy, and J. Etienne. Community-acquired methicillin-resistant *Staphylococcus aureus* carrying Panton-Valentine leukocidin genes: worldwide emergence. *Emerging Infectious Diseases*, Vol. 8, pp. 978-984.
190. Voss, A., F. Loeffen, J. Bakker, C. Klaassen, and M. Wulf. 2005. Methicillin-resistant *Staphylococcus aureus* in pig farming. *Emerging Infectious Diseases*, Vol. 11, pp. 1965-1966.
191. UK Telegraph. 2008. Chinese farmers bring home bacon for banks. http://www.telegraph.co.uk/finance/economics/2795222/Chinese-farmers-bring-home-bacon-for-banks.html (accessed 23 December 2008).
192. Walker, P., P. Rhubart-Berg, S. McKenzie, K. Kelling and R. S. Lawrence. 2005. Public health implications of meat production and consumption. *Public Health Nutrition*, Vol. 8, pp. 348-356.
193. Wang, L. 2008. International capital taps into China's agricultural sector. Available: http://www.chinastakes.com/story.aspx?id=576 (accessed 23 December 2008).
194. Wang, X. 2005. Diffuse pollution from livestock production in China. *Chinese Journal of Geochemistry*, Vol. 24, pp. 189-193.
195. Wang, Y., J. Guo, D. P. Bureau, and Z. Cui. 2006. Replacement of fish meal by rendered animal protein ingredients in feeds for cuneate drum (*Nibea miichthioides*). *Aquaculture*, Vol. 252, pp. 476-483.
196. Weber, C. L., and H. S. Matthews. 2008. Food-miles and the relative climate

impacts of food choices in the U.S. *Environmental Science and Technology*, Vol. 42, pp. 3508-3513.

197. Westerman, P. W., and J. R. Bicudo. 2005. Management considerations for organic waste use in agriculture. *Bioresource Technology*, Vol. 96, pp. 215-221.
198. White, D. G., S. Zhao, R. Sudler, S. Ayers, S. Friedman, S. Chen, P. F. McDermott, S. McDermott, D. D. Wagner, and J. Meng. 2001. The isolation of antibiotic-resistant Salmonella from retail ground meats. *New England Journal of Medicine*, Vol. 345, pp. 1147-1154.
199. Willems, R. J. L., J. Top, N. van den Braak, A. van Belkum, H. Endtz, D. Mevius, E. Stobberingh, A. van den Bogaard, and Jan D. A. van Embden. 2000. Host specificity of vancomycin-resistant *Enterococcus faecium. The Journal of Infectious Diseases*, Vol.182, pp. 816-823.
200. Wilson, S. M., F. Howell, S. Wing, and M. Sobsey. 2002. Environmental injustice and the Mississippi hog industry. *Environmental Health Perspectives*, Vol. 110, pp. 195-201.
201. Wilkinson, P., K. R. Smith, M. Joffe, and A. Haines. 2007. A global perspective on energy: health effects and injustices. *Lancet*, Vol. 370, pp. 965-978.
202. Windhorst, H. 2006. Changes and trade worldwide in poultry production. *World's Poultry Science Association Journal*, Vol. 62, pp. 505-603.
203. Wing, S., S. Freedman, and L. Band. 2002. The potential impact of flooding on confined animal feeding operations in eastern North Carolina. *Environmental Health Perspectives*, Vol. 110, pp. 387-391.
204. Wing, S., R. A. Horton, S. W. Marshall, K. Thu, M. Tajik, L. Schinasi, and S. S. Schiffman. 2008. Air pollution and odor in communities near industrial swine operations. *Environmental Health Perspectives*, Vol. 116, pp. 1362-1368.
205. Witte, W. 2000. Selective pressure by antibiotic use in livestock. *International Journal of Antimicrobial Agents*, Vol. 16, pp. S19–S24.
206. World Bank. 2004. Implementation completion report (SCL-41610 TF-29388) on a loan of U.S.$120 Million to the Peoples Republic of China for a Heilongjiang agricultural development project. Report no: 30270.
207. World Agricultural Supply and Demand Estimates. November 10, 2008. USDA and WAOB.
208. World Bank. 2006. Implementation completion report (SCL-45300 TF-29720) on a loan in the amount of U.S. $93.5 Million to the Peoples Republic of China for a smallholder cattle development project. Report no: 35962.
209. World Bank. 2009. Global economic prospects: commodities at the crossroads 2009. DOI: 10.1596/978-0-8213-7799-4
210. World Energy Council. 2007. *Deciding the future: energy policy scenarios to*

2050.

211. Worrel, R and Appleby, N. 2000. Stewardship of natural resources: definition, ethical and practical aspects. *Journal of Agricultural and Environmental Ethics*, Vol. 12, pp. 263 – 277.

212. Worosz, M. R., A. J. Knight, C. K. Harris, and D. S. Conner. 2008. Barriers to entry into the specialty red meat sector: the role of food safety regulations. *Southern Rural Sociology*, Vol. 23, pp. 170-207.

213. Zhao, Z., Y. Fang, N. G. Love, and K. Knowlton. 2009. Biochemical and biological assays of endocrine disrupting compounds in various manure matrices. *Chemosphere*, Vol. 74, pp. 551-555.

Glossary

BAS: Bureau of Agricultural Statistics, Philippines
BOD: Biological Oxygen Demand
BSE: Bovine Spongioform Encephalopathy
CA-MRSA: Community-Acquired Methicillin-Resistant *Staphylococcus aureus*
CAFO: Concentrated Animal Feeding Operation
COD: Chemical Oxygen Demand
CR4: Concentration Ratio of the top four firms in a particular industry
CSR: Corporate Social Responsibility
DDT: Dichlorodiphenyltrichloroethane
DENR: Department of Environment and Natural Resources, Philippines
DOH: Department of Health, Philippines
EIS: Environmental Impact Statements
EMB: Environmental Management Board, Philippines
EMS: Environmental Management Series
EMAS: Eco-Management and Auditing Scheme
ENRAP: Knowledge Networking for Rural Development in Asia/Pacific Region
EUFS: Environmental Users' Fee Systems
FAO: Food and Agriculture Organization of the UN
FCR: Feed Conversion Ratio
FIES: Family Income and Expenditure Survey, Philippines
FOB: Freight On-Board
GHG: Greenhouse Gas
GLEWS: Global Early Warning System for Major Animal Diseases
GMO: Genetically Modified Organism
GMP: Good Manufacturing Practices
HACCP: Hazard Analysis and Critical Control Points
ISO: International Organization for Standardization
LLDA: Laguna Lake Development Authority, Philippines
MAV: Minimum Access Volume
MRSA: Methicillin-Resistant *Staphylococcus aureus*
NGO: Non-Governmental Organization
NSO: National Statistics Office, Philippines
OECD: Organisation for Economic Cooperation and Development
OIE: World Organization for Animal Health
PCB: polychlorinated biphenyls
PCE: Personal Consumption Expenditure

PRRS: Porcine Reproductive and Respiratory Syndrome

SPS: Sanitary and Phytosanitary (measures)

SS: Suspended Solids

SSOP: Standard Sanitation Operating Procedures

TBT: Technical Barriers to Trade

UNIDO: United Nations Industrial Development Organization

USDA: United States Department of Agriculture

US FDA: United States Food and Drug Administration

vCJD: Variant form of Creutzfeldt-Jakob Disease

WHO: World Health Organization

Coauthor addresses:

Robert A. Kanaly
Department of Genome Systems, Faculty of Bionanoscience
Yokohama City University, Yokohama, Japan
Email: kanaly@yokohama-cu.ac.jp

Darryl Macer
UNESCO Bangkok
Email: d.macer@unesco.org

Lea Ivy O. Manzanero
University of the Philippines Diliman, Quezon City and Asia Pacific Regional Resource Center for Human Rights Education, Quezon City, Phillipines
E-mail: lea_ivy.manzanero@up.edu.ph, arrc@arrc-hre.org, leaivy.manzanero@gmail.com

Sivanandam Panneerselvam,
Department of Philosophy, University of Madras, Chennai, India
E-mail: sps@md4.vsnl.net.in